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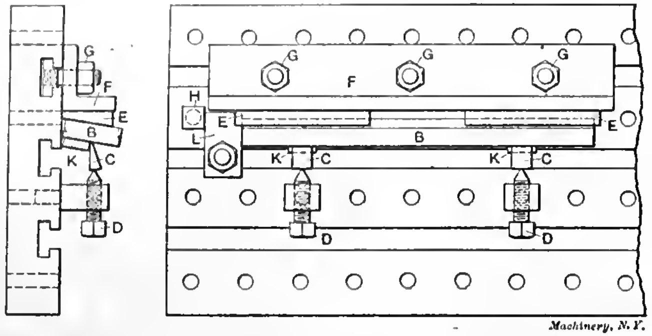
Index to Vol. XV.

Supplement to MACHINERY, September, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Planing and laying out a Blanking Die."

SHOP OPERATION SHEET NO. 73.

C. F. Emerson. MACHINERY, September, 1908.



To Plane the Beveled Sides of the Stock for Blanking Dies.

NOTE.—The stock for blanking dies is planed up in long strips, and subsequently cut off to correct lengths for different dies, in the hack-saw. It is assumed that, previous to the present operation, the stock has been planed on the top and bottom sides, a finishing cut being taken on the top side to make it very smooth.

1. Brush off all chips from planer table, clean out the T-slots, and fasten the knee bracket *F* on the planer table, by means of the bolts *G*.

2. Place the two 10-degree parallels *E* against the face of knee bracket *F*, resting the narrow sides of the parallels upon the bed of the planer.

3. Place the smooth side of the bar *B*, which is the work to be planed, against the parallels *E*, and hold it in place by the poppets *C* and screws *D*. Put the pieces *K* under poppets *C*, so as to bring the poppets about in the center of the stock, as shown.

4. Place a stop *L* at the end of the work *B*, to prevent it shifting forward when the tool is cutting. This stop consists of a small strap held at one end by a bolt and nut in the T-slot, and resting against the planer stop *H* at the other end. It is not shown in the end view, to avoid confusion.

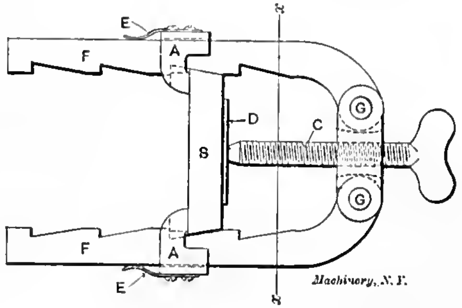
5. Take first a heavy cut, and then a light finishing cut over the top surface of *B*, with a diamond point tool.

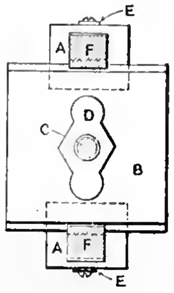
6. Loosen screws *D*, remove *B* and clean out all chips. Place the 10-degree side of the strip, just planed, on the bed of the planer, in such a manner that the smooth side again rests against parallels *E*. Tighten screws *D* as before, and repeat the planing operation on the side that is now the top side of *B*.

NOTE.—This operation can also be performed in the shaper. Place two 10-degree parallels in the shaper vise, one on each side of the work, and clamp the work between them. Then finish the top surface by taking a heavy and a light finishing cut. Turn the work around, and finish the other 10-degree surface in the same way, taking care that all chips are removed from the seating surfaces before again clamping the work in place.

SHOP OPERATION SHEET NO. 74.

C. F. Emerson. MACHINERY, September, 1908.





SECTION IN x-x

To Scribe the Outline of a Templet on a Die Blank, Using a Die-maker's Crab Clamp.

NOTE.—The die blank on which the outline of the templet or sample blank is to be scribed, has been planed on top and bottom, and the top face smoothly finished, previous to the present operation. The 10-degree beveled sides fitting into the dove-tail slide of the die-holder are also planed, as described in detail in Shop Operation Sheet No. 73.

1. Polish the face of the die blank, so that it is smooth enough to permit the scribing of the outline of the sample or templet, and heat it evenly all over, until a dark blue color is obtained. Then the blank is immersed in oil, after which it is permitted to cool slowly.

2. Place the die blank on the jaws *A* of the crab clamp, as shown in the engraving. Lay the sample or templet *D* on the face of the die blank *B*, and tighten the thumb-screw very slightly, permitting enough freedom so that the sample or templet *D* can be moved between the screw and the die blank, on the face of the latter, by tapping it lightly on the sides.

3. Adjust the templet *D* so that it is central with all four sides of die blank *B*, and in correct relation to them.

4. Tighten the thumb-screw *C* so that it holds the templet *D* securely in place.

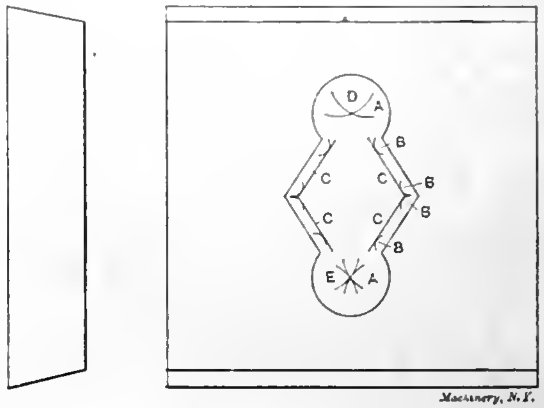
5. Scribe the outline of templet *D* on the face of die blank *B*, with a sharp scriber. Care should be taken to keep the point of the scriber close to the edges of the templet in order to insure that the dimensions and form of sample *D* are copied correctly on die blank *B*.

6. Release screw *C* from the sample *D*, remove the latter, and take the die blank out of the clamps. The die blank is now ready for working out the opening, to fit the templet *D*.

NOTE.—The design of the clamp shown in the engraving may not be familiar to all. The principal feature of this clamp is that there is no time wasted in screwing the clamp screw *C* up and down when pieces of different thicknesses are placed between the arms *F*, because the jaws *A* are made so that they can slide up and down on the arms *F*, which are provided with steps so that the jaws can rest at various places on them, as shown. The springs *E*, shown, act as frictions, and prevent the jaws from dropping when not resting on the steps. The arms *F* swing on pins *G*, thus making it possible to accommodate various widths of the die blanks.

SHOP OPERATION SHEET NO. 75.

C. F. Emerson. MACHINERY, September, 1908.



To Lay Out and Prick-punch the Drill Centers for Drilling Out the Core.

NOTE.—Previous to this operation the blank has been planed and the shape of the work laid out on its face.

1. If the diameter of holes *A* is known, the centers of these holes are found by scribing two circular arcs, with any point on the circumference as a center, as shown at *D*, having the same radii as the hole. The intersection of these two circular arcs is the center of the hole.

2. If the diameter of hole is not known, the dividers are set approximately to the radius and arcs scribed from centers located on the periphery, about 90 degrees apart. After having scribed four circular arcs, if these do not all tangent in one point, adjust the scriber according to judgment, and scribe again four arcs. When all the four arcs intersect or tangent in the same point as at *E*, this point is the center.

3. Spot and prick-punch, with a sharp prick-punch, where the scribed lines intersect.

4. To lay out the lines *C*, on which the centers of the holes drilled for removing the core are located, set the dividers to one-half the diameter of the drill to be used, then scribe circular arcs, as shown at *B*, with the centers located on the scribed outline of the die.

5. Lay a straight-edge so that it tangents these circular arcs, and scribe the lines *C*, as shown.

6. With an adjustable double prick-punch, spot the lines very lightly, adjusting the points of the double prick-punch so that the distance from one point to the other is a trifle less than the diameter of the drill to be used for removing the core, so that there will be no web between the holes when drilled.

7. With an ordinary prick-punch go over the prick-punched marks previously made, and make the spots a trifle deeper.

NOTE.—The dividers are often used to space the distance from center to center of the holes to be drilled, in place of a double prick-punch. This is not as convenient as the use of the adjustable prick-punch, although it cannot be called poor practice.

Supplement to MACHINE

Tables for the Article in this number entitled "I

I.—LOCK NUTS USED IN ENGINEERING PRACTICE.

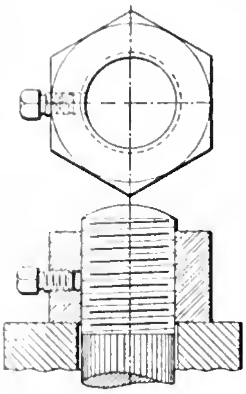


Fig. 1.

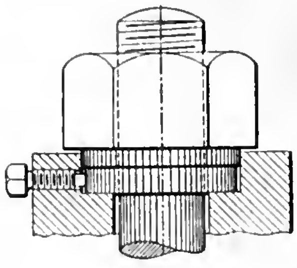


Fig. 2.

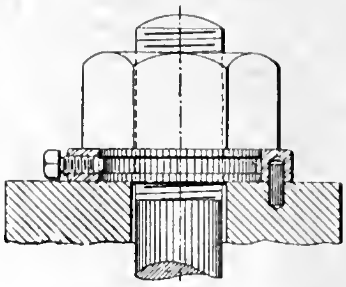


Fig. 3.

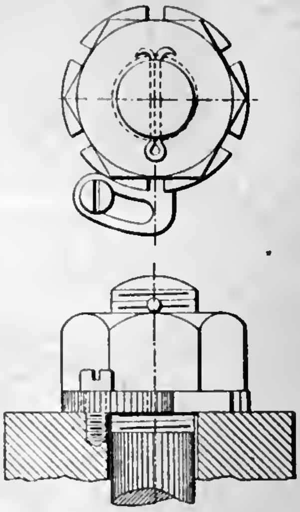


Fig. 4.

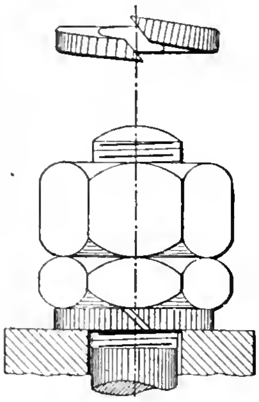


Fig. 5.

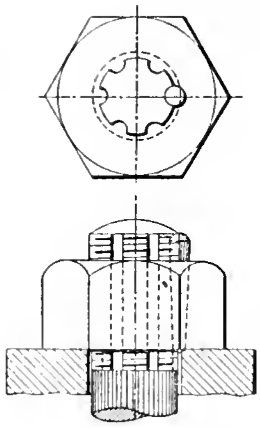


Fig. 6.

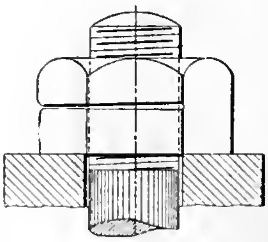


Fig. 7.

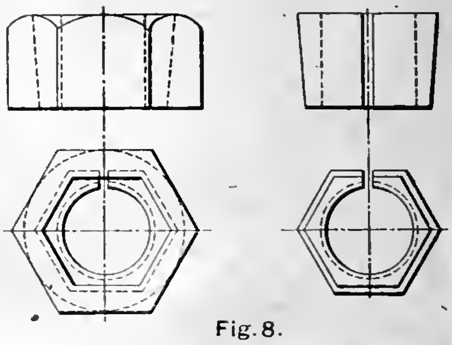


Fig. 8.

Compiled by R. B. Little.

II.—LOCK NUTS USED IN ENGINEERING PRACTICE.

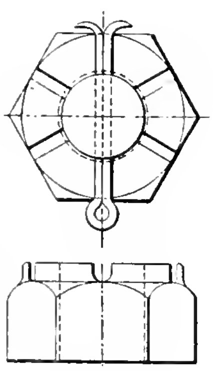


Fig. 9.

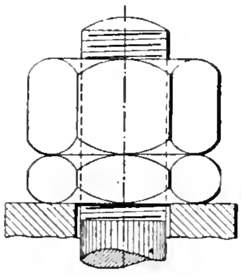


Fig. 10.

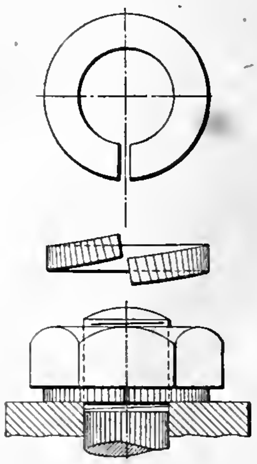


Fig. 11.

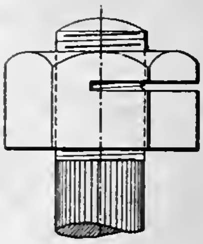


Fig. 14.

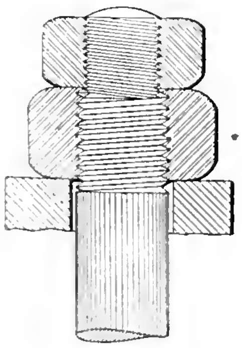


Fig. 13.

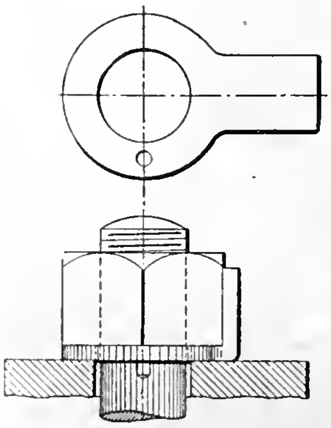


Fig. 12.

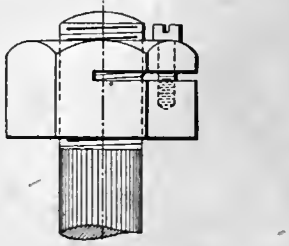


Fig. 15.

Compiled by R. B. Little.

III.—LOCK NUTS USED IN ENGINEERING PRACTICE.

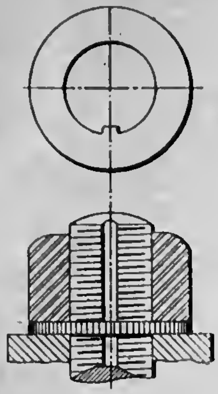


Fig.16.

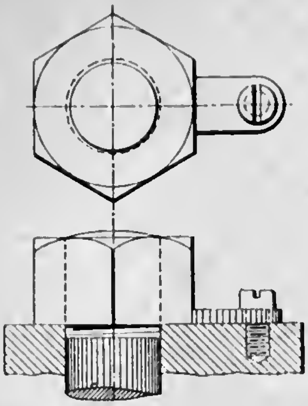


Fig.17.

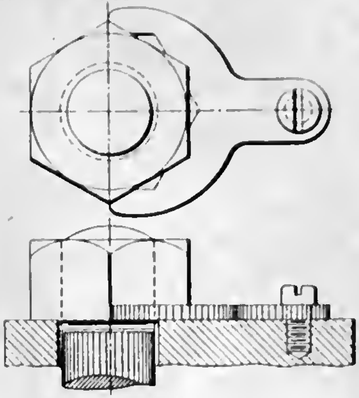
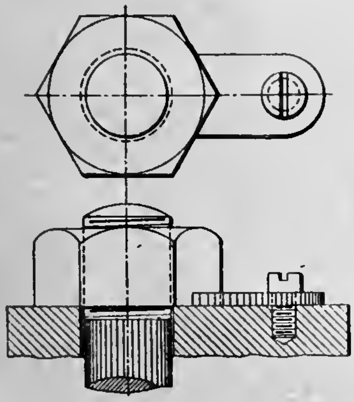


Fig.18.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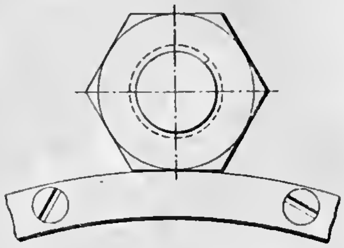
Fig.20.

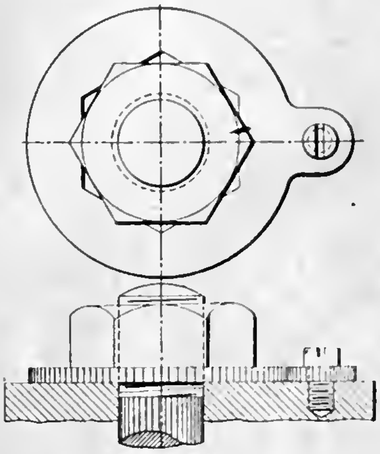
Fig.21.

Compiled by R. B. Little.

IV.—LOCK NUTS USED IN ENGINEERING PRACTICE.

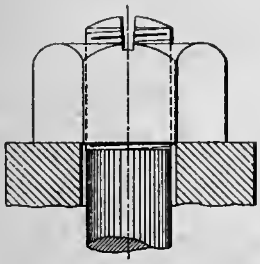
Fig.22.

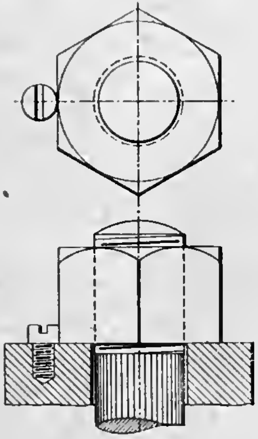
Fig.23.

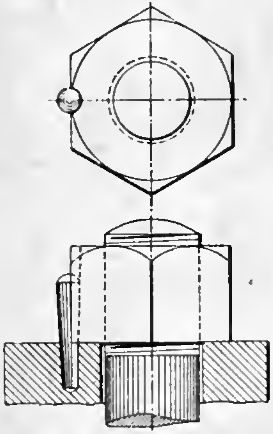
Fig.24.

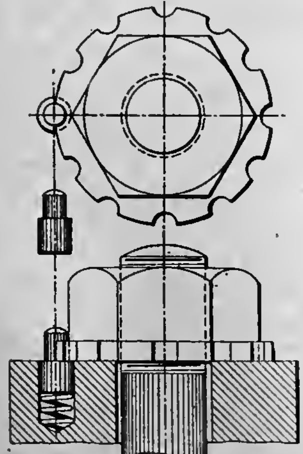
Fig.25.

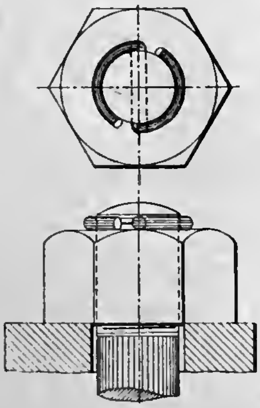
Fig.26.

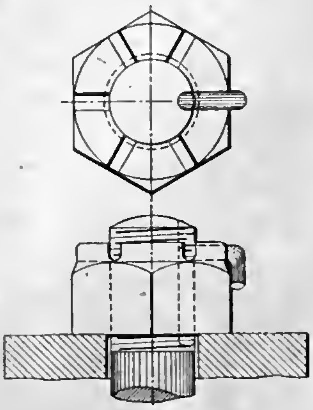
Fig.27.

Compiled by R. B. Little.

MACHINERY.

September, 1908.

DESIGN AND CONSTRUCTION OF METAL WORKING SHOPS[*]—1.

W. P. SARGENT.[†]

W. P. Sargent.[‡]

A PERIOD of general depression may not seem timely for projects involving the expenditure of large sums, but, obviously, thorough study and discussion of tentative plans can be the better made during dull times, as the efforts of all concerned are not directed towards the crowding of production.

The great advantages in having new shops ready, or, perhaps, one may better say, the disadvantages of insufficient space when a rush in business comes on, are well known. If the fact were better appreciated that a saving equal to thirty per cent of the amount expended may easily be made by building during a time of depression rather than during a period of inflation, many corporations would not, as may now be seen on every hand, have their new shops ready for occupancy at the *termination* rather than at the *beginning* of a prosperous period.

Irrespective, however, of the time when extensive improvements are to be made by a growing concern, the problems arising are involved and seemingly numberless. Few but they who have had to meet these problems can appreciate the paucity of general precedents that are available in the planning and carrying out of extensive improvements, especially under the severe condition that but slight interference with production is permissible.

Scope of Articles.

From the premise that the desired benefits from extensions must be secured at a reasonably low cost, as quickly as the need demands and conditions permit, and without restricting production, the author proposes to discuss in the following articles the subject of industrial plant extension as applied to metal working industries, from the time when extensions are tentatively considered to the time of occupancy. Data will be given enabling the plant engineer to proceed steadily and rapidly, and also giving his employers information by which his efforts may be intelligently checked. Presumably many of the propositions advanced will meet with a variance of ideas, but wherever positive positions are taken, the author will endeavor to give sufficient reasons therefor.

Main Periods of Construction.

The time necessary for the planning of an extensive series of improvements, and for the execution of these plans, may be divided into four main periods which will be styled, the inceptive, the formative, the progressive, and the conclusive period, respectively.

The Inceptive Period.—The inceptive period covers the time of compiling the necessary data and the study of the best examples of recently constructed plants. This study will reveal to the mind the comparative advantages of different arrangements and of various types of buildings. During this period one's mind will be forming various schemes, even though sub-consciously.

The Formative Period.—During this, the mental structures assume more and more tangible and definite forms as the tentative planning, revising, the definite planning, and the securing of prices are taken up.

The Progressive Period.—During this period the contracting, constructing, and moving are carried on.

The Conclusive Period.—When the new shops are partly operative, the inevitable gaps in the general scheme are filled, and summations and comparisons of costs are made.

The chart, Fig. 1, is prepared to show more clearly the relation of the various periods and sub-periods, and also to show approximately the duration of the periods, assuming that a total of twenty months should cover the work from the commencement of the tentative planning to the completion of the work. Before going into the detailed discussion however, the author will advance the following general propositions.

General Considerations.

Engineering the construction of a series of extensive industrial improvements is decidedly a one-man job as regards control. This statement holds good whether the engineering is done by one of the many firms or individuals making a specialty of industrial plants, or by a temporary organization drawn from the staff of the owners themselves. The engineer who is to successfully carry through to completion a large project of this kind should be a high-class man, and, consequently, well paid. Generally, an engineer from outside is to be recommended, as his work will meet with less obstruction. "A prophet is never without honor save in his own country" is peculiarly applicable to this class of engineering. One can be too conciliatory in trying to prevent friction. This idea of the author's results from a recent experience with the vacillating nature of a few individuals backed by a general, narrow, insular indisposition to move from the beaten track and to accept the benefits of more efficient facilities of proven merit.

The duties of the engineer-in-charge carry a great responsibility and demand a rare combination of abilities. Given that the engineer is to have undisputed charge of the work (of course, subject to his employers' approval), and is to be the sole intermediary between his principals and the contractors, he should possess to a high degree honesty, discretion, tact, and the ability to observe closely, to analyze well, and to think honestly and methodically. He should possess executive and originative capabilities, combined with good common sense. He should have the temperament and stamina to withstand intensive and tenacious application. He must not be afraid to say "I do not know," but he should know the next time, would he secure and retain the respect and confidence of his associates and subordinates.

The efficiency of an industrial plant is *not primarily dependent upon the buildings*, but is mainly dependent upon the personnel, the equipment, the facilities for handling the materials and the product, and the arrangement of space. The buildings proper only affect the efficiency inasmuch as they do or do not provide good light, good air, sufficient headroom, and a reasonable degree of comfort for the workmen Therefore, the nature of the covering for the space is secondary, and is determinable by the three main considerations of utility, cost, and reasonable architectural effect. No one type of buildings, whether mill construction, iron covered, brick and steel, or reinforced concrete will meet all condi-

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[*] For previous articles on works design and construction see series "Machine Shop Equipment," by Mr. Oscar E. Perrigo, in September. October, November, December, 1903, and January, February, March and April, 1904, Issues.

[†] Address: 948 Campbell Ave., Hamilton, Ohio.

[‡] William P. Sargent was born at Stoneham, Mass., 1878. He received a high school education, and then gained shop experience at Prentice Bros. Co., Worcester, Mass.; Draper Machine Tool Co., Worcester, Mass.; Lodge & Shipley Co., Cincinnati, Ohio; Pratt & Whitney Co., Hartford, Conn.; Niles Tool Works, Hamilton, Ohio; Barber-Coleman Co., Rockford, Ill. With these concerns he has filled the positions of stock-keeper; designer; superintendent of construction on large contract of automatic cheroot machines; assistant to Mr. C. Edwin Search, formerly engineer in charge of construction, Niles-Bement-Pond Co.; engineer in charge of construction, Niles Tool Works; designing engineer at Barber-Coleman Co.

tions. We will later take up the comparison of various types of buildings, and the conditions for which each is best adapted.

Successful large plants are not of mushroom growth, but have grown building by building from a single small shop. Seldom have additions been made with any thought aside from that of providing for the existing need. Consequently, many large plants are a compact, irregular collection of buildings, sometimes separated by streets, tracks or water courses. However, the floor space occupied by various branches of work, and the number of men and power consumption for various units of space, form the logical working basis either for designing a new plant on ample ground space, or for alteration and the providing of additional facilities on whatever ground is available contiguous to existing buildings. Of course, the *space per man* in some of the departments may be too little for efficient production, and care should be taken to make allowance for this factor.

The labor supply may weigh heavier than all other factors in determining the justifiable limits of extension. In one instance of a city of 30,000 inhabitants, metal working industries have enlarged in recent years to the extent that an employer of 1,100 men stated his belief that 1,500 men would be the maximum he could gather in his shops in years to come without resorting to colonization. This belief came from the knowledge of the fluctuating demand for the product, the few apprentices taken on from year to year, and the scarcity of houses rentable at a low figure. The doubling in size of this plant would be a precarious proposition compared with the same increase in Philadelphia, for instance, where the general manager of a large metal working firm stated that he had increased his force 18 per cent in two months, or in Milwaukee, where one concern increased its force 1,200 men in eight months. Both above instances were with business at its best.

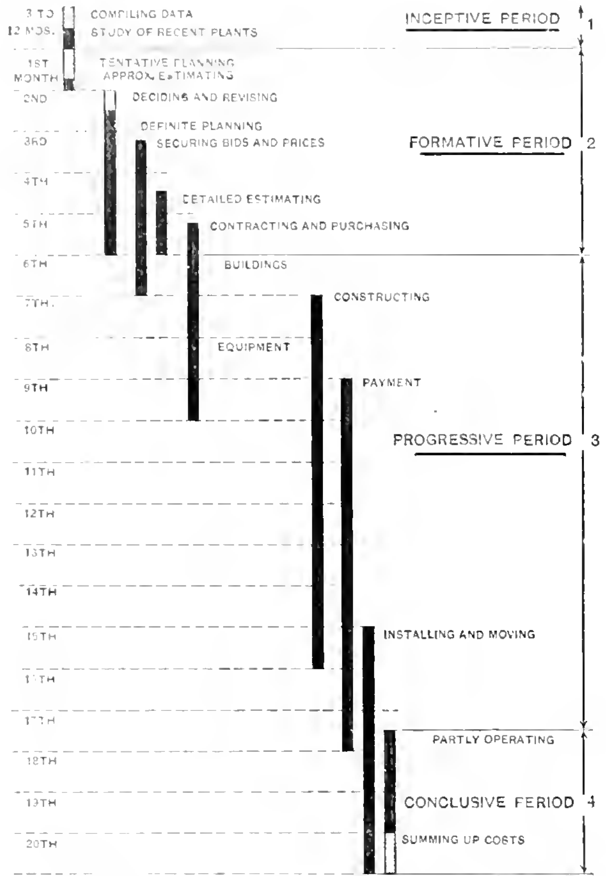


Fig 1. Relation of Different Stages of Shop Construction Work.

The sectional bookcase idea as applied to the laying out of new plants meets all the requirements of departmental balance and of future extension, the various departments corresponding to the sections, and a group of departments making up a unit. The West Allis Plant, of the Allis-Chalmers Co. in Milwaukee exemplifies this idea. The first buildings were designed for large engine work, while the recent additions were designed for both large and small work of an entirely different nature. The new buildings were slightly modified in type, yet they merge into the general scheme as naturally as rain into a river. Of course, old plants can not be changed to conform with this ideal; still, much can be done to give the product an economical routine through the works, and to arrange the departments so that future extensions could be made in conformity with a predetermined plan. Time may be profitably devoted to the critical study of recent plants. First study the main features of large plants from articles in various technical papers; these articles are generally written by men having a thorough understanding of the fundamental reasons for existing conditions. Generally, in visiting, one can only glance over the thousand and one features, and the information obtained is merely confirmative or disputative of predetermined conclusions.

Tentative plans should be comprehensive and flexible. Several solutions should develop from a thorough study of the problem, but each one of these various plans should be complete, comprising every item of work, and each item with an approximate estimate of cost. Approximate estimates based on square foot and cubic foot figures for cost of buildings, added to estimates on every item that can be thought of, will be, in total, close to actual costs even though some particular items may be within broad limits. The estimate of the total cost of a given project should never be decreased merely because some items may be excessive, for the reason that subsequent changes are more apt to increase the cost rather than to decrease it. The engineer will make a great mistake if, when the plans are decided upon and revised, he assents to the cutting of an estimate piece-meal, coupled with the expectation that the same definite quality and quantity of work is to be done. The "powers that be," in considering the tentative plans, will look at them from a business, rather than from an engineering, standpoint, and all statements must be well substantiated in order to secure an appropriation equal to the estimate. It is probable that from the several tentative schemes a definite general plan can be worked out, meeting all requirements and carrying the approval of the owners of the plant.

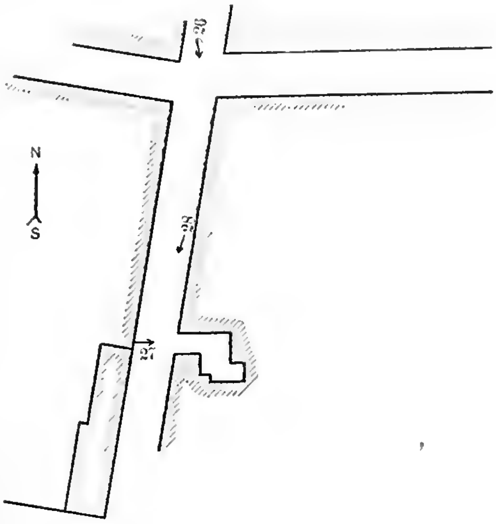
After the general plan is decided upon, the definite instructions and detailing should be rushed hard if the extensions are needed quickly, as it is economy to spend a couple of thousand dollars (on a large proposition) in correcting minor errors, if, by so doing, the plant may be in operation a month or two sooner. This latter statement should not be construed as advocating careless design, but the author does not believe in spending an excessive amount of valuable time altering and checking drawings where the monetary factor is small.

After a resumé of the items of data required and their bearing on various problems, an epitome of the leading features of recent plants will be given. The planning and construction of a large plant will then be taken up in detail.

Data Required for Planning Shops.

The following items of data have been found either a necessity or a convenience in planning alterations and in laying out new plants. In the first place, an engineer's plat of all the space within the property bounds is required. This plat should preferably be made by the city engineer's staff, or by a firm of civil engineers which can be held responsible for the accuracy of the work done, and which also is in touch with the city engineer's records and can derive exact information from deeds and records. The scale of the plat should be 1/32 inch to a foot, or some multiple of 1/32 inch. Many civil engineers will object to this requirement, as it necessitates a departure from their usual units of measurement, but their unit of a tenth of a foot is not adapted for construction work. If the total space cannot be covered by one sheet, approximately 36 x 48 inches, the plat should be made in sections. If made in sections, a street line or a witness line, not cutting any buildings, should be made the division line between the sections. For desk use, a photograph of the entire plat should be made, as it enables one to have all leading features and dimensions of a piece of property in a very convenient form for study.

The plat should show: 1. The owner's property limits. 2. The adjacent property limits and owners. 3. The block outlines of all buildings, and dimensions of the buildings outside of pilasters. 4. Accurate tape measurements between the various buildings and at all critical points. 5. Leading dimensions should all be referred to two base lines at right angles, one of these base lines paralleling the general trend of buildings. 6. Tracks should be shown with dimensions to nearest rail. 7. All municipal underground work in streets, such as sewers, water-pipes, gas-pipes, conduits, manholes, etc., should be shown in location, and their depths below the surface noted. 8. Grades or levels of floors, tracks, pits, streets, surfaces and beds of streams or ponds should be indicated. In a word, this plat should be sufficiently accurate to allow of larger scale drawings being made from it without prohibitive errors. Obviously, this plat is of most value in planning additions, as extensions can then be made without fear of encroaching on adjoining property; still it furnishes an accurate basis for comparison when designing a new plant.



Machinery, N.Y.

Fig. 2. Method of Recording Photographs on Plat.

A tracing should be made from this plat, and all underground pipes, sewers and also trackage on the owner's property should be added to the municipal underground work already laid out. Depths and location of these pipes can be obtained first from such drawings as may be available, and second by checking these drawings by boring with a 2-inch auger having an adjustable handle.

Space Data Required.

In making up details of space used for various purposes, it is better to have areas inclusive of walls, partitions and pilasters, so that the details may be totaled and checked against the gross area as obtained from the engineer's plat. The various divisions and sub-divisions of space required for the determination of the total occupied space for the extensions are indicated in the following lists. The number of square feet of floor space, and the number of men for each division must be ascertained, and from these figures may be obtained the number of square feet per man and the percentages of area of divisions compared with the space taken for machining.

Machine Shop. — Machining — Assembling — Tool-making —Tool storage—Shop stores—Work in progress—Storage—Washrooms—Closets—Shop offices.

Finished Work Storage.

Shipping.

Smith Shop.—Steam hammers—Forges and anvils—Bulldozers and furnaces—Case-hardening—Iron storage inside—Iron storage outside—Coal storage—Washrooms—Offices.

Foundry.—Molding under 20-ton or larger cranes; under 10-ton cranes; under 5- and 3-ton cranes; under 1-ton cranes—Bench molding — Machine molding — Core-making — Large cores made under cranes or baked on trucks—Small cores baked in portable ovens—Cleaning, under 20-ton cranes; under small cranes—Pickling tanks—Sand blast—Charging floors—Cupola floors—Sand mixing—Sand storage—Coke storage — Supply storage — Washrooms — Closets — Foundry office—Flask storage—Pig-iron storage—Casting storage.

Brass Foundry.—Molding—Core-making—Furnaces—Cleaning—Flask storage—Supplies.

Steel Foundry. — Molding — Core-making — Converters — Cupola room—Charging floor—Annealing—Cleaning — Supplies.

Pattern Making.—Pattern lumber storage—Dry kiln.

Carpenter Shop.—Lumber storage.

Power Plant.—Boiler room—Engine room—Pump room—Pipe shop—Electrical stores—Coal storage.

Main Office Building.—Offices—Drawing-rooms—Vaults.

Total Floor Space.—Ground floor—Galleries.

Total Yard Space.

Total Ground Space.

Heights and spans of crane tracks affect somewhat the arrangement of space, but this will be considered later.

Methods of Keeping Data.

In order to have the data of existing plants in shape for pocket or desk use, the following sizes of sheets will be found convenient. For tabulated and other data for pocket use, Morden's loose-leaf book No. 6—pages 4 x 7½ inches—is suitable. Write with fountain pen ink on one side of the sheet. Many engineers of the author's acquaintance use books of this size, and, as the pages blue-print nicely, there is a possibility of an interchange library of data.

For desk use only, employ a loose leaf book 9 x 12 inches. This size enables one to bring together drawings 9 x 12 inches, photographs 8 x 10 inches mounted on muslin, and typewritten correspondence on standard 8½ x 11-inch letter sheets.

For drawings, sizes in multiples of 9 x 12 inches are used, as most reference drawings of details are of sufficiently large scale when drawn on 12 x 18-inch sheets, and this size sheet can be placed in a desk drawer.

For indexing photographs, use the extremely simple method of placing an arrow on an 8 x 10-inch photograph of the engineer's plat, indicating the position and direction of camera when the photographs were taken, and put the distinguishing number of the negative close by the arrow. See Figs. 2 and 3.

Fig. 3. Photograph Marked to correspond with Number on Plat.

Photograph Data Required.

The photographs required are: photograph of engineer's plat, interiors and exteriors of buildings, yard space, vacant space, trackage, prospective sites, and photographs taken during construction. These latter are invaluable in many respects. Without leaving his desk, the engineer can study and plan unhampered by the numerous questions asked in the field whenever he is in sight. The photographs will often give bits of information, or verify some little point that it would take a fifteen minutes walk to investigate on the ground. An engineering salesman can often be given a general idea of what is wanted before he is taken on the ground, making his mental impression doubly strong, and therefore securing his attention on even small matters Photographs are also incontrovertible evidence, many times, when differences arise and claims are made by contractors.

Drawings of Existing Plant.

Drawings of existing plant should preferably be made on sheets 12 x 18 inches. Simple elevations and sections of various buildings, showing door, window, and skylight spaces, crane tracks and galleries, together with plans supplemented by photographs of interior views showing walls, columns, partitions, etc., furnish a reference basis for problems of lighting, heating and headroom. Plans of wiring for cranes, power and lighting, and piping for steam, water, gas, and air, furnish data for definite conditions that hand-books could not begin to supply. Plans of shafting giving sizes, length of sections, location of hangers, used and unused sections, etc., will save their cost many times over.

Production Data.

The production of various departments per unit of space, per man, and in total, will often times show where departments are lame and what variations are necessary in establishing unit space figures. The nature and value of the various classes of product in relation to the space occupied should be considered, as the project of extension may be expected to increase the production of various classes of machines by different percentages. For instance, a plant building a varied line of tools will want to perfect and increase the production of the class for which there is the greatest demand, and in which there is the greatest profit. Production data are, naturally, confidential, and should not be kept with other data that may be accessible to the construction engineer's assistants. The average number of labor hours of each class of workmen per machine, the number of hours worked per day, the number of square feet of floor space per man, and the number of machines to be built, will afford data for the planning of improvements if the problem is stated from a production basis rather than as a percentage increase of men and space. Dimensions and weights of the largest and heaviest pieces produced help to determine the capacity and headroom necessary. Maximum heights and widths of loaded flat cars that will be accepted by the railroads will give the minimum height of lintels of doorways through which the largest pieces are shipped.

TABLE I. SPACE. PLANT NO. 3, ALLIS-CHALMERS CO.

Data from old shops.

Department.	Floor Space, square feet.	No of Men.	Sq Feet per Man.	Ratio.
Machine Shop.......	276,484	966	331	100
Erecting Shop.......	43,425			15.8
Shipping............	......	...	...	.....
Foundry............	142,984	607	235	52
Sand Floor..........	......	..	...	.....
Pattern Shop........	28,643	80	358	10.4
Smith Shop..........	11,830	65	182	4.4
Manufacturing Space	503,366	1718	Average 293	.....
Pattern Store......	82,870	....	...	29.7
Engine Room........	......	....	...	.....
Boiler Room.........	......	....	..	.....
Office Building	40,170	175	230	14.6
	626,406	1893	Average 330	.....

TABLE II. SPACE. ONE COMPLETE UNIT FOR 555 MEN.

One-unit.	Space, square feet.	No. of Men.	Square Feet per Man.
Machine Shop.......... Erecting...............	116,000	351	331
Foundry...............	41,000	175	235
Pattern Shop.	10,400	29	358
	167,400	555	Average 302

Expense Data.

The costs of handling materials, and other expense items, should be carefully collected, as successful overgrown plants generally are carrying an overhead expense that can be materially reduced when the business is established in a new plant. This reduction of overhead expense is often the principal factor in increasing the productive efficiency of a new plant, as the production per producer is high, correlative to the fact that the overgrown plant has been, generally, successful.

The problems in reducing expenses are generally of two classes, first, to lessen manual labor, and, second, to increase the efficiency of apparatus used in work chargeable to expense accounts. The importance of knowing these costs is shown by the following data from a plant employing 1,000 men: The cost of handling pig iron per ton is 23 cents; coke, 42 cents; sand, 40 cents; coal, 10 cents; and bar steel and billets, 90 cents. The total for these five items per year amounts to over $7,000, and a saving of 50 per cent can be made by installing efficient apparatus in a new plant. As many conservative managers believe that a saving of laborer's wages of $600 per year justifies the expenditure of $5,000, this saving of 50 per cent on $7,000 alone would justify an expenditure of $30,000. The heating of this same plant costs $6,000 per year, and a saving of $4,000 per year can be effected in a new plant with proper apparatus.

TABLE III. SPACE. PLANT NO. 6, ALLIS-CHALMERS CO.

Data from new shops as built.

Department.	Floor Space, square feet.	Ratio.	Block Space, Dimensions.
Machine Shop........	189,750	100	two 575 × 118 575 × 47 each
Erecting Shop	40,752	21.5	566 × 72
Shipping	21,508	11.5	566 × 38
Foundry.............	123,388	65	566 × 218
Sand Floor	8,490	4.5	283 × 30
Pattern Shop.........	31,000	16.5	566 × 55
Smith Shop..........	50,150	26.5	425 × 118
Manufacturing Space	465,038	....	....
Pattern Store	144,900	76.5	566 × 64
Engine Room...... ..	8,850	4.6	75 × 118
Boiler Room........	8,850	4.6	75 × 118
Office Building......	....	....	....
	627,638	....	....

TABLE IV. UNITS REQUIRED FOR NEW SHOP.

Department.		Square Feet.
Machine Shop........... Erecting Shop.......... ..	two units	230,500
Foundry	three units	123,390
Pattern Shop.	three units	31,000

Power Data.

The cost of coal, supplies, water, and attendance, also the capacity and efficiency of engines, generators, boilers, condensers, transmission lines, shafting, belting, etc., should be found, and costs of power obtained under the varying conditions of day and night operation, busy times and bad times. This information will aid in settling the question of increasing or changing the power plant.

Construction Data.

Local prices of materials entering into construction, and cost of labor in the building trades, should be obtained early, as it will take some time to check and verify them sufficiently for use in close estimating. The various items of material that will be used in large quantities are as follows:

Foundation Work.—Cement; crushed rock; sand; reinforcement steel bars; expanded metal; water-proofing compounds, such as "Medusa"; lumber for form work.

Framework.—Structural steel work erected per ton; trusses; girders; columns; bracing; floor plate.

Walls.—Plain brick; face brick; bull nose brick; cut stone sills; tile coping; window frames, single, double, and triple; windows per square foot.

Roofing.—Purlins; sheathing; gravel or slag roofing; skylights per square foot; tin and copper flashing per square foot; galvanized iron and cast iron down spouts.

Floors.—Sleepers; under planking; maple top flooring.

Underground.—Piping; tile and iron sewer pipe; galvanized and black standard wrought iron pipe; electrical tile conduits.

The above heads will also serve as a guide in obtaining costs of labor. Any architect who has had experience on this class of buildings can give unit prices both of material and labor, though an engineer on good terms with contractors can obtain more definite data on labor costs.

The number of working hours per day, and the average working days per year (this latter data should be taken for a number of recent years), together with the amount of work done per day by bricklayers and carpenters, comprise the data for estimating the time necessary for the completion of the buildings.

Equipment Data.

The class and capacity or size of tools pertaining to the different lines of product, should be listed and compared with the amount of product, as this will give an idea of the necessary new equipment. The speeds and power consumption of machines will be needed in determining size of motors for group driving, and also for individual motor drive. The percentage of tools running and the power consumption for the same will give figures from which may be deduced the new power plant requirements. The data of floor space occupied by the various tools are in the best shape for future use in the form of "dummies," cut from heavy cross-section paper to a scale of 3/16 or 1/4 inch to the foot, and including the necessary clearance space for withdrawing shafts, etc. These dummies, when laying out the location of the tools, are moved around on a floor plan drawn on the same scale cross-section paper. The cross-section paper facilitates the arrangement, as definite widths of gangways and clearances between tools, walls, columns, etc., are easily maintained.

Derivation of Base Units.

That, from the known floor space per man as a base unit, a modern highly efficient plant with but few buildings can be built to take care of the production of a large number of miscellaneous types of old buildings, is shown by the comparative tables, I to IV. Table I is made up from figures derived from all of the old buildings of the Allis-Chalmers Co. The intention was to build a new plant of approximately the same productive capacity as that of the combined old shops, and to have this new shop susceptible of methodical extension. The number of men in the machine shop and erecting spaces in the old shops are considered together, on account of the difficulty of allotting any definite amount of space per man to the erectors, the erecting space being a function of the space covered by the machine being set up, and of the time taken for its erection, rather than of the number of men. Approximately one-third of the number of men, together with the unit space figures per man, was taken from Table I to form a unit (Table II) better adapted for use in planning the four main buildings of the new plant. The machine shop space in Table III is but two-thirds of that in Table I, while the erecting space is approximately the same. The smaller floor space in the machine shop is due to the fact that the modern equipment with its high efficiency was expected to increase the efficiency of the machine shop about 50 per cent. Table IV is derived from Table II, and is placed side by side with it to make comparison easy.

BRITISH MACHINE TOOLS AT THE FRANCO-BRITISH EXHIBITION.

OSKAR KYLIN *

In the English machinery section of the Franco-British Exhibition, which is now in progress in London, a few of the English machine tool manufacturers are presenting some types of their, generally, many different designs. Although not all of the machines exhibited, by far, possess any radically new features attracting the attention of the visitor, they still give a very good example of the present state of the English machine tool manufacture, and the general lines along which English makers are at present designing and building their tools. For this reason, a selection of some of the machines exhibited will undoubtedly prove interesting to American readers.

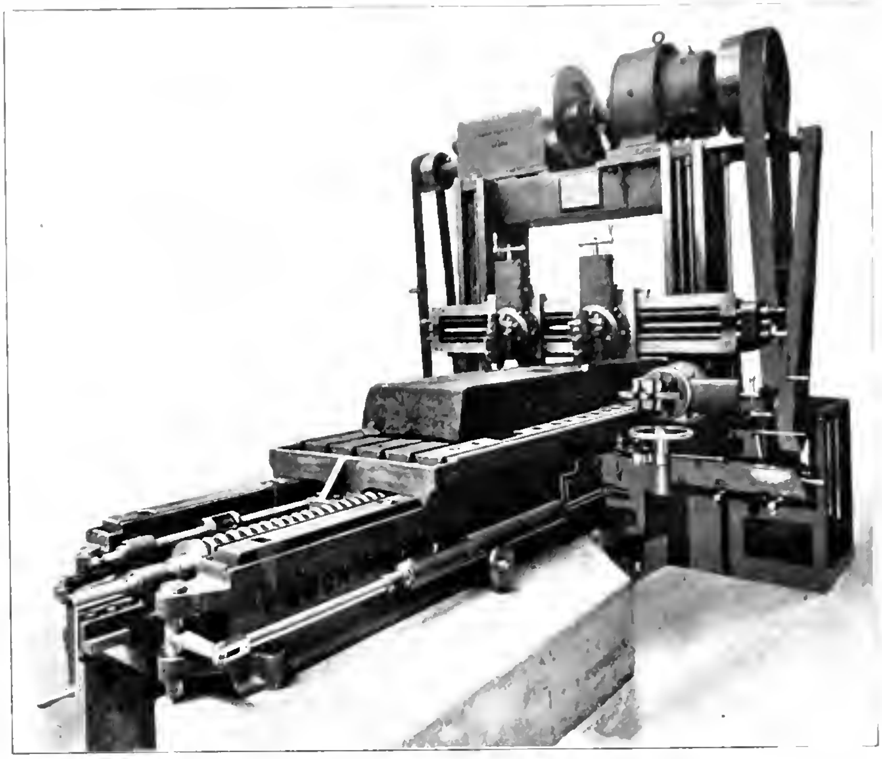


Fig. 1. Buckton & Co. Regenerative Reverse Planer.

Buckton Regenerative Reverse Planer.

Fig. 1 of the accompanying illustrations shows a heavy duty planer built by Joshua Buckton & Co., Ltd., Leeds. The difficulties of driving and reversing a heavy planer at a high speed without the consumption of excessive power is well known, and has been one of the most important problems in planer design since the introduction of high-speed steel. On account of the reciprocating motion, there is a large amount of kinetic energy which must be absorbed and redeveloped at each stroke. This absorbs an amount of power which was not determined until electric drives made its measurement possible. The sudden jump of the ammeter needle at the

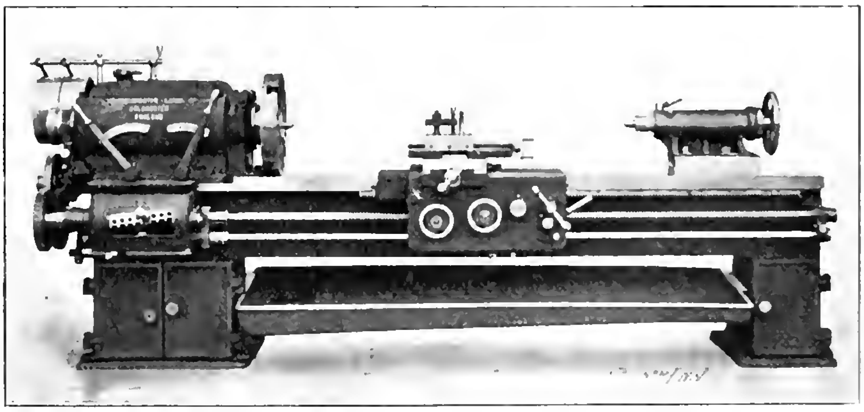


Fig. 2. Colchester Geared Head Lathe.

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* Foreign Traveling Representative of MACHINERY.

point of reversal of a planer is well known, and every attempt to reduce the power consumed deserves consideration. The principle underlying the design of the Buckton planer is that of balancing the forces by recoil springs. These springs absorb a large amount of energy, and when the planer reverses, they restore, during the moments of acceleration, the energy which would otherwise be wasted. The planer shown is provided with a motor, the power of which need only be great enough for taking the cut, there being no overload on the motor during the return stroke, although this is at the rate of 180 feet per minute. In the illustration, a large steel ingot is placed on the table; it is claimed that the weight of the work has no measurable effect upon the accuracy with which the planer is reversed.

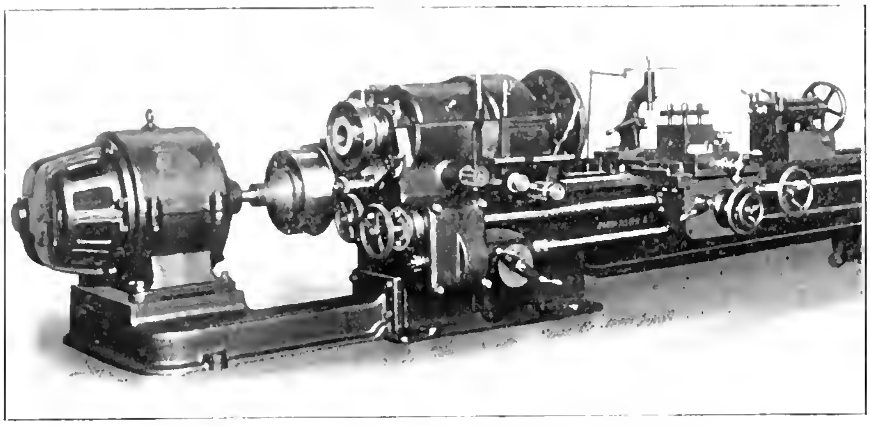

Fig. 3. High Speed Lathe built by John Stirk & Sons.

The illustration plainly shows one of the recoil springs with which the planer is provided; another spring is placed in a similar position at the other end of the machine. During the stroke, the springs remain in the position shown, and abut against one of the cross bars of the bed. Two screws pass through these springs, and extend the whole length of the bed. On these screws are placed heavy adjustable bronze nuts, and against these nuts impinge brackets attached in fixed positions to the underside of the moving table, the impact being transmitted to the springs through the screws and suitable collars. By altering the position of the nuts upon the screws, any required length and position of stroke may be obtained; the minimum length of the stroke is 12 inches. There is nothing required for the changing of the length or position of the stroke except to turn the screws around so as to bring the nuts to the required location. The stroke can be adjusted while the machine is running. It will be understood that while the return stroke of the machine takes place at a constant speed of 180 feet per minute, the cutting stroke can be varied by means of change gearing, the slowest cutting speed being 20 feet and the fastest 60 feet. In spite of the fact that the forward and return speed thus vary in the ratio of from 9 to 1 to 9 to 3, yet no adjustments are required for the spring action when using the fastest or slowest cutting speed. This is very important, because the danger in planers provided with spring buffers of any kind is that the amount of overrun is uncertain, and there is a danger of injuring the tool when planing up to a wall. It is claimed, however, that with the Buckton planer, under any circumstances, 1/8 to 3/16 inch is ample clearance.

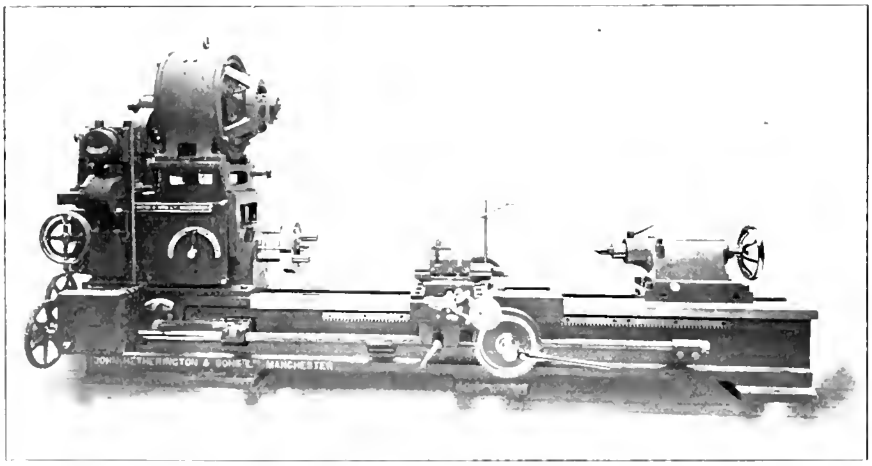

Fig. 4. John Hetherington & Sons High Speed Lathe.

Modern British Lathe Design.

The Colchester Lathe Co., Hythe, Colchester, exhibits a few lathes of which Fig. 2 represents the largest and most interesting one. The new patent geared head gives 18 spindle speeds which are obtainable by manipulating the levers conveniently placed for the operator. The mechanism consists of thirteen steel gears. In order to avoid all possibility of accidents, due care has been taken in the design of the head-stock so that it is impossible for more than one pair of gears to be in mesh at the same time. The driving pulley is 12 inches in diameter, and runs at a constant speed of 400 revolutions per minute. The head may be driven either direct from the main line shaft or coupled direct to a motor. One feature is that the carriage is made especially long, and is guided by a projecting strip or way which runs along in the front of the bed. This, the builders claim, makes it much easier to move the carriage, and eliminates the side strains which are present when the carriage is guided along the bed in the usual way. The number of feeds obtainable through the feed box shown in the illustration is 32, ranging from 0.125 to 0.008 inch per revolution. When the lathe is used for thread cutting, thirty-two different pitches of screws can be cut, ranging from 2 to 30 threads per inch.

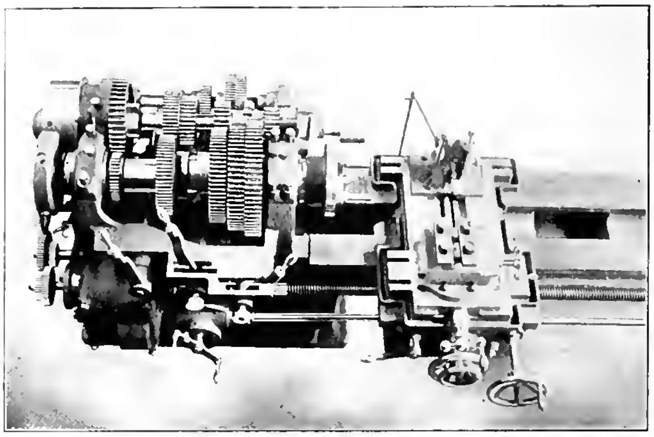

Fig. 5. The Head-stock and Carriage of Lathe shown in Fig. 3.

In Fig. 3 is shown a 20-inch high speed lathe built by John Stirk & Sons, Halifax. The engraving shows the machine direct connected to a 30-H.P. motor, but it can also be belt driven direct from the line shaft, the only change required being to remove the motor. The pulley shown in the illustration between the motor and head-stock is employed in this case. The lathe, of course, is provided with geared head, permitting sixteen changes, giving spindle speeds from 10 to 250 revolutions per minute. As will be noticed from the engraving, the head-stock is cast in one piece with the bed for the sake of obtaining great rigidity. In Fig. 5 is shown the head-stock and carriage of this lathe, the cover over the geared head being removed so as to show the arrangement of the gearing. The feeds are all obtained from the gear box shown at the front of the bed below the head in Fig. 3.

John Hetherington & Sons, Ltd., Manchester, exhibit the 28-inch lathe illustrated in Fig. 4. The bed is made of a strong box section with two flat ways on the top provided with T-slots for locking the carriage and tail-stock. The

sliding rest is designed to swivel completely around, and is well secured to the carriage by three binding bolts. The geared head is driven by a direct connected motor mounted on the top of the head-stock. The machine, however, can also be driven direct from the line shaft. The number of spindle speeds obtainable is 24, arranged in geometrical progression.

Alfred Herbert, Ltd., Coventry, Exhibit.

The part of the machinery section of the exhibit which has the most of interest to offer to the visitor is the exhibit of Alfred Herbert, Ltd. This famous English machine tool company presents a few of the types and sizes built. The machines are interesting, perhaps mainly because of the high class workmanship and their capacity in regard to output. The three different types of turret lathes built by the firm, the hexagon, the combination, and the capstan, are well represented by different sizes, and in order to give an idea of the class of work of which these machines are capable, samples of work are also exhibited. The representative machine of the turret lathe class is the No. 2 hexagon turret lathe which was illustrated and described in the March, 1907, issue of MACHINERY. Another machine exhibited by the firm is illustrated in Fig. 6, and represents the line of automatic turret lathes built. This class of machine is intended for working upon individual pieces of castings or forgings, or blanks previously cut off. The work is chucked by hand, but all the operations performed on the work are automatic, including the stopping of the machine at the completion of its cycle of operations. The head is driven by gearing and is exceptionally powerful. The pulleys provide either a two-speed automatic change, or a forward and reverse motion according to the requirements of the work. The turret slide is adjustable to four positions, according to the length of the work operated upon, the turret slide drum having a corresponding adjustment. The turret has five faces, and is provided with a rigid over-head support. The cross slide in this machine is particularly wide, the object being to provide plenty of room for the tool-holders of various types, at both front and back.

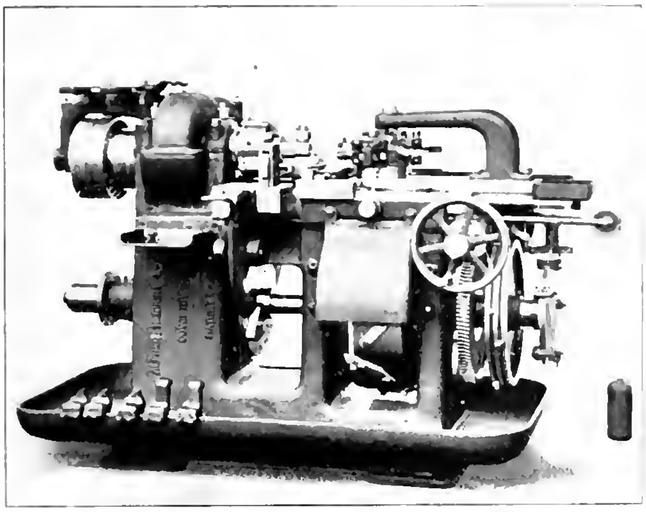

Fig. 6. Alfred Herbert, Ltd., Automatic Turret Lathe.

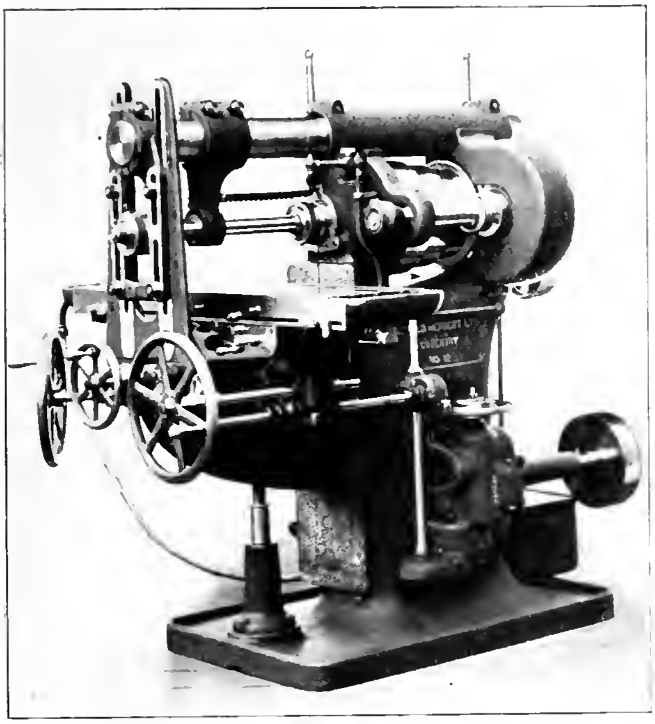

Fig. 7. Horizontal Plain Milling Machine, built by Alfred Herbert, Ltd.

The firm of Alfred Herbert is further exhibiting some vertical as well as horizontal types of milling machines. The engraving, Fig. 7, shows the horizontal plain milling machine on exhibition; the firm does not built universal milling machines. As seen from the illustration, the machine has cone pulley drive with double back gearing, permitting a great range of spindle speeds. The feed changing is accomplished by means of the Herbert patent dial feed motion of similar construction to the one used on the turret lathe and shown on the side of the column in the engraving, and the feed can be driven either independently or from the spindle. The firm recommends strongly the use of the independent drive for the feed. There is a drawback to driving the feed from the spindle, because the range of feeds becomes insufficient for the slowest and fastest spindle feeds; for instance, for slow speed and large cutters, the feed cannot be obtained coarse enough, and for high speed and small cutters it cannot be obtained fine enough, at least for certain classes of work. By driving the feed independently, however, from the counter-shaft, this drawback is eliminated. The whole machine is operated from the front and does not require the at-

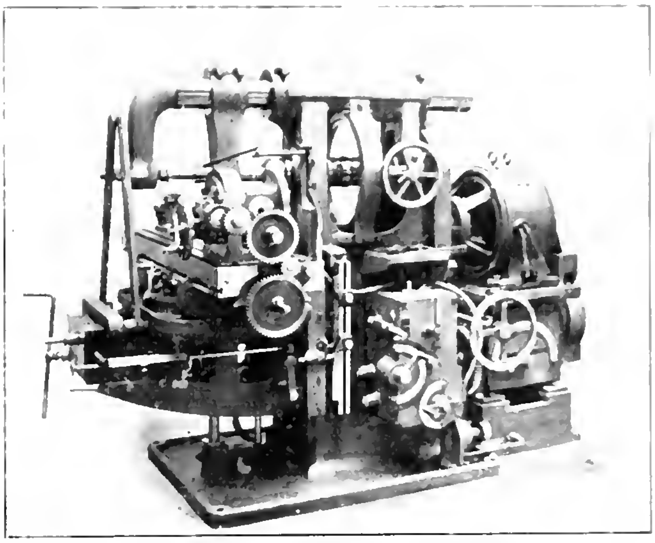

Fig. 8. Hetherington Universal Milling Machine.

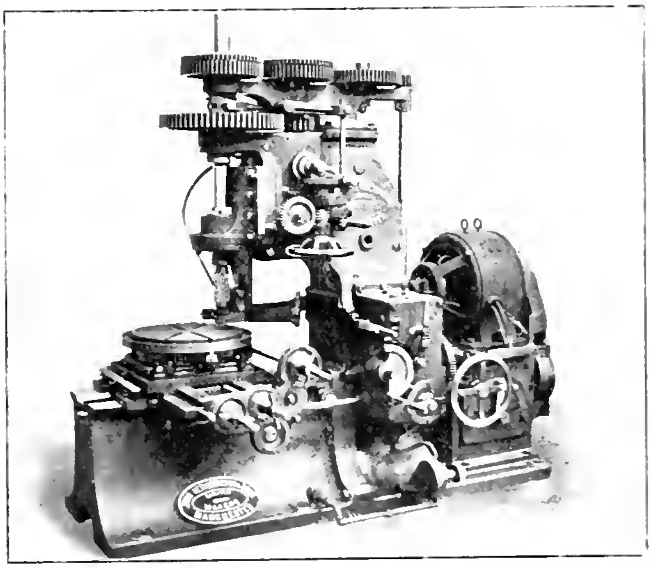

Fig. 9. Hetherington Vertical Drilling and Milling Machine.

tendant to change his position and go around to the back. All the movements are governed by hand-wheels of sufficient size to permit easy action. It will be noted from the illustration that the drive of the feed from the gear box to the knee is not by means of the ordinary telescope tube shaft and universal joints, but by means of shafts at right angles.

The John Hetherington Exhibit.

We have already mentioned the geared head motor-driven lathe exhibited by John Hetherington & Sons, Ltd., Manchester. In Figs. 8 and 9 are shown two heavy duty milling machines exhibited by these makers. These machines are both of exceptionally heavy and powerful design, and are particularly intended for heavy work. As shown in the illustrations, these machines are driven by independent motors, but they are also built to be driven by constant speed belts and tight and loose pulley. The universal milling machine shown in Fig. 8 is provided with a geared drive, the spindle having 16 speed changes which are obtained by means of an index hand-wheel and levers. The feed motions are reversible and automatic, both for the vertical, traverse, and longitudinal motions. The feed change is executed by indexing levers giving a feed variation of eight feeds to each spindle speed.

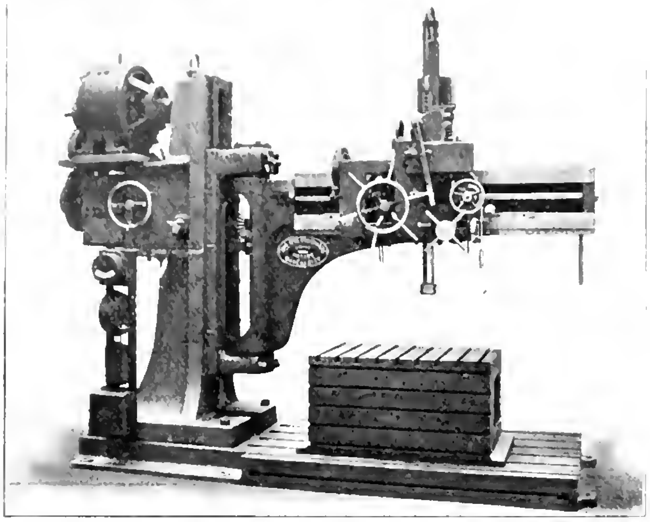

Fig. 10. High Speed Radial Drill, built by John Hetherington & Sons, Ltd

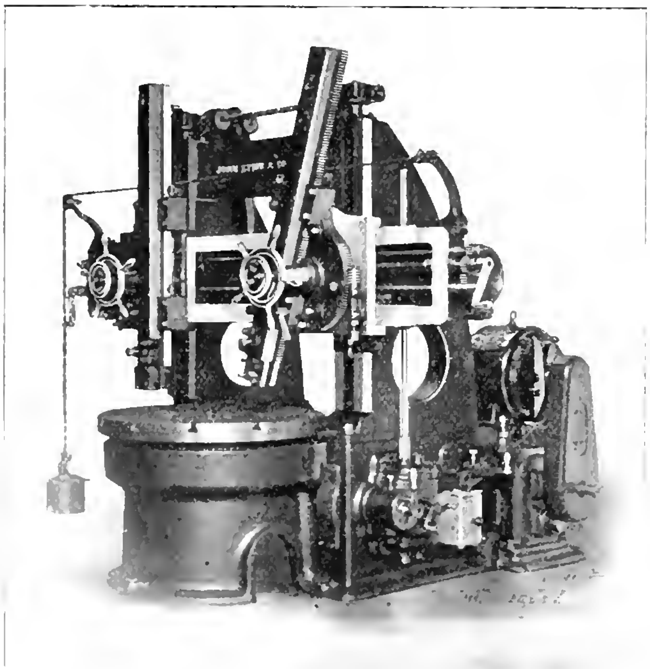

Fig. 11. Forty-eight-inch Vertical Boring and Turning Mill, built by John Stirk & Sons.

On the [illegible] milling and drilling machine shown in Fig. 9 also 16 different spindle speeds are provided, and there are also [illegible] feed variations to each spindle speed. In addition to the motions required for milling, there is also a positive and continuous drilling feed giving a variation of three feeds to each spindle speed.

This firm also exhibits the radial drill shown in Fig. 10. This machine is driven by a 14-H.P. motor, mounted as shown in the illustration, but, of course, can also be driven by a constant speed belt. The cone box for changing the spindle speeds without stopping is operated by the index hand-wheel shown in the front of the frame under the motor. The spindle is fitted with clutch reverse motion, and with speed changing device for reducing the speed for tapping. The machine is also provided with a quick hand traverse for running the spindle to and from the work. The radial arm is supported on a ball bearing and can swing through an arc of 180 degrees, the minimum radius being 3 feet, and the maximum 7 feet.

John Stirk & Sons' Exhibit.

In Fig. 11 is illustrated a vertical boring and turning mill manufactured by John Stirk & Sons, Halifax, builders of the high speed lathe already described and illustrated in Figs. 3 and 5. This 48-inch vertical boring mill is driven by a direct connected 13-H.P. motor. The tool-holders are provided with swiveling slide and counter-balancing arrangement; independent automatic positive feeds are provided for each of the two slides, nine changes of feed being obtainable in any direction. The drive of the machine is through a gear box giving eighteen changes of speed, the final motion to the table being through a multiple thread worm and gear; this ensures a perfectly steady drive. The table speeds vary from approximately 1 to 50 revolutions per minute. The general design of the machine throughout is typically English.

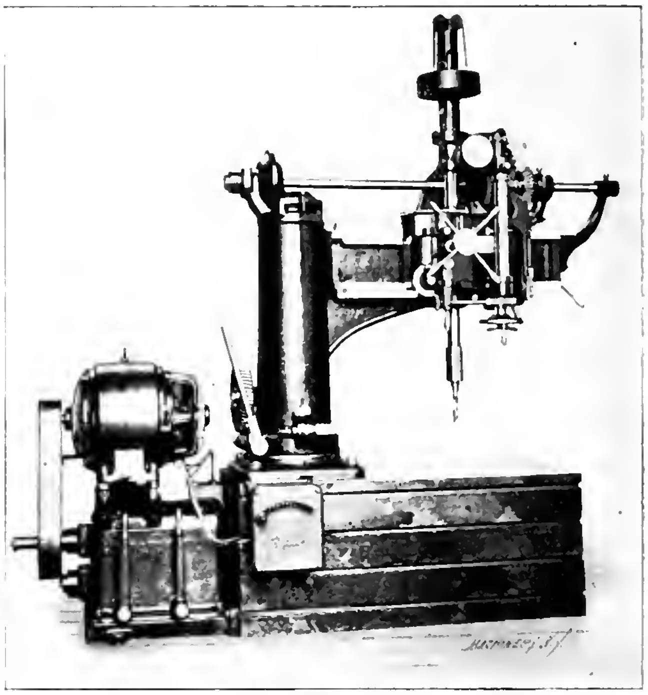

Fig. 12. High Speed Radial Drill, built by John Stirk & Sons

The same firm is also exhibiting the radial drill shown in Fig. 12. This machine is designed especially for the use of high-speed drills, and is driven by a direct connected 13-H.P. motor. The arm can be swung around on a pivot of large diameter in a complete circle. When in its lowest position, it rests on steel balls, but it can be raised 12 inches if required. The carriage is moved on the arm by rack and pinion in the usual manner. The reversing motion consists of a combination friction and positive clutch of unique design for which patents are applied for. The drive is through a gear box, giving nine changes of speed, which can be operated without stopping the machine. A back gear arrangement on the carriage doubles the number of speeds to 18, varying from 13 to 560 revolutions per minute. The gear box forms a receptacle for oil, the gears thereby running constantly lubricated. The manufacturers guarantee that this machine will drill one-inch diameter holes in mild steel at a rate of 9 inches feed per minute. The approximate weight of this machine, including the motor, is 10,000 pounds.

GEAR-CUTTING MACHINERY—9.

RALPH E. FLANDERS.[*]

This, the concluding installment of the series of articles on gear-cutting machinery, continues the discussion of methods of cutting bevel gear teeth with special reference to machines which act on the molding-generating principle.

Molding-Generating Machines Employing the Milling Operation for Cutting the Teeth of Bevel Gears.

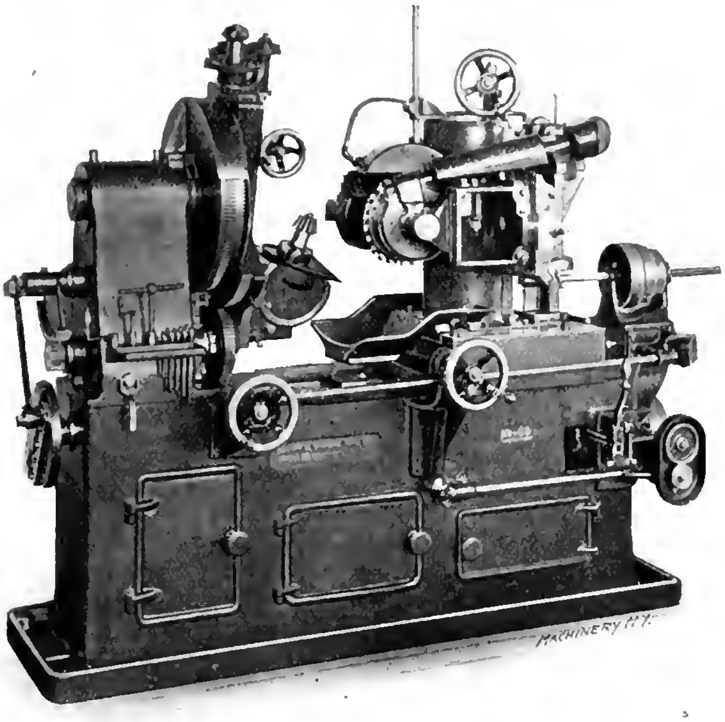

Fig. 171. Brown & Sharpe Bevel Gear Generating Machine, cutting the Teeth by the Use of Interlocking Milling Cutters of Large Diameter.

One of the most interesting and ingenious of all the machines for cutting the teeth of bevel gears is that shown in Fig. 171. It operates on the principle shown in Fig. 140, in which the sides of the crown teeth are represented by the plane faces of milling cutters. In this machine the milling cutters and the imaginary crown gear remain stationary so far as position is concerned, though, of course, the cutters revolve about their own axes. The work is held in the spindle of a head (resembling the universal head of the milling machine) which is mounted on the slide of a swinging sector at the left, which sector is rocked about a horizontal pivot in line with the axis of the imaginary crown gear. The work spindle and the rocking movement of this sector are so connected by change gearing that, as the latter is oscillated through a sufficient angle to generate the teeth, the work is rolled in the proper ratio to mesh with the imaginary crown gear, a tooth of which is represented by the milling cutters. This movement, referring to Fig. 139, is thus seen to be identical with the case in which the crown gear is stationary, while the frame is rocked, rolling the master gear on the crown gear, and the work over the tool.

The cutters used are of large diameter in proportion to the work for which the machine is intended, in order to minimize the deepening of the tooth space at the center which is characteristic of a gear cut in this way, as was explained in connection with Fig. 140. It will be seen that the teeth of the two milling cutters are set so as to interlock. In this way comparatively stiff cutting blades may be made to represent a complete crown gear tooth of very fine pitch.

The machine is universally adjustable within its range. The cutter spindles may be set to give teeth of greater or smaller pitch, and to work with gears of large or small pitch cone radius. They may also be adjusted for teeth of greater or less angularity than the 14½-degree standard involute generally used. The details of the mechanism of this machine are very interesting, but there is space here only for this description of its action. The Brown & Sharpe Mfg. Co., Providence, R. I., is the builder.

In Figs. 172 and 173 are shown views of two sides of the Warren bevel gear generating machine, first developed and built, if the writer's memory serves him, by the Pratt & Whitney Co., of Hartford, for the manufacture of chainless bicycle gears. The machine we show, however, is a design built for general manufacturing use by Ludwig Loewe & Co., of Berlin, Germany. This machine is approximately similar in its action to the one built by Brown & Sharpe, and just described. Aside from the differences in the mechanism, however, there are two important differences in its action. One is the fact that the two cutters do not cut on opposite sides of the same tooth, but on facing sides of alternate teeth, leaving a whole tooth untouched between them. The independent slides in which they are set are so arranged as to allow the plane cutting face of the cutters to be set to agree with the corresponding faces of the imaginary crown gear. The other difference is the means taken to cut a tooth space having a straight bottom, with cutters of small diameter. This is done by making the rolling of the cutter holder and the blank on each other a continuous rocking movement at a quite rapid rate. During this rapid rocking, the cutter slides are fed inward on their respective guides to form the sides of the particular teeth at that time presented to the cutters.

The cutter slides and guides are mounted on a circular head, which is rocked about the axis of the imaginary crown gear by the slotted crank and link seen at the side of the machine in Fig. 173. The upper end of this circular slide carries a segment of a crown gear, which meshes with the corresponding segment of a master gear on the work spindle, this arrangement being very similar to that of the Gleason machine shown in Fig. 170. The work and the cutters being thus rapidly rocked about each other while the cutters are slowly fed down through the tooth spaces, the sides of the teeth exposed to the action of the cutters are properly formed to the theoretical tooth curves. As in the previous case, there is no space here to go into the ingenious construction of this machine, with its provision for

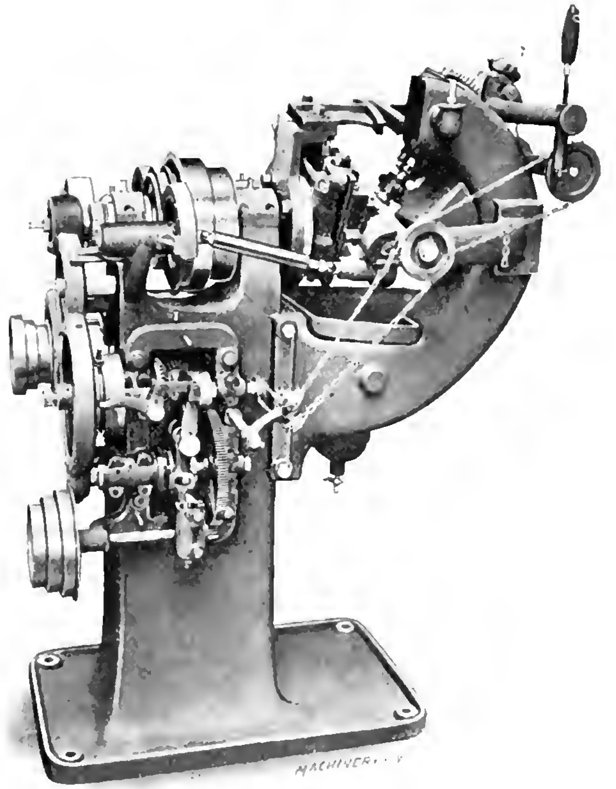

Fig. 172 The Warren Bevel Gear Generating Machine as built by Ludwig Loewe & Co., Berlin.

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[*] Associate Editor of MACHINERY.

automatically effecting all the movements for rocking the cutter slides and the blank, feeding downward and returning, indexing, etc. nor for following out in detail the various adjustments provided for cutting gears of all kinds within the range of the machine.

Bevel Gear Cutting Machines using a Hob and Operating on the Molding-Generating Principle.

While the hobbing principle is easily and simply applied to the cutting of spur and spiral gears, as illustrated in Figs. 50 and 96, it requires but little thought to show that the application of the same principle to the cutting of bevel gears is a difficult, if not hopeless, task. Nevertheless, this problem has been attacked in two different directions. The principle of the mechanism and tools employed, however, requires to be studied with greater care than in the case of any of the machines we have previously described, if the reader is to have a clear understanding of their method of operation. The first of the two processes is that developed by M. Chambon, of Lyons, France. The operation of the machine is dependent on the principle of the hob, whose generation and finished form are illustrated in Figs. 174 to 178, inclusive.

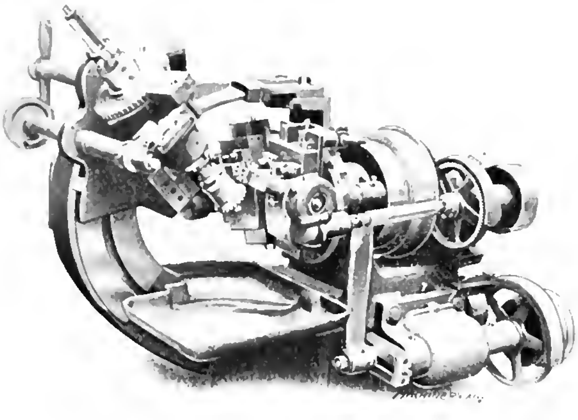

Fig. 173. The Working Side of the Warren Machine showing the Milling Cutters whose Plane Surfaces represent Sides of Adjacent Crown Gear Teeth.

In Fig. 174 is shown the basic principle of the molding-generating process applied to the cutting of bevel gears, identical in its essentials with the mechanism shown in Fig. 139, with the exception of the fact that a hob is used as a cutting tool, instead of a reciprocating planer tool. At the left of the engraving a face view of the crown gear is shown. The width of the top of the tooth at the outside diameter is W, at the inner end of the tooth w. A hob may be made, such as No. 1, having teeth whose shape on a normal section EF exactly matches the same section of a tooth of the crown wheel when the teeth of both are centered on line CD, and the hob is set at the helix angle θ. Under these circumstances, a tooth of the hob would have a width W at the top. If the hob is single-threaded, and the crown gear has, for instance, 24 teeth, the two may be revolved together, the hob making 24 revolutions to one of the crown gear. Then this tooth of the hob, which comes into action at the time it is central with line CD, will exactly match the outline at the larger end of each of the teeth of the crown gear in turn, as it revolves. To have a hob which would similarly match the teeth at the smaller or inner end, we could construct one of the same diameter and of smaller pitch, smaller helix angle θ', and a corresponding width of flat, w, at the top of the tooth, all to correspond with the shape of the inner end of the crown gear tooth. It also should revolve in the ratio of 24 to 1 with the crown gear, and the tooth which comes central with the line CD at each revolution may be made to match accurately with the outline of the inner end of the tooth. In the same way, hobs may be made to be used at any intermediate point in the length of the tooth of the crown gear, so that one of the cutting edges will match the outline of the tooth at this point, once for every revolution of the hob. The problem is to construct a single hob which will do the work of hobs No. 1 and No. 2, and of all possible intermediate hobs between the two positions.

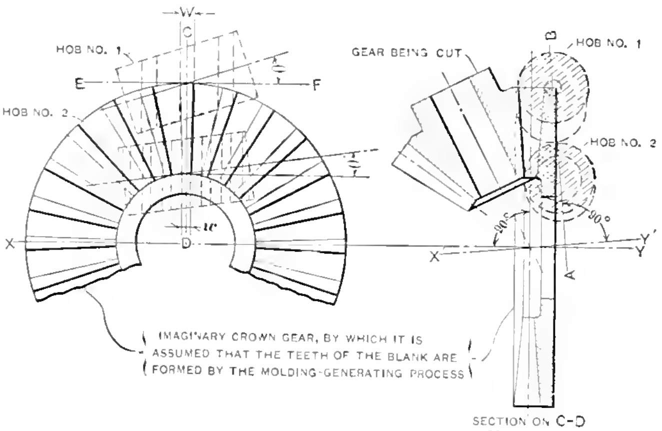

Fig. 174. Diagram showing the Possibility of Representing a Crown Gear Tooth by Teeth in a Series of Hobs of the Same Pitch Diameter, but of Varying Lead and Helix Angle.

In Fig. 175 the two hobs of Fig. 174 are shown enlarged. As previously explained, they are of the same diameter, with the normal width at the top of the teeth W and w, the same as that of the large and the small ends of the tooth of the crown gear, and with the leads of each, P and p, as required by the pitch of the large and small ends of the teeth. This gives corresponding angles, θ and θ' in the two cases. At T and V are shown axial sections of the thread for hobs Nos. 1 and 2. Since T and V correspond to the large and small ends of the teeth of a crown gear, the widths W' and w' are proportional to the leads P and p, and the angle of inclination of the sides, ϵ, is the same in each case. What we have to do now is to combine Nos. 1 and 2 into a third, which will do the work of both of the previous ones.

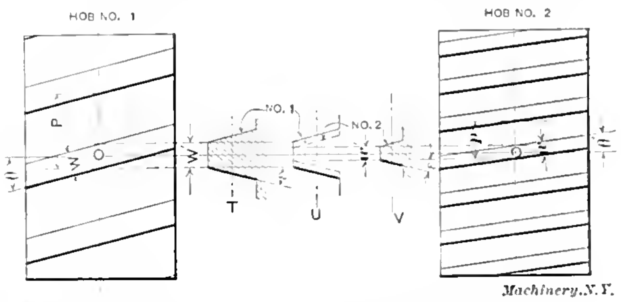

Fig. 175. Comparison of the Hobs representing the Large and Small Ends of the Crown Gear Tooth in Fig. 174.

Suppose we take a blank of the same diameter as the two hobs in Fig. 175 and thread it first with the same shape and pitch of thread as for No. 1, and second with the same pitch and shape as for No. 2, except that while the width of the top and the inclination of the sides remain the same, the cut will be carried to the full depth required for the thread of No. 1. As shown at U, in Fig. 175, the dotted section of No. 2 is the same as for V, except for its increased depth. When the hob has been thus threaded, the developed circumference at the point where the tops of the two threads cross each other will be shown in Fig. 176. Here lines FC and AH represent the top of thread No. 1, inclined at the threading angle θ as determined by the pitch, while the space included between lines AG and EC correspondingly represents the top surface of thread No. 2, inclined at angle θ'. These two threads have widths at the top of W and w, proportional to the pitch as before. The center lines of the tops of the two threads cut in the blank cross each other at point O. The top of the thread is seen to be cut in a parallelogram $ABCD$, this being the metal left after the grooves for the two different

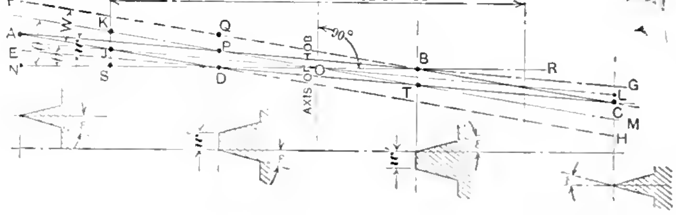

Fig. 176. Development of the Thread of a Hob of the Same Diameter as in Fig. 175, in which have been cut the Two Threads of the Two Hobs there shown

threads have been cut. Axial sections of this remaining fragment of the thread are shown on lines *FN*, *QD*, *BT* and *CH*; as may be seen, the inclination of the sides of the thread, as measured on an axial section at each of these points (and at all other points as well) is made ϵ.

A short hob, threaded as in Fig. 176, is shown in Fig. 177. Similar points in each figure have similar letters. Since the two sides of the teeth, which unite in point *B*, have the same inclination as measured on a plane passing through the axis of the hob, their intersection will also have the same inclination, and the line of intersection will pass through the axis of the hob. The same is true of point *D* on the other side of the thread. If the hob is gashed at *B* and *D*, the cutting edges thus formed are evidently common to both the large thread of width *W* and angle θ, and the small thread of width *w* and angle θ', and when properly set in the machine and rotated with the crown gear, the relation to the imaginary crown gear will correspond exactly to that gear in the position of either hob No. 1 or No. 2, in Fig. 174, the same hob thus taking the place of both.

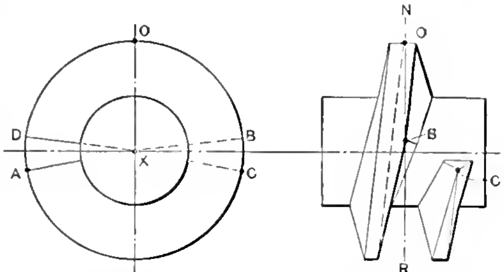

Fig. 177. Hob (ungashed) Produced by Combining the Two shown in Fig. 175; the Thread is the same as that shown Developed in Fig. 176.

It next remains to be shown that these two cutting edges at *B* and *D* in Fig. 177 can be made to correspond with all the sections of the crown gear intermediate between the large and the small ends in Fig. 174.

To prove this, we have to show that the sides of any thread cut in this hob with a center line passing through *O*, whose width of top and lead are in the same proportion as in Fig. 175, and whose sides have the same inclination as measured on an axial plane, will include the cutting edges *B* and *D*, which we have formed as described in the hob in Fig. 177. In Fig. 176 any thread of the given proportions, such as *FCAH*, will cut the horizontal line *NR* at *D*, in such a way that $OD : OS = DP : KS$. Now *DP* is half the width of the tooth on the axial section, and *KS* is half the circumferential pitch, so that $OD : OS = \frac{W'}{2} : \frac{P}{2} = W' : P$. But all the threads we are concerned with have this same ratio between *W'* and *P*, so that the sides of all of them cross line *RS* at *D*.

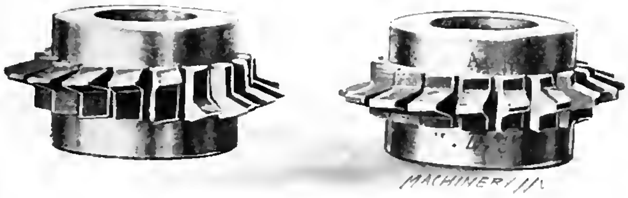

Fig. 178. The Completed Hobs as used in the Chambon Machine, Developed as shown in the Preceding Illustrations.

The same thing applies to the crossing at *B* on the upper side. The cutting edges, then, at *D* and *B* are common to all the hobs of the same diameter which will fill the required condition for the infinite number of sections between hobs Nos. 1 and 2 in Fig. 174.

In practice, the hob of Fig. 177, made as we have described, is gashed throughout the full length of the thread, as well as at the cutting edges *B* and *D*. Such a hob is shown in two positions in Fig. 178. The edges *B* and *D*, however, are the ones which are relied on to give the true shape to the teeth of the gear.

The next problem, and a somewhat complicated one, is that of providing a machine which will utilize this hob, in accordance with the principles of its construction, to take the place of the imaginary crown gear of Fig. 174 in generating teeth in a bevel gear blank. In the first place, the hob must be moved from the position occupied by No. 1 to that occupied by No. 2, changing its angle continuously meanwhile from θ to θ' to agree with the change in helix angle due to the change of pitch as the tooth grows smaller. Next, the hob and the blank being cut must be rotated with each other, so that the hob revolves during one revolution of the gear as many times as there are teeth in the latter, the hob being supposed to be single-threaded. These two conditions are easily fulfilled, but there still remains a third. The two cutting edges we have made for the hob represent the sides of each tooth of the imaginary crown gear only when each tooth in turn is passing the center line *CD*. In order to have a generating action on the blank, the imaginary teeth of the crown gear must have a cutting action over a considerable angle about *D*, on both sides of the section *CD*. This may be effected by rocking the holder which carries the hob about center *D* in either direction, meanwhile rotating the hob to keep its thread in the proper relation with the teeth of the crown gear, as if the latter was stationary. In the machine this oscillation of the hob and its carrier about *D*, on each side of *CD*, takes place continuously, while the hob is being fed down from the position occupied by No. 1 to that of No. 2, and the rotation of the hob required by this oscillation (to keep the hob and the crown gear continuously in step) is superimposed on the other rotation in unison with the imaginary crown gear and the work, the two being combined by differential gearing of the same style as required for combining the movements in spiral gear cutting machines as illustrated in Fig. 97. When this is done, a cutting edge will be provided by the hob, closely paralleling the molding action of the crown gear as shown at the right of Fig. 174.

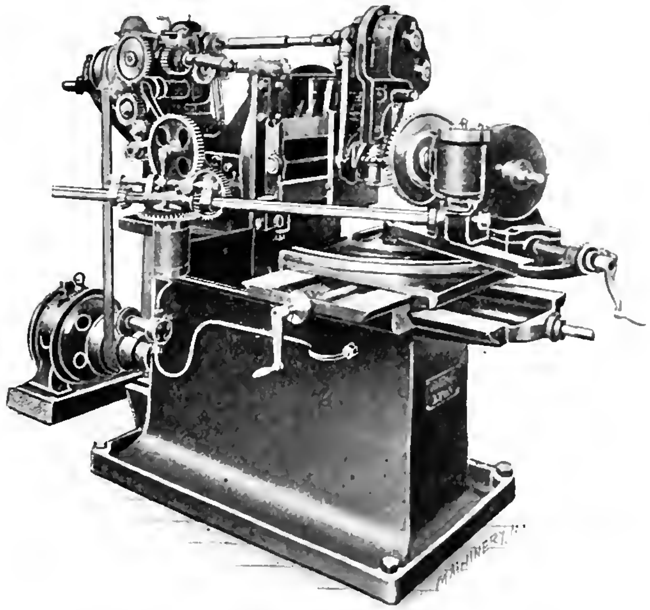

Fig. 179. The Chambon Continuous Bevel Gear Hobbing Machine, employing the Cutters shown in Fig. 178.

The machine for accomplishing all this is shown in Fig. 179. The work is mounted on an arbor, adjustable to any angle and to any axial position in relation to the hob. The spindle for the latter is mounted in a swinging carrier which slides on ways provided on the face of a head, which latter is oscillated about a horizontal axis. A suitable compensating movement is provided, so that this rocking movement is translated into the required rotary motion of the cutter, as was shown, to keep it from getting out of step with the imaginary crown gear, and for combining it properly with the constant rotation of the cutter, derived from its connection with the work-revolving mechanism. The spindle carrier feeds in along the ways of the oscillating head, being swung around by a templet as it proceeds, to change the helix angle θ as required. Suitable change gears are provided for all the movements, and one passing through of the continuously rotating hob finishes the gear complete. The mechanism is rather too

intricate to describe here in detail. A number of compensating movements are required, which add somewhat to its complexity.

We should not leave the discussion of this machine and its principle, ingenious though it is, without noting that the process involves a number of minor inaccuracies. For one thing, an error is introduced by the fact that in the machine the rocking of the spindle-head, carrying the hob, is about the axis *X′Y′*, instead of about axis *XY*, as it should be. (See Fig. 174.) This is doubtless done to avoid the complication of having to set the machine for the angle of the top of the crown tooth. The error introduced would be entirely negligible, except perhaps in the case of gears very closely approaching crown gears in their pitch cone angle. There are several other little discrepancies which, however, are scarcely worth taking into account.

In Fig. 180 is shown another machine operating on the Chambon plan, built by the Société Suisse pour la Construction des Machines-Outils Oerlikon, Oerlikon près Zurich, Switzerland. This machine employs the cutter in Fig. 179, but the mechanism is very much simpler, since the oscillating head and the connections required for operating it have been abandoned, the spindle slide being mounted directly on fixed ways on the front of the column. For this reason the generating action is not, it will be seen, fully carried out, the cutting action, however, resulting in the production of a groove tapering properly from the large to the small end and of approximately the correct shape. The machine is thus especially adapted to roughing blanks previous to finishing them in a planing machine operating on the templet or molding-generating principles. It is claimed to do its work with great rapidity, and to be capable of leaving a very small and uniform amount of stock over the whole area of the sides of the tooth.

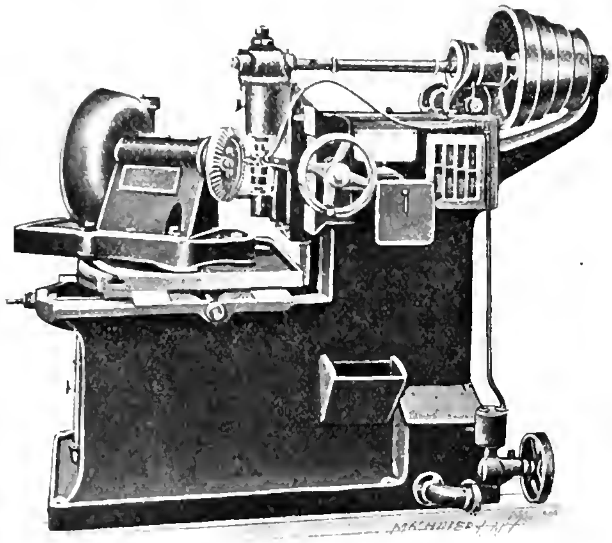

Fig. 180. The Chambon Bevel Gear Hobbing Machine as Developed by the Oerlikon Co., particularly adapted for Roughing Bevel Gears Preliminary to Planing.

Besides this Chambon process, another and, it seems to the writer, a fruitless attempt, has been made to cut the teeth of bevel gears by the molding-generating principle with a hob as the cutting tool. This method is shown in its principle in Fig. 181, the construction being referred to the imaginary crown gear and the bevel gear to be cut, as in the previous case. Also, as in the previous case, the action hinges about the design of the hob. Here we have a hob of such a taper, and with the pitch continuously decreasing in such a ratio, that the helix angle is constant. This decrease in pitch is, of course, accompanied by a correspondingly uniform and proportional decrease in the section of the thread. In the machine the hob is so set (in the "first position," for instance) that the center line of the thread in the cutting position passes through center *D* of the imaginary crown gear. Here the width of the top of the hob tooth is *W*, corresponding to the desired width at the top of the imaginary crown gear tooth. In feeding, the hob is moved, without changing the angle of its axis, along line *EF*, so that when it arrives at the inner end of the face of the imaginary crown gear, that tooth that is on the center line *CD* will be so near the small end of the hob that it has the required width at the top, *w*, and the proper pitch, to agree with the small end of the tooth in the imaginary crown gear. In a similar way, all the intervening positions match up with the teeth of the crown gear on line *CD*.

In the machine for utilizing this hob (which has been referred to in a number of English papers and described in an American contemporary*), it is mounted on a slide which is adjustable to give the line of feed, *EF*, the angle for the conditions required, while, as shown at the right of Fig. 181, the spindle of the hob is set at such an angle that its pitch cone is tangent to the pitch plane of the imaginary crown gear. The feeding movement along line *EF* is so connected with the rotating mechanism of the hob that, as it progresses from the first to the second position, the hob is rotated to keep its diminishing thread always coincident with the central tooth of the crown gear shown. In addition to the rotation thus given the hob by the feeding movement, another rotating movement is given it in connection with the work, the same as for all hobbing processes. These two rotating movements are combined by differential gearing. It will thus be seen that with the machine properly set up, the hob may be fed from the first to the second position, with the hob and work rotating together, the former being under a rotative influence from the feeding movement as well, giving somewhat the effect of the rotation of the ordinary crown gear.

What the writer feels sure, however, is a vital error in the principle of this machine, is plainly evident in Fig. 181, where it is seen that the only point where the teeth of the hob coincide with those of the imaginary crown gear is on line *CD*. At the right of *CD* and at the left of it the coincidence ceases, and the hob teeth cross the crown gear teeth at different angles, so that they must cut entirely different shaped spaces in the work. Of course, everything in the diagram shown is exaggerated, but the exaggeration only shows the principle more clearly. While it is stated that the machine and the process are beyond the experimental stage, and while, from long experience, the writer knows that it is unsafe to predict the failure of any principle until it has actually been tried out, the analysis given above is surely enough to make one skeptical as to the success of this operation, particularly in the case of gears of such large pitch cone angle as to nearly approach the crown gear. With smaller angles, down to the spur gear the action should be more nearly correct, as the blank curves away from the hob so rapidly as to avoid most of the interference, though even here the fact that the pitch is coarser at one side of the line *CD* than at the other would still prevent proper action. It would thus seem that interference would prevent the consideration of this device as a practical possibility. The inventor of this machine is Mr. F. J. Bostock, Birmingham, England.

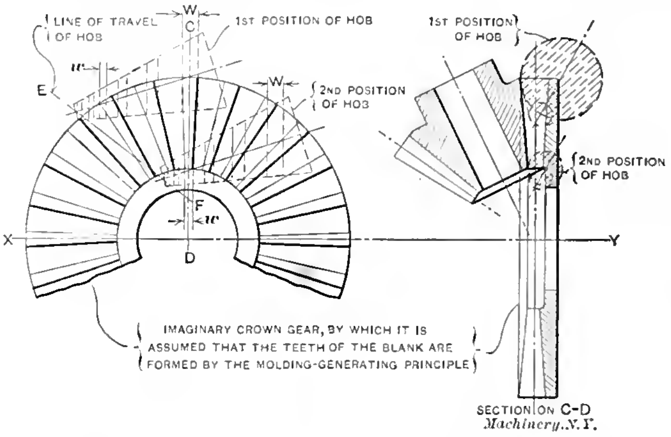

Fig. 181. The Principle of the Bostock Hobbing Process.

Comparison of Molding-Generating Machines for Bevel Gears.

It is interesting to note, in the various molding-generating machines for bevel gears, the different ways used for rolling the cutter head and the work in relation to each other. In the Bilgram machine the proper relation is maintained by

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* American Machinist, March 5, 1908.

the rolling of the pitch surfaces of the work and the crown gear on each other, the rolling being controlled by steel tapes or wires in such a way as to make the movement positive. In the Ducommun machine the same movement is effected by spherical linkage which, while not exact in its action, is so nearly so that the error introduced is entirely negligible. The Gleason and Ludwig Loewe machines employ segments of the actual crown and master gears shown in Fig. 139, although, of course, it is not necessary to have the teeth of the master gear of the same number for the full circle, and of the same form, as those of the work, the only requirement being that the pitch cone of the master gear be coincident with that of the work. In the Ernault machine the proper ratio of movement is obtained by a system of angular slides, which automatically adjust themselves to the required ratio (which is dependent on the pitch cone angle of the gear) in the manner described in referring to Fig. 169. Finally, in the Brown & Sharpe, Chambon, and Bostock machines the proper ratio is obtained by the use of change gears.

Another interesting point relates to the considerable size and complication of each of these machines, as compared with the small size of the work they are adapted to operate on. While the principle of the molding-generating process is comparatively simple, as shown in Fig. 139, considerable mechanism is required for making a machine built according to this principle universal in its application, easily set up and operated, and automatic in its operation.

Conclusion.

This concludes this series of articles on gear-cutting machinery. The number of commercial machines of this kind is much greater than was believed possible when the series was first undertaken. It is safe to say that in no other field of the machine tool business has there been such an opportunity for the display of mechanical ingenuity and skill in designing as in that of gear cutting, and in no field have these possibilities been so fully grasped. That we have not yet reached final development in any of the various forms of this machinery is shown by the fact that the past year has been particularly prolific in new designs, as may be seen from an inspection of the New Tools Department of the various issues of MACHINERY since January, when the series was commenced. Besides these, a number of new machines are in process of development in this country and Europe, and doubtless such as are worthy of mention will be brought to the attention of the readers of MACHINERY as soon as the information concerning them is available for publication.

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SUPERHEATING IN ENGLAND.

BRITISH CORRESPONDENT.

The opinions and experiences of engineers in the north of England engineering and manufacturing districts on the important subject of superheating are briefly summarized below, and may interest American readers, who will be able to compare them with American experience and with the opinions of American experts. The economy, which may be attained by superheating is now freely recognized in England, and although a great deal has yet to be learned respecting the nature of steam, the majority of steam users now exhibit less fear in the adoption of a practice which after its introduction for a time was received with disfavor. The actual steam users are not the only ones interested in superheating. Boiler and steam engine makers in England are fully alive to the fact that if steam engines are to successfully compete in efficiency with internal combustion motors, they must cooperate with each other with the object of securing the utmost possible percentage of heat units from every pound of coal put into the boiler furnaces. Even English colliery owners, who are not usually particular in the matter of fuel economy, are now beginning to recognize the fact that superheating offers too great a saving to be ignored.

In the case of gas engines, the size and the power of which are now steadily increasing in England, the problem of using the operative fluid is a comparatively simple one, and that probably accounts, to a large extent, for the success of this type of prime mover; but in the case of the steam engine, the fact that the steam may be gradually reduced to a liquid state during its stages of operation introduces risks of loss, which it has been the constant aim of engine builders to minimize, ever since the time of Watt. Multiple expansion has now been extended to its utmost limit; steam jacketing and reheating are only means to an end. Apparently, therefore, the only course left is to convert the steam temporarily into a gas by giving it such a degree of heat that there is no possibility of its condensation while passing through the cylinders of the engine. Condensation represents the principal source of loss in all reciprocating steam engines, and means of preventing it other than by superheating can only be regarded as palliatives. But it is not for reciprocating engines alone that superheating is found to pay. In the turbine engine, largely used in England in electric lighting stations, although the condensation of steam by cold external surfaces does not take place, it has been proved that superheating is an advantage. The steam in the turbine, as Prof. Watkinson, a well-known expert, has pointed out, is wet from another cause, namely, on account of the expansion it has undergone while doing work; consequently, the efficiency of this type of prime mover may be very considerably increased by superheating the steam prior to its admission to the steam chest. In the steam turbine the reduction in the amount of steam required when superheated is mainly due to the increased volume and the decreased frictional resistance between the rotating vanes and the steam. In one type of turbine in which the steam is discharged through nozzles, the flow has been found to vary or fluctuate, which is asserted to be due to partial choking of the nozzle with water. When the steam was superheated, the flow was found to be continuous and unvarying, to have a higher velocity, and consequently a much greater efficiency.

The soundness of the practice of superheating being therefore easily demonstrable, the question that faces the steam user is one of degree. It is generally understood in England that in the United States they are very conservative in regard to superheating, a "moderate superheat" being understood to mean from 100 to 150 degrees F. at the boiler, or about 100 degrees F. at the engine. This is considered in England a somewhat too moderate degree, which may probably entail reheating between the high-pressure and the low-pressure cylinders. In England, many engineers are not afraid of using higher temperatures. The engine builder is prepared for them, and the engineer is not afraid of his packings burning out or of his lubricants carbonizing. In consequence, no practical difficulties are encountered in superheating to a considerably higher extent. At the same time, it is very essential that the temperature of the superheated steam should be constant.

Early difficulties with the superheating tubes have also been overcome. Solid drawn steel is now being generally adopted in England in place of copper and cast iron, and the apparatus is therefore not only safer, but its life approximates more nearly the life of the boiler itself. The large English steam user, when invited to consider superheating, naturally asks what he may expect to save by it. On this point experiences vary very considerably, and the figures given by the makers of superheaters are subject to some discount. In a paper read some time ago before the Sheffield Municipal Electrical Association, Mr. R. S. Downe stated that, with a superheat of 500 degrees F., he could effect a saving in coal and steam amounting to between ten and twenty per cent. The saving is, of course, greater where the engines are working under uneconomical conditions, and where steam jacketing is used, or where the piping is inordinately long. A superheater attached to a boiler may abstract ten per cent of the heat in the flue gases, and reduce the efficiency of the boiler by something like the same figure, but as this extra ten per cent heat in the steam may reduce the engine losses by twenty per cent, the net gain is a substantial one, and justifies the adoption of superheating in the opinion of English users. Mr. Downe finds that the saving in steam is greater than the loss in coal, which is, of course, due to more fuel being required to obtain the superheat.

It is stated that 100 degrees F. of superheat in the steam turbine gives an extra economy of 12 per cent. and it has been estimated at 20 per cent with 350 degrees of superheat.

Superheating in the turbine secures dry steam, and freedom from the clogging of the blades and guides by water.

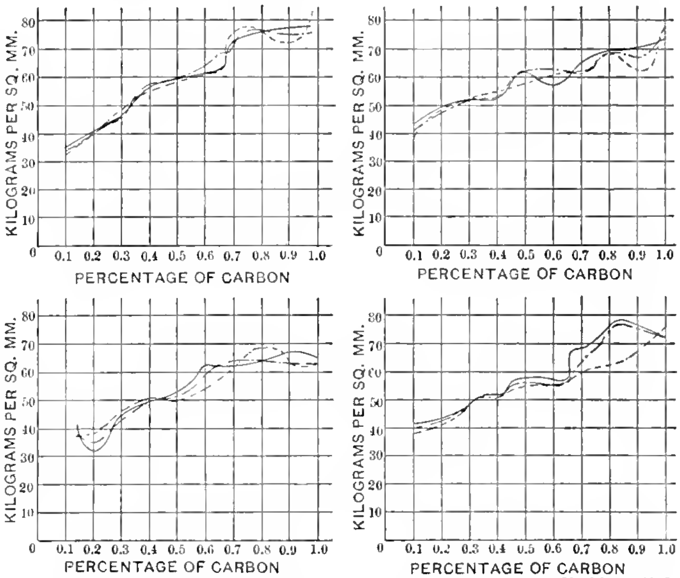
It may be of interest to add here the views of those not favorably impressed with superheating. They suggest that many practical engine builders object to superheat exceeding 150 degrees F., as valves and cylinders are apt to become scored. It is true that by adopting drop valves, instead of Corliss or slide valves, the troubles can be reduced, though not entirely avoided, but there are objections to the change. The new valves and valve gear necessitate new designs and patterns, and in addition bring along special operating troubles of their own. Most turbines have a natural advantage over the reciprocating engine so far as the use of superheated steam is concerned, because they have no bearing or rubbing surfaces under pressure exposed to the action of the superheated steam. On the other hand, the fine clearances, which are so desirable in the working parts, are more influenced and altered by superheated steam. This is especially the case in reaction turbines. In blades of certain nickel alloys, highly superheated steam has been found to produce brittleness.

As regards the economy of superheated steam, it is usually taken for granted that it effects a substantial one. Information, the opponents claim, on this point is limited, owing in part to a tendency of comparatively recent growth for engineers to speak of the performance of an engine in terms of the weight of steam consumed per horse-power. It is not so long since it was usual to estimate the performance in terms of the coal consumption at the boiler. This, of course, by introducing the unknown efficiency of the boiler as a factor, rendered comparisons of engine efficiencies a very difficult and uncertain matter. This was recognized, and in order to eliminate the boiler from the comparison, the weight of steam consumed is now generally the basis of comparison. But superheated steam contains more heat than saturated steam, and assuming that the boiler efficiency remains unaltered, it is clear that the weights of saturated and superheated steam used by the same engine are not directly of use for comparing the efficiencies in the two cases. Thus, tests show that a good steam engine or turbine will have its steam consumption reduced by about 1.7 pound of steam per kilowatt hour, or from 8 to 10 per cent of the normal steam consumption, for every 100 degrees F. of superheat. Taking the higher figure so as to allow everything possible to the superheated steam, it must be pointed out that these figures do not signify that the coal consumption is reduced by 10 per cent. With independently fired superheaters, the coal consumption is probably no less than with saturated steam. With ordinary fine or integral superheaters the effect on the coal consumption depends upon whether or not an economizer is fitted, and the position of the superheater, whether directly over the fire or in the flue, meeting the gases after leaving the boiler proper. Superheaters are most economical when there is no economizer, and in that case should never meet the hot gases before they reach the boiler heating surface.

If it be assumed that the over-all efficiency of the boiler is not affected by the superheater, then the extra heat in a given weight of steam as compared with saturated steam is about 5 per cent for 100 degrees of superheat. The decrease in the steam consumption being 10 per cent, the net economy of fuel is 5 per cent, or, say, from 0.07 to 0.1 pounds of coal per indicated horse-power hour for the main engine. The question is whether or not this saving in fuel pays for the means employed to obtain it. With a 1,000-horse-power engine for one year, the charges on the superheater for interest, depreciation and maintenance at 12½ per cent would be about £35. For each 1 per cent of the engine's maximum yearly output (continuous running day and night at full load), the saving in fuel would be from three to four tons. From this, the saving can be estimated under any given conditions of working, and for any given price of fuel. For instance, consider a mill or factory in which the engine output is 35 per cent of the maximum, coal costing 6 shillings a ton, delivered. The coal is usually slack: the greater saving in weight of four tons per 1 per cent, or 140 tons per year may, therefore, be taken. This gives a reduction in the coal bill of £42, or a saving over the fixed charges of £7 per year; with dearer coal a larger saving would result.

THE BRINELL METHOD OF TESTING THE HARDNESS OF METALS.

The method of testing the hardness of metals devised by Mr. J. A. Brinell has received very favorable attention from metallurgists in this, as well as in other countries. In 1900 Mr. Brinell, then chief engineer and technical manager of the Fagersta Iron and Steel Works in Sweden, first made public his method of testing the hardness of iron and steel, by submitting it to the Society of Swedish Engineers in Stockholm. At the meeting of the *Congrès International des Méthodes d'Essai des Matériaux de Construction* in Paris the same year the method attracted general attention, and its merits were duly acknowledged by awarding the inventor with a personal *Grand Prix* at the Paris Exposition. The method was first described in the English language by Mr. Axel Wahlberg in a paper before the Iron and Steel Institute in 1901. Since then, the practical value of this method has been amply substantiated on various occasions by means of comprehensive tests and investigations undertaken by several distinguished scientists in different countries. In working out his method, Brinell kept in view the necessity of taking into account the requirements that the method must be trustworthy, must be easy to learn and apply, and capable of being used on almost any piece of metal, and particularly, to be used on metal without in any way being destructive to the sample.



Machinery,N.Y.

Fig. 1. Diagrams showing Relation between Results Obtained by Various Methods for ascertaining the Ultimate Strength of Materials.

Principle of Method for Testing Hardness of Metals.

The Brinell method consists in partly forcing a hardened steel ball into the sample to be tested so as to effect a slight spherical impression, the dimensions of which will then serve as a basis for ascertaining the hardness of the metal. The diameter of the impression is measured, and the spherical area of the concavity calculated. On dividing the amount of pressure required in kilogrammes for effecting the impression by the area of the impression in square millimeters an expression for the hardness of the material tested is obtained, this expression or number being called the *hardness numeral.* In order to render the results thus obtained by different tests directly comparable with one another, there has been adopted a common standard as well with regard to the size of ball as to the amount of loading. The standard diameter of the ball is 10 millimeters (0.3937 inch) and the pressure 3,000 kilogrammes (6,614 pounds) in the case of iron and steel, while in the case of softer metals a pressure of 500 kilogrammes (1,102 pounds) is used. Any variation either in the size of the ball or the amount of loading will be apt to occasion more or less confusion without there being any advantage to compensate for such inconvenience. Besides, making any comparisons between results thus obtained in a different manner would be more or less troublesome, and complicated calculations would be required.

The diameter of the impression is measured by means of a microscope of suitable construction, and the hardness numeral

may be obtained without calculation directly from the table given herewith, worked out for the standard diameter of ball and pressures mentioned. The formulas employed in the calculation of this table are as follows:

$$y = 2\pi r\,(r - \sqrt{r^2 - R^2}) \qquad (1)$$

$$H = \frac{K}{y} \qquad (2)$$

In which formulas

r = radius of ball in millimeters,
R = radius of depression in millimeters,
y = superficial area of depression in square millimeters,
K = pressure on ball in kilogrammes,
H = hardness numeral.

Suppose, for instance, that the radius of the ball equals 5 millimeters (0.1968 inch), and that the test is undertaken on a piece of steel, the pressure consequently applied being 3,000 kilogrammes (6,614 pounds). Assuming that we found the diameter of the depression equal to 2 millimeters (0.7874 inch) by measurement, we have:

$$2\ \pi \times 5\ (5 - \sqrt{25 - 4}) = 13.13 = y,$$

and

$$\frac{3{,}000}{13.13} = 228 = H,$$

which as we see agrees with the figure given in our table for a 4 millimeters diameter of impression.

TABLE OF HARDNESS NUMERALS.

Steel ball of 10 millimeters diameter.

Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.		Diameter of Impression, mm.	Hardness Numeral. Pressure, kg.	
	3000	500		3000	500		3000	500		3000	500		3000	500
2.00	946	158	3.00	418	70	4.00	228	38	5.00	143	23.8	6.00	95	15.9
2.05	898	150	3.05	402	67	4.05	223	37	5.05	140	23.3	6.05	94	15.6
2.10	857	143	3.10	387	65	4.10	217	36	5.10	137	22.8	6.10	92	15.3
2.15	817	136	3.15	375	63	4.15	212	35	5.15	134	22.3	6.15	90	15.1
2.20	782	130	3.20	364	61	4.20	207	34.5	5.20	131	21.8	6.20	89	14.8
2.25	744	124	3.25	351	59	4.25	202	33.6	5.25	128	21.5	6.25	87	14.5
2.30	713	119	3.30	340	57	4.30	196	32.6	5.30	126	21	6.30	86	14.3
2.35	683	114	3.35	332	55	4.35	192	32	5.35	124	20.6	6.35	84	14
2.40	652	109	3.40	321	54	4.40	187	31.2	5.40	121	20.1	6.40	82	13.8
2.45	627	105	3.45	311	52	4.45	183	30.4	5.45	118	19.7	6.45	81	13.5
2.50	600	100	3.50	302	50	4.50	179	29.7	5.50	116	19.3	6.50	80	13.3
2.55	578	96	3.55	293	49	4.55	174	29.1	5.55	114	19	6.55	79	13.1
2.60	555	93	3.60	286	48	4.60	170	28.4	5.60	112	18.6	6.60	77	12.8
2.65	532	89	3.65	277	46	4.65	166	27.8	5.65	109	18.2	6.65	76	12.6
2.70	512	86	3.70	269	45	4.70	163	27.2	5.70	107	17.8	6.70	74	12.4
2.75	495	83	3.75	262	44	4.75	159	26.5	5.75	105	17.5	6.75	73	12.2
2.80	477	80	3.80	255	43	4.80	156	25.9	5.80	103	17.2	6.80	71.5	11.9
2.85	460	77	3.85	218	41	4.85	153	25.4	5.85	101	16.9	6.85	70	11.7
2.90	444	74	3.90	241	40	4.90	149	24.9	5.90	99	16.6	6.90	69	11.5
2.95	430	73	3.95	235	39	4.95	146	24.4	5.95	97	16.2	6.95	68	11.3

Relation between Hardness of Materials and Ultimate Strength.

It has been pointed out by Mr. Brinell himself that this method of testing hardness of metals offers a most ready and convenient means of ascertaining within close limits the ultimate strength of iron and steel. This, in fact, is one of the most interesting and important results of this method of measuring hardness. In order to determine the ultimate strength of iron and steel, it is only necessary to establish a constant coefficient determined by experiments which serves as a factor by which the hardness numerals are multiplied, the product being the ultimate strength. Rather comprehensive experiments were undertaken with a considerable number of specimens of annealed material obtained from various steel works for the purpose of establishing the coefficient by the present director of the Office for Testing Materials of the Royal Technical Institution at Stockholm. The results obtained were as follows:

For hardness numerals below 175, when the impression is effected transversely to the rolling direction, the coefficient equals 0.362; when the impression is effected in the rolling direction, the coefficient equals 0.354.

For hardness numerals above 175, when the impression is effected transversely to the rolling direction, the coefficient equals 0.344; when the impression is effected in the rolling direction, the coefficient equals 0.324.

If the hardness numerals are multiplied by these coefficients, the result obtained will be the ultimate tensile strength of the material in kilogrammes per square millimeter. It is evident that coefficients can easily be worked out so that if the hardness numerals be multiplied by these the strength could be obtained in pounds per square inch. Suppose for instance, that a test of an annealed steel bar by means of the Brinell ball test gave an impression of a diameter of 4.6 millimeters. Then the hardness numeral, according to our table, would be 170, and the ultimate tensile strength consequently 0.362 × 170 = 61.5 kilogrammes per square millimeter, provided the impression was effected transversely to the rolling direction.

In Fig. 1 are shown a number of diagrams which indicate the results obtained at the tests undertaken to ascertain the coefficients given. In these diagrams the full heavy line indicates the tensile strength of the material, as calculated from the ball tests in the rolling direction. The dotted lines indicate the strength as calculated from the ball tests in a transversal direction, and the "dash-dotted" lines show the actual tensile strength of the material as ascertained by ordinary methods for ascertaining this value. It is interesting to note how closely the three curves agree with one another, and considering the general uncertainty and variation met with when testing the same kind of material for tensile strength by the ordinary methods, it is safe to say that the ball test method comes nearly as close to the actual results as does any other method used. Especially within the range of the lower rates of carbon, or up to 0.5 per cent, or in other words, within the range of all ordinary construction materials, the coincidents are, in fact, so very nearly perfect as to be amply sufficient to satisfy all practical requirements.

In the case of any steel, whether it be annealed or not, that has been submitted to some further treatment of any other kind than annealing, such as cold working, etc., or in the case of any special steel, there would be other coefficients needed which would then also be ascertained by experiments. The same coefficient, however, will hold true for the same kind of material having been subjected to the same treatment. Thus, the ball testing method for strength is equally satisfactory, and far more convenient, in all cases where the rupture test would be applied. One of the greatest advantages of the Brinell method is that in the case of a large number of objects being required to be tested, each one of the objects can be tested without demolition, and without the trouble of preparing test bars.

Application of the Brinell Ball Test Method.

Summarizing what has been said in the previous discussion, and adding some other important points, we may state the various uses for which the Brinell ball test method may

be applied, outside of the direct test of the hardness of constructing materials and the calculation from this test of the ultimate strength of the materials, as follows:

1. Determining the carbon content in iron and steel.

2. Examining various manufactured goods and objects, such as rails, tires, projectiles, armor plates, guns, gun barrels, structural materials, etc., without damage to the object tested.

3. Ascertaining the quality of the material in finished pieces and fragments of machinery even in such cases when no specimen bars are obtainable for undertaking ordinary tensile tests.

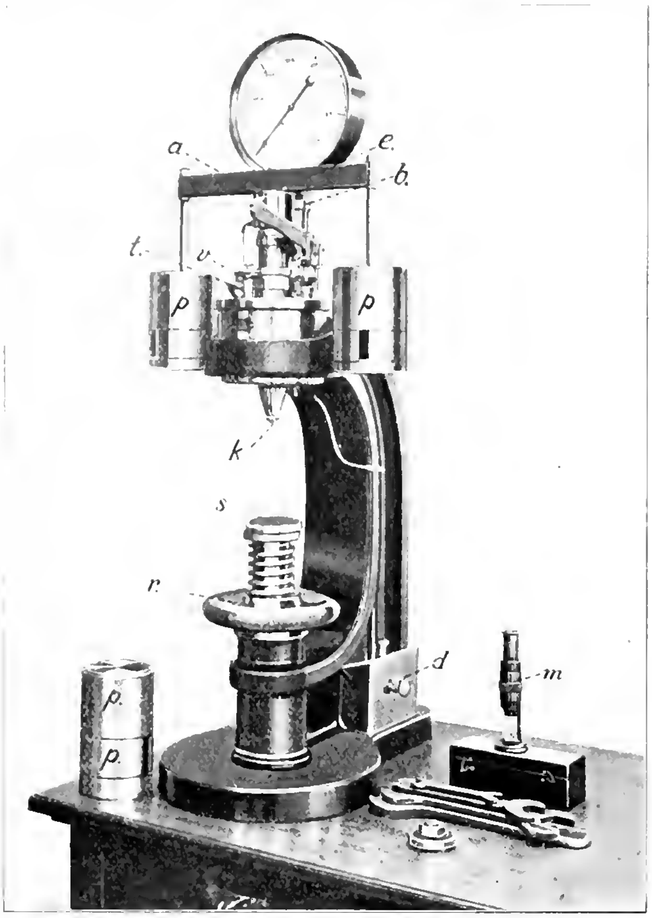


Fig. 2. Aktiebolaget Alpha's Machine for Testing Hardness of Materials.

4. Ascertaining the effects of annealing and hardening of steel.

5. Ascertaining the homogeneity of hardening in any manufactured articles of hardened steel.

6. Ascertaining the hardening power of various quenching liquids, and the influence of temperature of such liquids on the hardening results.

7. Ascertaining the effect of cold working on various materials.

Machines used for Testing the Hardness of Metals by the Brinell Method.

The method of applying the Brinell ball test was at first only possible in such establishments where a tensile testing machine was installed. As these machines are rather expensive, the use of the ball test method was limited. For this reason a Swedish firm, Aktiebolaget Alpha, Stockholm, Sweden, has designed and placed on the market a compact machine specially intended for making hardness tests. This machine, as shown in Fig. 2, consists of a hydraulic press acting downward, the lower part of the piston being fitted with a 10-millimeter steel ball *k* by means of which the impression is to be effected in the surface of the specimen or object to be tested. This object is placed on the support *s* which is vertically adjustable by means of the hand-wheel *r*, while at the same time it can be inclined sideways when this is needed on account of the irregular shape of the part tested. The whole apparatus is solidly mounted on a cast iron stand. The pressure is effected by means of a small hand pump, and the amount of pressure can be read off directly in kilogrammes on the pressure gage mounted at the top of the machine.

In order to insure against any eventual non-working of the manometer, this machine is fitted with a special contrivance purporting to control in a most infallible manner the indications of that apparatus, while at the same time serving to prevent any excess of pressure beyond the exact amount needed according to the case. This controlling apparatus consists of a smaller cylinder, *a*, directly communicating with the press-cylinder. On being loaded with weights corresponding to the amount of pressure required, the piston in this cylinder will be pushed upward by the pressure effected within the press-cylinder at the very moment when the requisite testing pressure is attained. Owing to this additional device, there can thus be no question whatever of any mistake or any errors as to the testing results, that might eventually be due to the manometer getting out of order.

Method of Performing the Ball Test.

The test specimen must be perfectly plane on the very spot where the impression is to be made. It is then placed on the support *s*, Fig. 2, which, as mentioned, is adjusted by means of the hand-wheel *r* so as to come into contact with the ball *k*. A few slow strokes of the hand pump will then cause the pressure needed to force the ball downward, and a slight impression will be obtained in the object tested, but as soon as the requisite amount of pressure has been attained, the upper piston is pushed with the controlling apparatus upward, as previously described. On testing specimens of iron and steel, the pressure is maintained on the specimen for 15 seconds, but in the case of softer materials for at least half a minute. After the elapse of this time, the pressure is released, and the contact between the ball and the sample will cease. A spiral spring fitted within the cylinder, and being just of sufficient strength to overcome the weight of the press piston, pulls the same upward into its former position, while forcing the liquid back into its cistern. The diameter of the impression effected by the ball is then measured by the microscope *m*, which is specially constructed for this purpose, the results obtained by this measurement being exact within 0.05 millimeter (0.002 inch). Fig. 3 shows a cross-section through the cylinder and piston part of the machine. Another type of machine is designed for special tests in which very high pressures are required. The ball in this machine is 19 millimeters (0.748 inch) in diameter, and the pressures employed vary from 3 to 50 tons. The construction and operation are otherwise exactly the same as that of the smaller machine in Fig. 2.

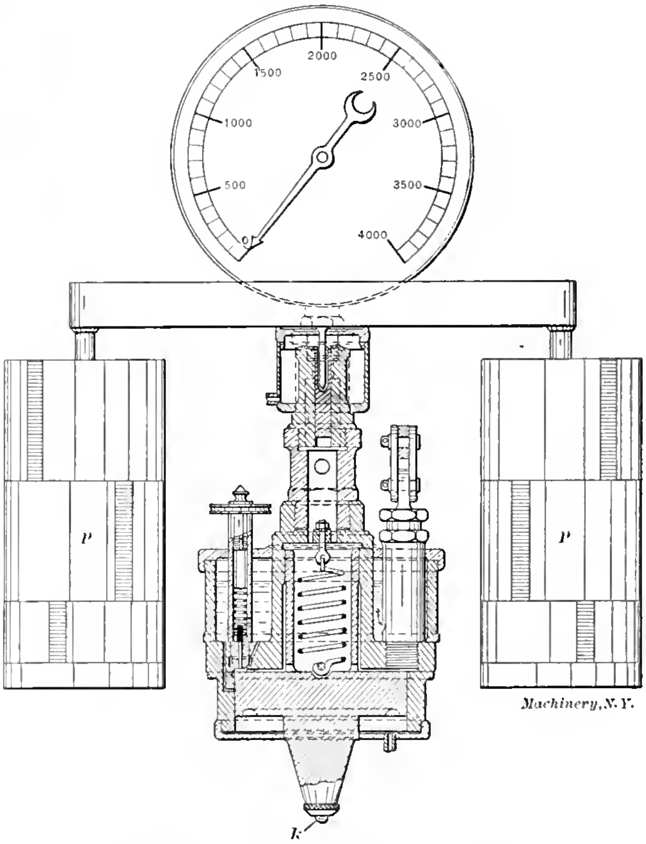


Fig. 3. Section of Press Cylinder of Machine in Fig. 2.

DROP FORGE WORK IN AN AUTOMOBILE SHOP.*

ETHAN VIALL.†

Ethan Viall.‡

Very little of value has been written on drop forging die work and shop practice as it actually exists in the modern drop forging shop. Here and there, a solitary die or device has been pictured and described, or a few sketches made of dies that may be entirely imaginary, so far as can be learned from any evidence offered, and which are of such a simple and elementary nature as to convey no adequate idea whatever of the magnitude or difficulty of the work, to anyone not familiar with it. This class of contributions covers the greater part of what has been published on a practice that has grown and developed from the hand forging process of the hammer and anvil, to one of the most important branches of modern machine industry.

Hundreds of parts that were formerly cast from malleable iron are now drop forged, the extra cost being more than made up by the uniformity, strength and reliability of the product; and no one has been quicker to realize this than the really live, up-to-date automobile manufacturer to whom the mechanical world is indebted for so many other valuable mechanical developments.

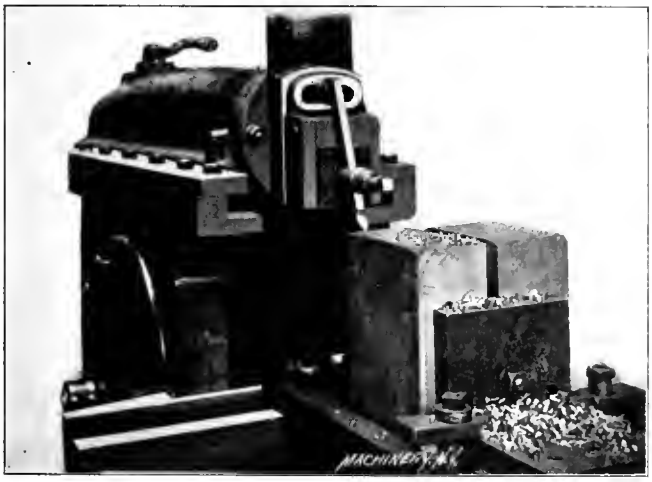


Fig. 1. Planing a Die-block on a Shaper.

The making of drop forging dies, together with the hardening process through which they are put and the methods of using them, is a trade in itself, though closely allied to tool and die making as understood in the big shops of to-day. Each branch of shop work presents its individual problems, and a tool- and die-maker, though skilled in other lines, cannot go into a forging shop and make drop forge dies without special instruction and training.

In drop forge die work, as in other kinds of tool work, there are various grades of accuracy and finish required. Some forgings must come from the hammer practically finished to size, while others are made large enough to allow considerable machining. Where only a few pieces of a rough nature are required, little skill is needed in the making or maintenance of the dies, but where small accurate parts are to be made in large quantities, special tools for both hand and machine use, and trained, skillful diemakers are needed, as well as a careful selection of the steel used

Materials for, and Life of, Drop Forging Dies

Steel, cast into blocks, is not suitable for this work, as flaws or blowholes are likely to develop where least expected or desired, so as a general rule, forged blocks of open hearth crucible steel are used. These blocks are either purchased ready forged, in various sizes, from the steel manufacturers, or are forged in the shop where they are used, the former plan being the usual one.

A rough estimate as to the average life of a drop forging die, used for medium sized work on Bessemer steel, was given by a foreman of long experience, as about forty thousand pieces. Some dies might be broken immediately when put in operation, while others might stand for a hundred thousand pieces or even more.

Automobile Shop Drop Forging Practice.

In preparing this article, the photographs and data were obtained in the factory of Thomas B. Jeffery & Co., Kenosha, Wisconsin, the manufacturers of the famous "Rambler" automobile. This company's drop forging department is far ahead of anything outside of the big concerns that make a specialty of drop forgings, and consists of a well-lighted, finely-equipped tool-room, used only for drop forge die work, a thoroughly up-to-date hardening plant, and a big building full of steam hammers, punch presses, heating furnaces and every appliance necessary for first-class work. This department is under the direct supervision of one of the best all-round drop forge men in the West.

The greater part of the drop forgings made here are of Bessemer bar steel, though some of the more particular automobile fittings are made of special grades of tool steel. All of the drop forging dies are of the highest class, calling for the best die-making skill, and necessitating a great deal of hand work in addition to the most accurate machining.

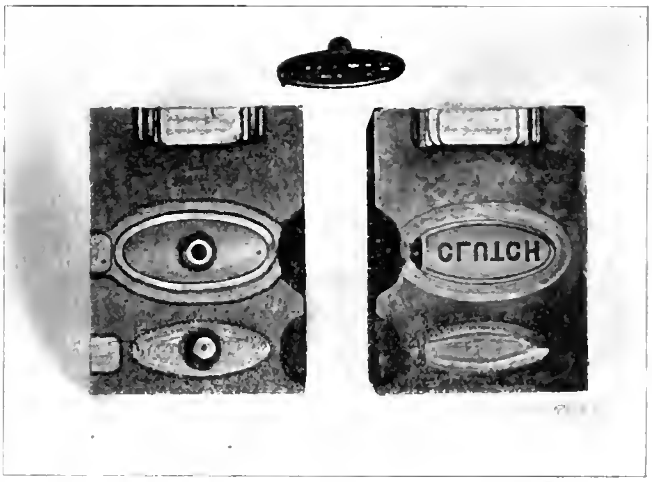


Fig. 2. A Pair of Typical Drop Forging Dies and Their Work

Making a Die.

In the original outlining of a set of drop forging dies, the measurements for the forming cavities may be taken from a blue-print supplied by the drafting-room, or they may be taken from a piece already made—possibly a forging or a lead casting obtained from some former set of dies, or perhaps a piece made up for a model. Sometimes a sheet metal templet is made to assist in obtaining the desired shape of the die cavities, while in other cases, only the outline scribed on the coppered surface, together with the necessary measurements, is needed. The size and outline of the forging to be made, as well as the accuracy required, govern the method of procedure.

The die blocks, which, as already stated, are forged of open hearth crucible steel, are first placed in a shaper and carefully surfaced off to the required dimensions, as shown in Fig. 1. These blocks are made over-size, so that enough of the surface can be machined off to insure good, sound metal to work on. The outlines for the breaking-down or roughing, the finishing, and sometimes the bending forms are then laid

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* For previous articles on drop forging, see "Drop and Stamped Forgings," by Joseph Horner, May, 1908, and the previous articles there referred to.

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‡ Ethan Viall was born in Kalamazoo, Mich., in 1873. He received a high school education, and took a course in mechanical engineering in a night school. He served an apprenticeship with E. T. Harris Co., Chicago, Ill., and has worked for the Pope Mfg. Co., Hartford, Conn.; Onward Mfg. Co., Williams-Lloyd Co., E. Goldman Co., Whelpley-Payson Co., all of Chicago; Ford Auto Co., Detroit, Mich.; and H. Mueller Mfg. Co., Decatur, Ill., with which concerns he has held positions of foreman of tool, machine and forge departments, and superintendent. His specialty is tool and die work.

off on the coppered faces, and the cavities roughed out on the drill press or lathe as the case may require, or on the profiling machine, as shown in Fig. 3.

The same set of dies shown in this engraving is shown still further roughed out in Fig. 2. The shape of the forging to be made in this set is shown at the top of the illustration, and it is a foot pedal for a clutch lever. The channel for the fin, or "flash," which is formed in the finishing operation, is plainly shown in the middle cavities.

The letters, C L U T C H, were first lightly stamped on the metal with special steel letters to get the outline; then they were chiseled out, and finally finished by driving in the steel letters to smooth up the roughness caused by chiseling.

Fig. 4 shows the final cuts being taken on the breaking-down part of this die, the rest of the work consisting of scraping, gouging and chiseling.

Tools Employed in Making Dies.

For the hand work, the die block is held in a special "ball vise" which is shown in Fig. 5. A vise of this type is the handiest device imaginable for heavy die work. This illustration also shows the breaking-down part of the die a little more plainly than the previous examples.

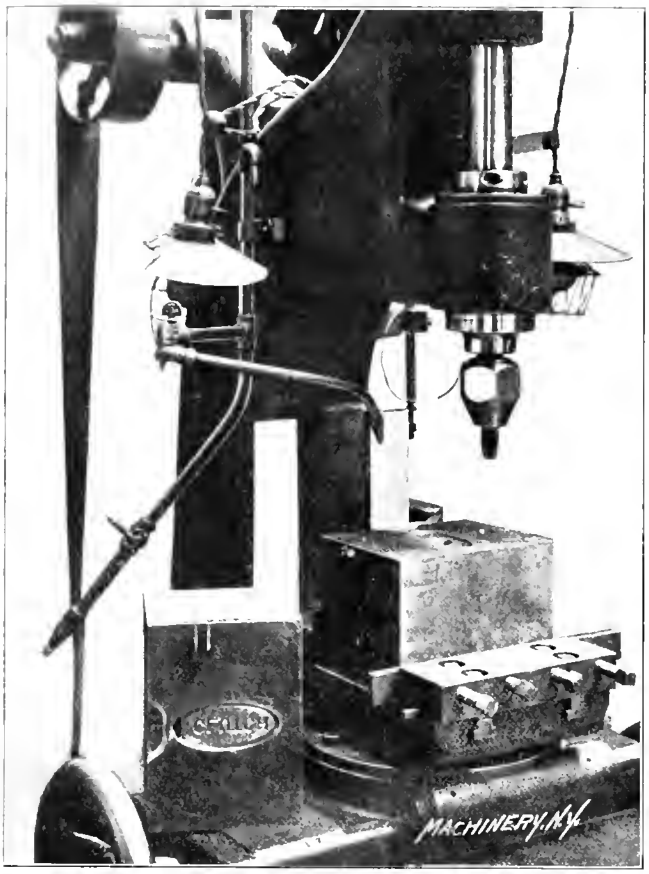

Fig. 3 Profiling Machine much Used in Die-sinking

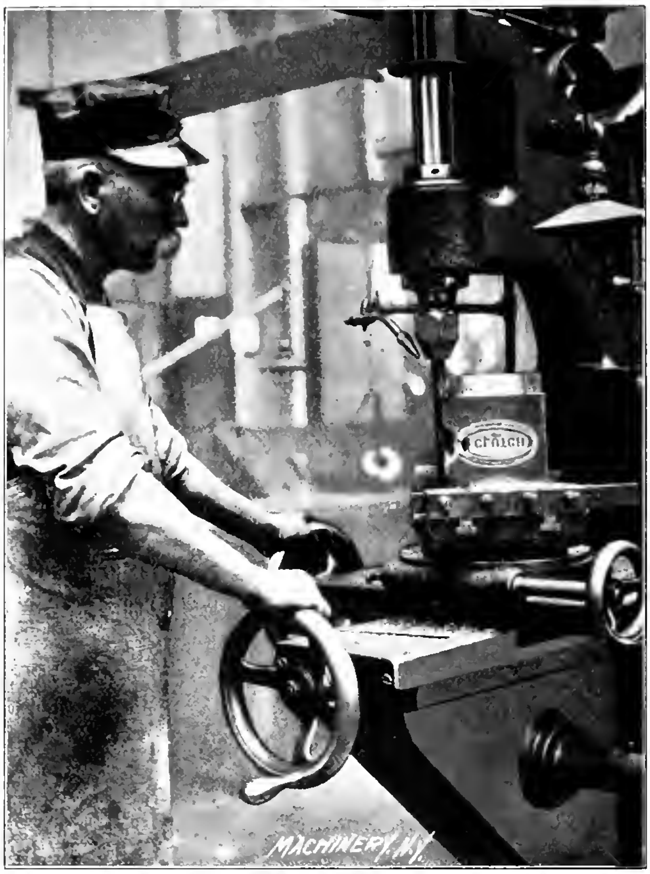

Fig. 4. Finishing the Die shown in Fig. 2 on the Profiling Machine.

Fig. 5 Special "Ball Vise" used in Sinking Drop Forging Dies.

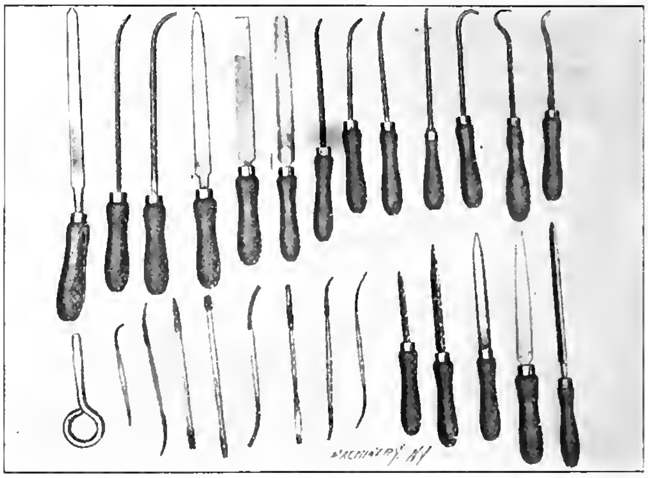

Fig. 6. Scrapers, Files, Rifflers and other Tools used by Die-sinkers.

Fig. 6 shows a few of the tools, scrapers, and rifflers used in the finishing work. These are mostly made of old files and are ground or bent to suit the needs of particular cases.

In Fig. 7 are some of the milling tools that have been made especially for this work. Only twenty-four of them are shown, though several hundred of all shapes and sizes are in stock. Another set of special cutters is shown in Fig. 8. Two of these have a single inserted blade or "fly-cutter" held in place by a set-screw, and are very useful tools for some kinds of work.

The tools shown in Fig. 9 are known as "types," and are used in scraping out cylindrical cavities to size. These types are turned to the proper size, and when used are smeared with lead and rocked back and forth in the partly finished cavity. The metal is then scraped away wherever the lead shows. For cylindrical work, these types are indispensable tools.

The tools shown in Fig. 10 were made by one of the expert die sinkers in the Jeffery shop. The tool shown at the right is used to scribe an outline from a forging. It consists of a hardened steel blade, with a point on one end, set into a flat steel block in such a way that it is free to move up and down to a limited extent. The rivet shown on the side passes

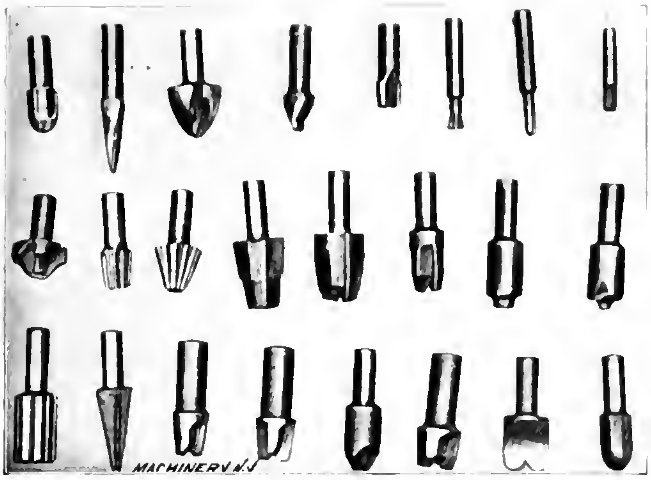

Fig. 7. A Few Milling Tools used in Die-sinking.

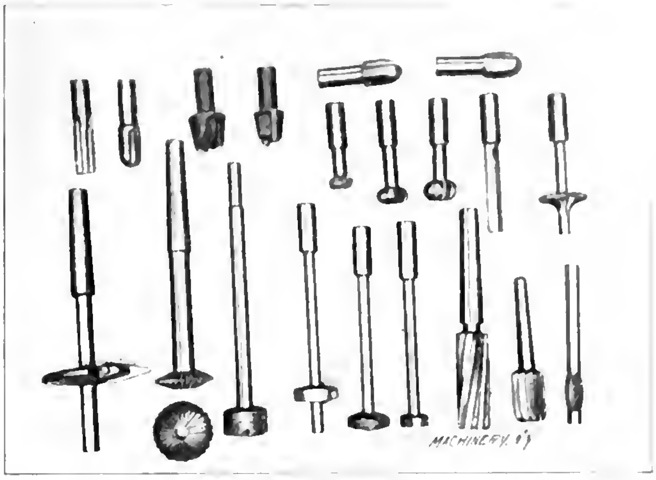

Fig. 8. Milling Tools used in Die-sinking, with Examples of Fly Cutters

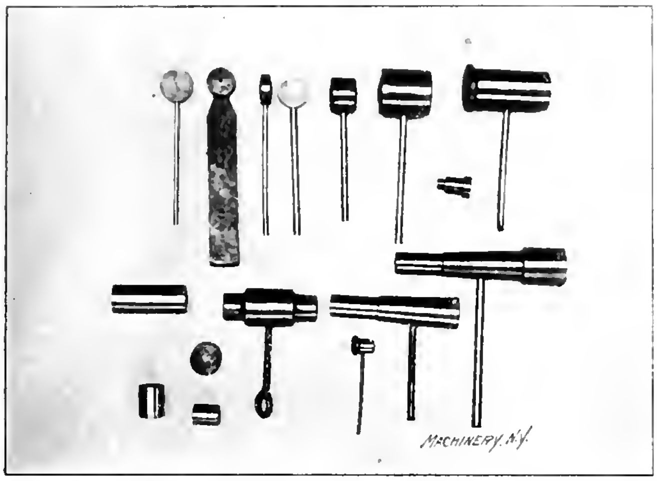

Fig. 9. "Typing" Tools used by Die-sinkers to Form Circular Cavities.

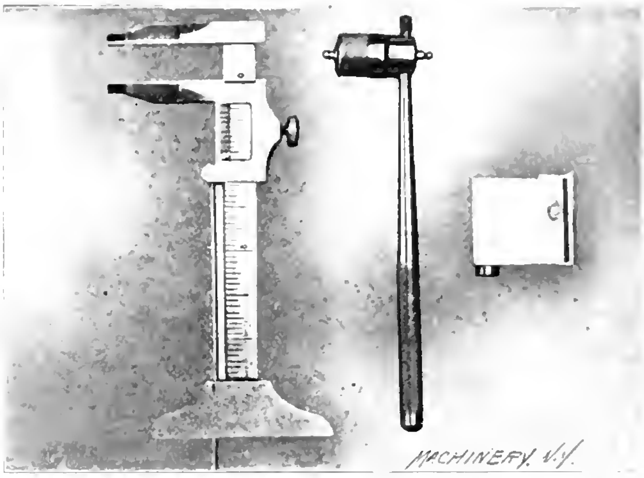

Fig. 10. Vernier Caliper Depth Gage, Inside Micrometer, and Scribing Block.

Fig. 11. Samples of Lead Castings or Proofs taken from Drop Forging Dies for Testing the Accuracy of Outline.

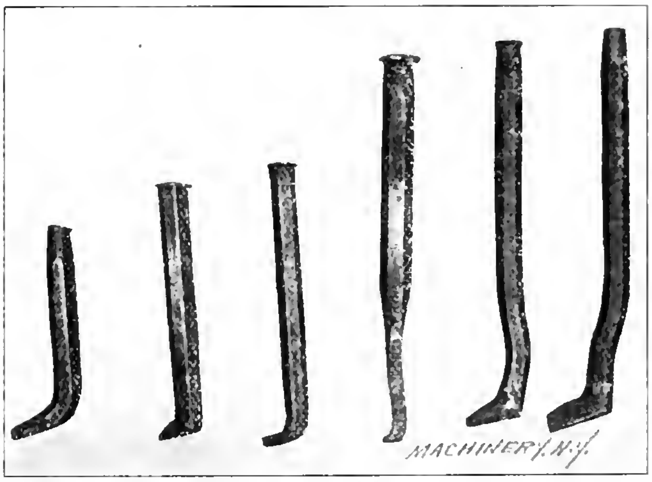

Fig. 12. Staking Tools used to Repair Worn and Cracked Drop Forging Dies

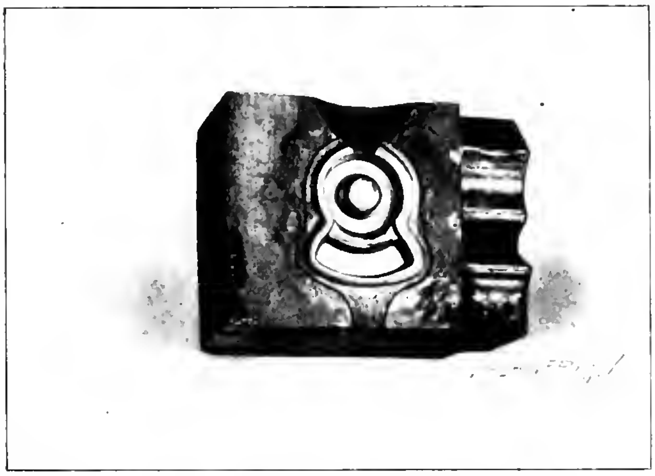

Fig. 13. An Example of Drop Forging Die showing Breaking-down Die at the Right.

Fig. 14. Drop Forging Die showing both Edging and Flatting Breaking-down Dies.

through a short slot in the blade. When in use, a flat spring on the top edge of the tool presses the point down onto the coppered surface, causing a mark wherever moved. To use this tool, it is held on edge with the point down and the edge of the hardened blade in contact with the forging. The steel block keeps the blade perpendicular, and by keeping the edge of the blade in contact with the forging while scribing, a correct outline is obtained, which could not be done with an ordinary scriber on account of the working outline being considerably above the die face.

The middle tool shown in Fig. 10 is a one-inch inside micrometer, which was made by the die-sinker because he could not buy one small enough for the purpose. The other tool is a regular stock caliper square, to which has been added a depth gage. The gage is so made that the rod projects the same distance that the caliper jaws are apart. The usefulness and convenience of this tool are at once apparent to a toolmaker.

Examples of Drop Forging Dies.

One-half of a die set, showing the breaking-down and finishing forms, is illustrated in Fig. 13. In this illustration the method of leaving a ridge around the finishing form and cutting a channel for the fin is very plainly shown. This method is followed in all of the drop forge dies made in the Jeffery shop. Fig. 14 shows a more complicated die. In this, both edging and flatting breaking-down die forms are shown. In using this die, the hot bar from which the forging is being made, is alternately swung from one to the other form, it being held edgewise in one and flat in the other, and given a blow or two until sufficiently reduced for the finishing form, after which it is cut off from the bar by a shear fastened to the hammer at one side of the die block.

In Fig. 15 the roughing or breaking-down die is shown and also a bending form, the bar being roughed into shape, and then bent and finished. Of course, in these last two illustrations it is understood that the cuts show only one-half of the set, the other half corresponding in shape to the one shown in such a way as to produce the desired shape. To better illustrate this for the benefit of those not familiar with this class of work, both halves of a set of dies are shown in Figs. 16 and 17. These show the complete forging and bending parts for this particular piece. The end of the finishing form also shows a place where one of the types illustrated in Fig. 9 was used when first working out the cavity.


Fig. 15. Drop Forging Die showing Bending Form in Front.

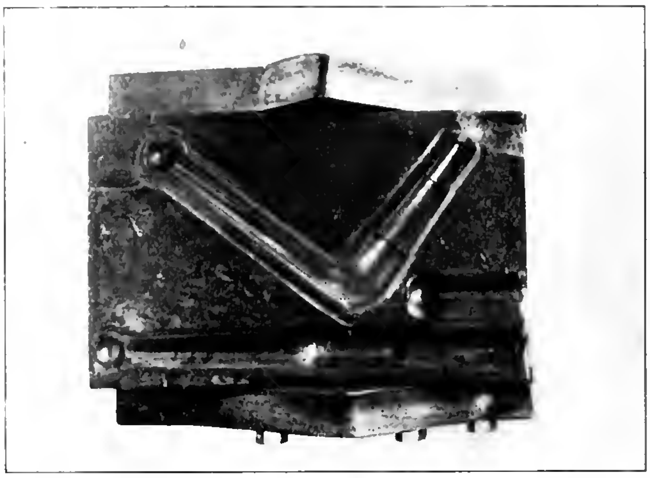
Fig. 16. Drop Forging Die and Bending Die for Steering Gear Part.

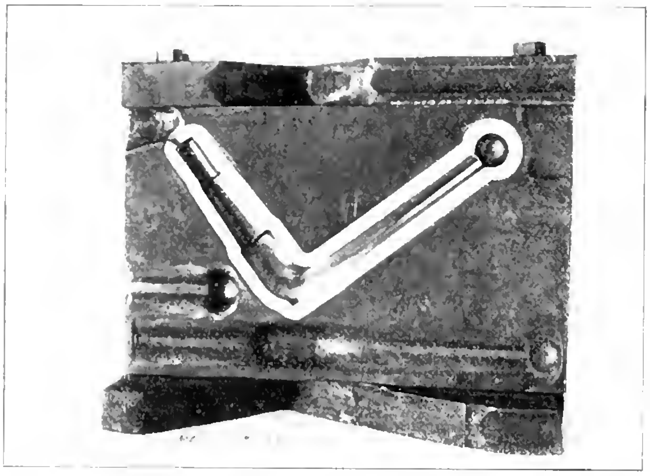
Fig. 17. Mating Die to Die in Fig. 16.

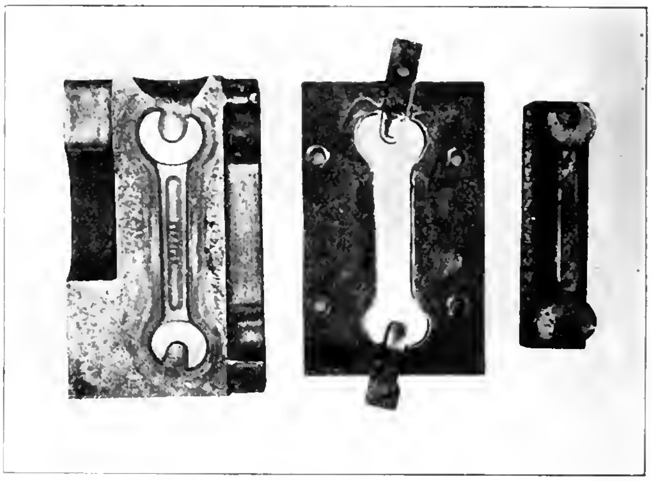
Fig. 18. Drop Forging Die for Wrench and Trimming Die for Same.

The Lead Casting or Proof.

After the mechanical work on a set of dies is done, a lead casting of the cavity is made and sent to the superintendent to be passed upon. If it is correct, the dies are hardened and sent to the forging shop, but if it is off size or shape, or for any reason not satisfactory, suitable changes are made, and another lead impression taken and passed upon as before. Fig. 11 shows a number of these lead castings which are kept in the tool-room for reference, and they often save considerable trouble when making duplicate dies.

Staking Tools used for Repairing Dies.

After a set of dies has been in use for some time, the dies are likely to develop cracks or drawing seams which cause ridges and [illegible] spots on the forgings. These cracks are closed up by hammering first on one side and then on the other with a hammer and what are called "staking" tools, which are simply specially shaped tempered steel punches made of chisel steel stock. Some of these staking tools are shown in Fig. 12.

Trimming Dies.

Some of the forgings are of such shape that the fin or flash formed is easily ground or machined off, while others are put through a trimming die. These trimming dies are about the same as the trimming dies used for other classes of work, and so need little comment. Fig. 18 shows a set of forging and trimming dies used for making "Rambler" wrenches. The breaking-down form is very plainly shown, as is also the finishing cavity. The trimming punch is at one side, while the trimming die in the middle is shown made up

of four separate parts. This is done because the die parts that shear out the wrench slots wear or break sooner than the rest of the die, and when made this way they are easily replaced without necessitating a wholly new die, which would be the case if made solid.

Fig. 19 shows a number of dies on the storage shelves, only one-half of each set being shown, the other half of each set being back of the one visible. The trimming dies which are in constant use are kept conveniently near the presses in the forge room. Both the trimming and forging dies are stored on heavy shelves close to where they are used, thus saving the unnecessary "toting" that is practiced in so many shops.

The keynote of the whole Jeffery factory is: "System without red tape," and the result is visible everywhere to the practiced observer, though a casual visitor would wonder how material traveled through as smoothly as it does.

Heating Furnaces.

The heating furnaces in a forging shop must be set near the hammers, and Fig. 20 shows how the oil furnaces are placed, so that little time is lost getting the heated metal to the hammers. Fig. 21 is an illustration of two of the big Brown & Sharpe furnaces in the hardening room. For small work several smaller furnaces are used, but those shown are used for large work, and are said to be the best obtainable.

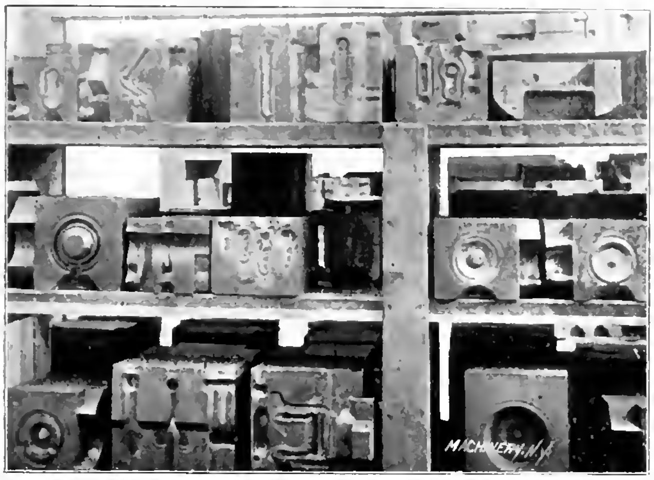

Fig. 19. A Few Examples of Drop Forging Dies in Storage.

Fig. 20. Oil Heating Furnaces and Drop Hammer

Fig 21. Brown & Sharpe Heating and Annealing Furnaces.

Fig. 22. Hardening the Face of a Drop Forging Die.

Hardening Drop Forging Dies.

In hardening drop forge dies only the face is hardened. The die is heated and placed face down in a tank of water on a sort of spider support, and a stream of water pours upward onto it. Fig. 22 shows how this is done. In the illustration a round piercing die is being hardened, so the water appears to be boiling up through the center, which would not be the case were it a solid block like a forging die. Large special shaped tongs make the handling of the heavy steel blocks of the drop forge dies comparatively easy.

* * *

Beware of the man who is going to do things to-morrow.—*The Silent Partner.*

JIGS AND FIXTURES 6.

EINAR MORIN *

EXAMPLES OF THE DESIGN OF OPEN JIGS

The present installment will be devoted to explaining and illustrating the application of the principles outlined in the previous issues, to the simplest and most common design of drill jig—the open jig. We will assume that the drill jig is to be designed for a piece of work, as shown in Fig. 61. Consideration must first be given to the size of the piece, to the finish given to the piece previous to the drilling operation, the accuracy required as regards the relation of one hole to the other, and in regard to the surfaces of the piece itself. The number of duplicate pieces to be drilled must also be considered, and, in some cases, the material.

The very simplest kind of drill jig that could be used for the case taken as an example would be the one illustrated in Fig. 62, which simply consists of a flat plate of uniform thickness of the same outline as the piece to be drilled, and provided with holes for guiding the drill. Such a jig would be termed a jig plate. For small pieces, the jig plate would be made of machine steel and case-hardened, or from tool steel and hardened. For larger work, a machine steel plate can also be used, but in order to avoid the difficulties which naturally would arise from hardening a large plate, the holes are simply bored larger than the required size of drill, and are provided with lining bushings to guide the drill, as shown in Fig. 63. It would not be necessary, however, to have the jig plate made out of steel for larger work, as a cast iron plate provided with tool steel or machine steel guiding bushings would answer the purpose just as well, and at the same time be much cheaper, and almost as durable. The thickness of the jig plate varies according to the size of the holes to be drilled and the size of the plate itself.

The holes in the jig in Fig. 62 and in the bushings in the

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*Address: 833 W. Sixth St., Plainfield, N. J.

jig in Fig. 63, are made the same size as the size of the hole to be drilled in the work, with proper clearance for the cutting tools. If the size and location of the holes to be drilled are not very particular, it is sufficient to simply drill through the work with a full size drill guided by the jig plate, but when a nice smooth, standard size hole is required, the holes in the work must be reamed. The hole is first spotted by a spotting drill, which is of exactly the same size as the reamer used for finishing, and which fits the hole in the jig plate or bushing nicely. Then a so called reamer drill, which is 0.010 inch, or less, smaller in diameter than the reamer, is put through, leaving only a slight amount of stock for the reamer to remove, thereby obtaining a very satisfactory hole. Sometimes a separate loose bushing is used for each one of these operations, but this is expensive and also unnecessary, as the method described gives equally good results.

By using the rose reaming method very good results will also be obtained. In this case two loose bushings besides the lining bushing will be used. These bushings were described and tabulated in the second installment of this series, appearing in the May issue of MACHINERY. The drill preceding the rose chucking reamer is 1/16 inch under the size of the hole. This drill is first put through the work, a loose drill bushing made of steel being used for guiding the drill. Then the rose chucking reamer is employed, using, if the hole in the jig be large, a loose bushing made of cast iron.

When dimensioning the jig on the drawing, dimensions should always be given from two finished surfaces of the jig to the center of the holes, or at least to the more important ones. In regard to the holes, it is not sufficient to give only the right angle dimensions, *a*, *b*, *c*, and *d*, etc., Fig. 62, but the radii between the various holes must also be given. If there are more than two holes, the radii should always be given between the nearest holes and also between the holes standing in a certain relation to one another, for instance, between centers of shafts carrying meshing gears, sprockets, etc. This will prove a great help to the tool-maker. In the case under consideration, the dimensions ought to be given from two finished sides of the work to the centers of the holes, and also the dimension between the centers of the holes to be drilled.

When using a simple jig made as outlined in Figs. 62 and 63, this jig is simply laid down flat on the work and held against it by a C-clamp, a wooden clamp, or, if convenient, held right on the drill press table by means of a strap or clamp, as shown in Fig. 64. Here two pieces of the work are shown beneath the jig plate, both being drilled at one time.

Improving the Simple Form of Jig shown in Fig. 62.

The first improvement that could be made on the jig shown in Fig. 62 would be the placing of locating points in the jig plate in the form of pins, as shown in Fig. 65, in which the dotted lines represent the outline of the work. The plate need not necessarily have the shape shown in Fig. 65, but may have the appearance shown in Fig. 66, according to the conditions. As mentioned in the article last month, exact rules could not be given for the form and shape of jigs, but common sense together with the judgment obtained by long practice must be relied upon in determining the minor points of design.

The adding of the locating points will, of course, increase the cost of the jig somewhat, but the amount of time saved in using the jig will undoubtedly make up for the added expense of the jig, provided a fair number of pieces is to be drilled; besides, a great advantage is gained in that the holes can always be placed in the same relation to the two sides resting against the locating pins on all the pieces drilled.

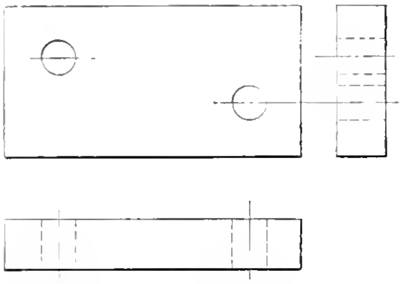


Fig. 61. Sketch of Piece to be Drilled.

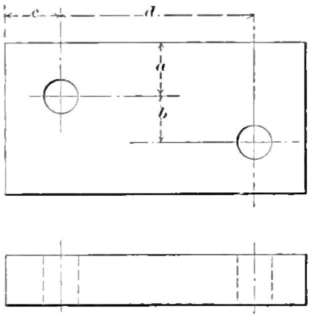


Fig. 62. Simplest Form of Jig for Piece shown in Fig. 61.

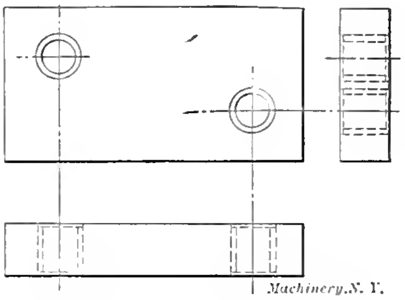


Fig. 63. Plate Jig with Inserted Guide Bushings.

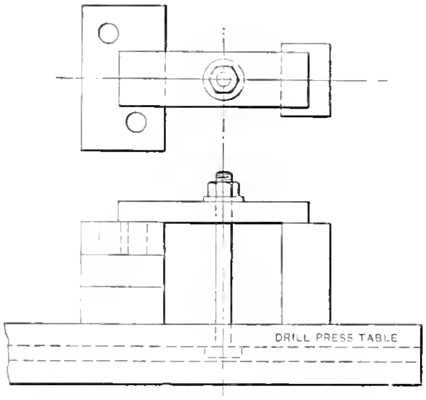


Fig. 64. Holding Jig and Work on Drill Press Table. Two Pieces drilled at Once.

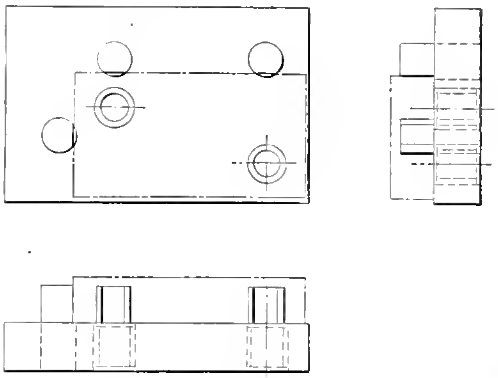


Fig. 65. First Improvement of Plate Jig Locating Pins Inserted.

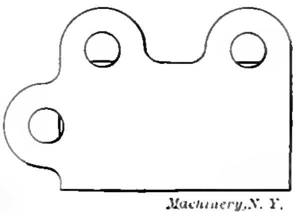


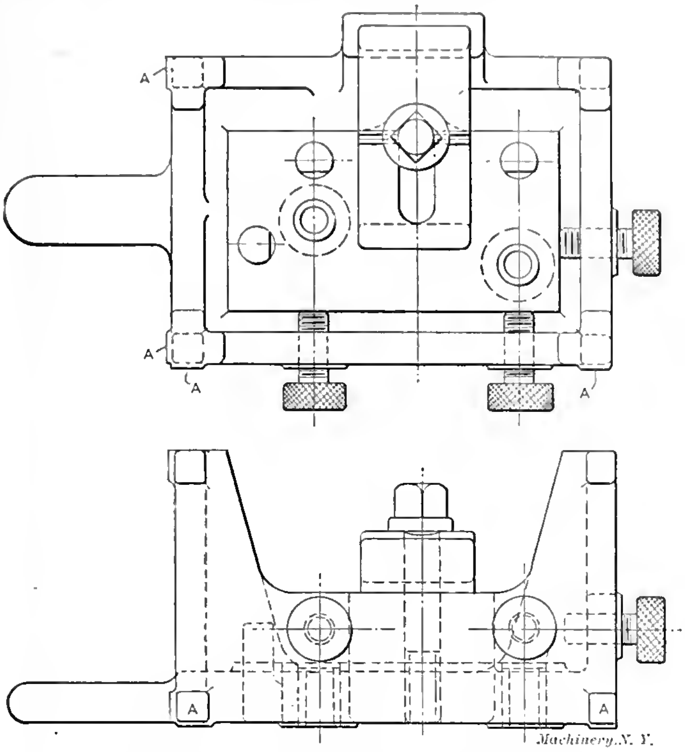
Fig. 66. Variation in Shape of Plate Jig.

The locating pins are flattened off to a depth of 1/16 inch from the outside circumference, and dimensions should be given from the flat to the center of the pin holes and to the center of the nearest or the most important of the holes to be drilled in the jig. The same strapping or clamping arrangements for the jig and work, as mentioned for the simpler form of jig, may be employed.

Improving the Jig by adding Locating Screws.

The next step toward improving the jig under consideration would be to provide the jig with locating screws, as shown in Fig. 68. By the addition of these, the locating arrangements of the jig become complete, and the piece of work will be prevented from shifting or moving sideways. These locating screws should be placed in accordance with Rule 10 laid down in the summary of the principles of jig design in the first installment of this series, in the April issue of MACHINERY, saying that all clamping points should be located as nearly opposite to some bearing points of the work as possible. In order to provide for locating set-screws in our present jig, three lugs or projections *A* are added which hold the set-screws. If possible the set-screw lugs should not reach above the surface of the piece of work, which should rest on the drill press table when drilling the holes.

The present case illustrates the difficulty of giving exact rules for jig design and indicates the necessity of individual judgment. It is perfectly proper to have two set-screws on the long side of the work, but in a case like this where the piece is comparatively short and stiff, one lug and set-screw, as indicated by the dotted lines at *B* in Fig. 68, would be fully sufficient. The strain of the set-screw placed right between the two locating pins will not be great enough to spring the piece out of shape. When the work is long and narrow two set-screws are required on the long side, but whenever a saving in cost can be accomplished without sacrificing efficiency, as in the case illustrated, two lugs would be considered a wasteful design.



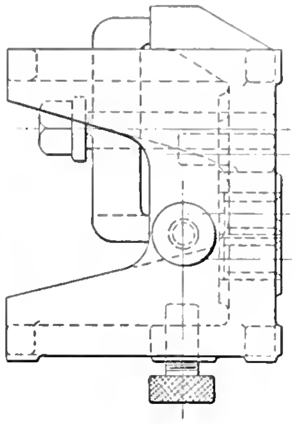


Fig. 67. Complete Jig for Rapid Duplicate Work.

Providing Clamps and Feet for the Jig.

The means by which we have so far clamped or strapped the work to the jig when drilling in the drill press (see Fig. 64) have not been integral parts of the jig. If we wish to add clamping arrangements that are integral parts of the jig, the next improvement would be to add four legs in order to raise the jig plate above the surface of the drill press table enough to get the required space for such clamping arrangements. The completed jig of the best design for rapid manipulation and duplicate work would then have the appearance shown in Fig. 67. The jig here is provided with a handle cast integral with the jig body, and with a clamping strap which can be pulled back for removing and inserting the work. Instead of having the legs solid with the jig, as shown in Fig. 68, loose legs, screwed in place, are sometimes used, as shown in Fig. 70.

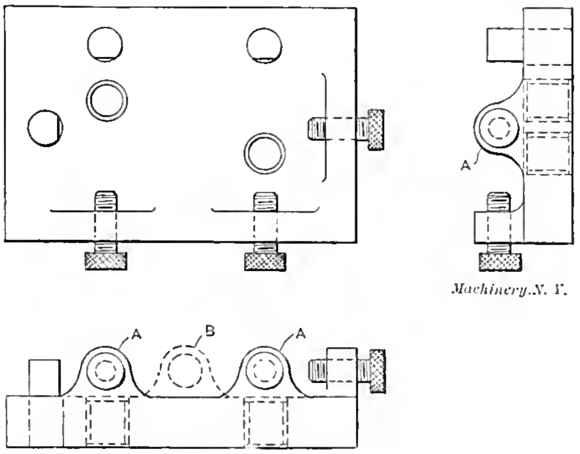


Fig. 68. Second Improvement: Locating Screws Holding Work in Place.

These legs are round, and provided with a shoulder *A*, preventing them from screwing into the jig plate. A headless screw or pin through the edge of the circumference of the threads at the top may prevent the studs from becoming loose. These loose legs are usually made of machine steel or tool steel, the bottom end being hardened and then ground and lapped, so that all the four legs are of the same length. It is the practice of many tool-makers not to thread the legs into the jig body, but to simply provide a plain surface on the end of the leg, which enters into the jig plate, and is driven into place. This is much easier, and there is no reason why for almost all kinds of work, jigs provided with legs attached in this manner should not be equally durable.

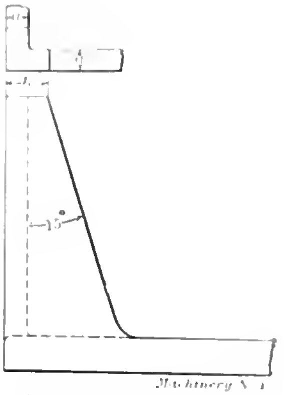


Fig 69 Design of Legs for Cast Iron Jig Bodies.

Of course, when jigs are made of machine or tool steel, and legs are required, the only way to provide them is to insert loose legs. In the case of cast iron jigs, however, solid legs cast in place are preferable. The solid legs cast in place generally have the appearance shown in Fig. 69. The two webs of the leg form a right angle, which, for all practical purposes, makes the leg fully as strong as if it were made solid, as indicated by the dotted line in the upper view. The side of the leg is tapered 15 degrees, as a rule, as shown in the engraving, but this may be varied according to conditions.

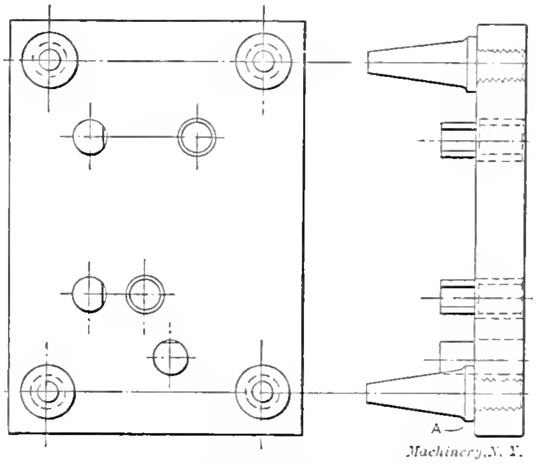


Fig. 70. Legs Screwed into Jig Body.

The thickness of the leg varies according to the size of the jig, the weight of the work, and the pressure of the cutting tools, and depends also upon the length of the leg. The length *b* on top is generally made 1½ times *a*. As an indication of the size of the legs required, it may be said that for smaller jigs, up to jigs with a face area of 6 square inches, the dimension *a* may be made from 5/16 to 3/8 inch; for medium sized jigs, ½ to ⅝ inch; for larger sized jigs, ¾ to 1½ inch; but of course, these dimensions are simply indications of the required dimensions. As to the length of the legs, the governing condition, evidently, is that they must be long enough to reach below the lowest part of the work and the clamping arrangement.

If a drill jig is to be used in a multiple spindle drill, it should be designed a great deal stronger than it is ordinarily designed when used for drilling one hole at a time. This is especially true if there is a large number of holes to drill

simultaneously. The writer has had sad experiences with drill jigs which would give excellent service in common drill presses for years, but which, when put on a multiple spindle drill, immediately broke to pieces as if subjected to a hammer blow. It is evident that the pressure upon the jig in a multiple spindle drill is as many times greater than the pressure in a common drill press as the number of drills in operation at once.

Referring again to Fig. 67, attention should be called to the small lugs *A* on the sides of the jig body which are cast in place for laying out and planing purposes. The handle should be made about 4 inches long, which permits a fairly good grip by the hand. The design of the jig shown in Fig. 67 is simple, and fills all requirements necessary for producing work quickly and accurately. At the same time, it is strongly and rigidly designed. Locating points of a different kind from those shown can, of course, be used; and the requirements may be such that adjustable locating points, as described in the June issue may be required. A more quick acting, but at the same time, a far more complicated clamping arrangement might be used, but the question is whether the expense of making is warranted by the added increase in the rapidity of manipulation.

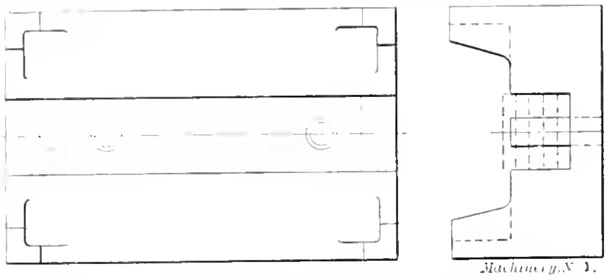


Fig. 71. Form of Jig which may be used for drilling a Number of Pieces Simultaneously.

Another improvement which should not be overlooked, and which in a case like this probably could be made, and which it is always wise to look into at any rate, is: Can more than one piece be drilled at one time? In the present case, the locating pins can be made longer, or, if there is a locating wall, it can be made higher, the legs of the jig can be made longer, the screw holding the clamp can also be increased in length, and if the pieces of work are thick enough, set-screws for holding the work against the locating pins can be placed in a vertical line, or if the pieces be narrow, they can be placed diagonally, so as to gain space. If the pieces are very thin, the locating might be a more difficult proposition. If they are made of a uniform width, they could simply be put in the slot in the bottom of the jig, as shown in Fig. 71, or if a jig on the principles of the one shown in Fig. 67 is used, they must be located sideways by a wedge, as shown in Fig. 72. A couple of lugs *A* would then be added to hold the wedge in place, and take the thrust. In both cases the pieces must be pushed up in place endways by hand. If the pieces are not of exactly uniform size, and it is desired to drill a number at a time, they must be pushed up against the locating pins by hand from two sides, and the clamping strap must be depended upon to clamp them down against the pressure of the cut and at the same time prevent them from moving side or endwise. If the accuracy of the location of the holes is particular the pieces should not be piled up on one another to be drilled.

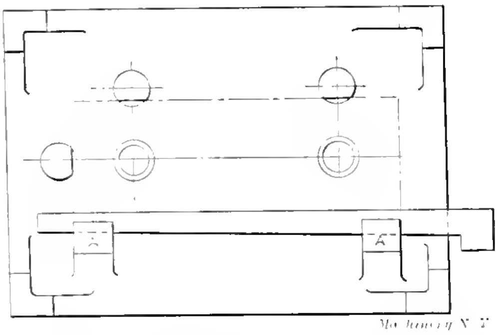


Fig. 72. Jig with Wedge for Holding the Work

TOOLS FOR THE BLACKSMITH SHOP.*

JAMES CRAN†

Among mechanics, the blacksmith holds a unique position, he being practically the only one who makes his own tools. This he often does without any apparent aim at economy, beauty, or usefulness, if judged by the chunks of steel on the ends of handles to be found in the odd corners of a great many blacksmith shops. It would not be fair to put the whole blame on the blacksmith, as he is usually allowed but very little time either to keep his tools in repair or to make new ones; the result is that if ever blacksmiths' tools have had a high standard of efficiency, they soon depreciate. Too much reliance seems to be put on the old saying: "A good workman can do a good job with any kind of tools." But when it comes to saving time, which is one of the most important points in modern manufacturing, the good workman with good tools comes out ahead.

Tools used by blacksmiths do not have to be so accurate to size, or made with the same precision as those used by machinists or tool-makers. Still, some of the points most essential to doing good work seem to have been overlooked. It would be to the advantage of all concerned to have one smith in every shop do the tool-making. He would soon become an expert, and would make better tools in less time than the smith who makes a tool occasionally. It would also insure every man employed having equally good tools and equal chances of doing good work. Tools made by a good blacksmith are preferable to those upon the market for several reasons, the principal of which is the poor quality of the material of which the article on the market is made. Besides, the blacksmith's tools on the market are often poorly constructed and are mostly used in small or country shops where there is no steam hammer.

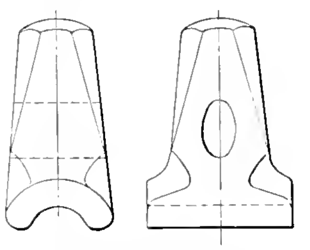


Fig. 1. Correct Form of Top Part of Blacksmith's Swage.

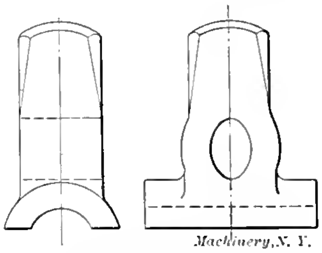


Fig. 2. Incorrect Form of Blacksmith's Swage, Top Part.

Tools such as swages are usually made with the impression or hollow part too deep, the corners too sharp, and the face too long for the best results. Swages, being tools used for finishing round or semi-round work at the anvil after it has been drawn nearly to size at steam or trip hammers, should be constructed so that finishing can be done in the best and quickest manner possible. They should be made in pairs consisting of one top and one bottom piece. The depth of the impression ought to be about one-third the diameter of the piece the swages are intended to finish. The edges or lips of the impression should be well backed off, and all corners rounded to prevent cold shuts and unsightly marks being left upon the work. The swages may be slightly crowned from end to end, which will give them a tendency to draw the stock, should it be a trifle over size, and if the crowning is not overdone, it will help to leave the work smooth.

The bottom swage should be made to come flush with one side of the anvil, and to reach about half way across it. The swages can then be used for finishing hubs, bosses, forgings with large heads or arms, at right angles to the hub of the work. The bottom swage can also be reversed and used from the other side of the anvil when necessary. Bottom swages should preferably be a little longer on the face than the top swages. For small sizes they might be from 2¼ inches to 2½ inches from end to end of the impression, while the corresponding top swages might be about 1¾ inch. For larger sizes the bottom swage could be from 4 inches to 4½ inches

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* See MACHINERY, June, 1908; Reasons Why so Little is Heard from Forge Shops; and August, 1908; System for the Blacksmith Shop.

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long and the top swage from 2¼ inches to 2½ inches. The number and sizes to constitute a set for one forge would have to be determined by the size and class of work for which the swages would be used. The following list would cover the average range of machine blacksmithing: Top and bottom from 3/16 inch to 1/2 inch, inclusive, advancing by 1/16 inch; from ⅝ inch to 2¼ inches, inclusive, advancing by ⅛ inch; larger sizes up to the limit to advance by ¼ inch. Fig. 1 shows the correct style of top swage, and Fig. 2 an objectionable style. Fig. 3 shows the correct style of bottom swage, and Fig. 4 the incorrect style.

The shape and style of fullers is not so important from the fact that there can be no sharp corners to come in contact with the work. Care should be taken to make them in pairs which match each other perfectly. With bottom fullers it is well to have a large shoulder to rest on the anvil. The shank should be a snug fit to keep it from wobbling.

Flatters as a rule are too large and too level on the face for doing good work, and like swages are usually too sharp and square on the corners and edges. More and better work can be done with a flatter 2½ inches square on the face than can be done with one 3 inches square face. When a large level flatter is used, the edges come in contact with the work and leave a mark every time it is struck with a sledge. With a small flatter with crowning center and rounded edges a blow with the sledge will have more effect, and it will be almost impossible to leave a mark upon the work. The same principle applies to sets. The style best suited for machine blacksmithing should be from 2¼ inches to 2½ inches long, and from 1⅜ inch to 1½ inch wide on the face. It would be of advantage to have one with the edges well rounded to use around fillets, and one with sharp square edges to finish corners which must be sharp.

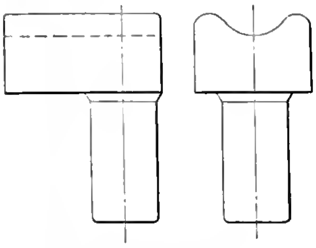


Fig. 3. Correct Form of Bottom Part of Swages.

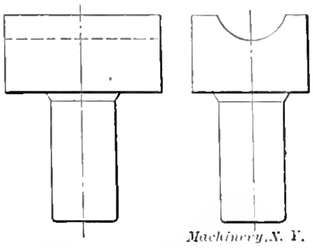


Fig. 4. Incorrect Form of Bottom Part of Swages.

Breaking-down tools should be made with the edge rounded, which will prevent the leaving of a cold shut where the shank joins the body of a forging. Fig. 5 shows the correct style in full lines; the dotted lines show the incorrect style. When square work is being drawn at the steam or trip hammer, it will sometimes become diamond shaped, and it is very hard to work it back to the square form without flattening two of the corners, unless a pair of V swages are used. These ought to have a place in every set of tools, the impression in both top and bottom to be 90 degrees, with the edges well rounded so that they would have their greatest bearing at the apex of the V. This forces out the other two corners of the work until it is perfectly square, without marking it. Chisels, punches, and gouges must be made to suit the work. The tools previously mentioned, with the exception of chisels punches, and gouges, could be made of steel of about 0.60 carbon. All tools intended for cutting should be made of steel not less than 0.75 carbon.

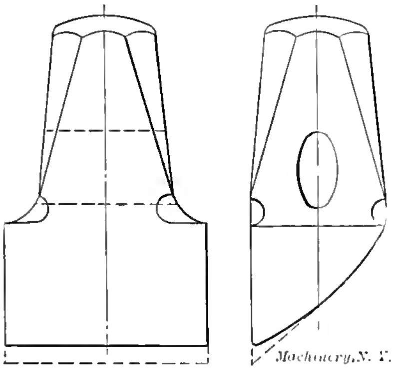


Fig. 5. Correct and Incorrect Shape of Blacksmith's Breaking-down Tool.

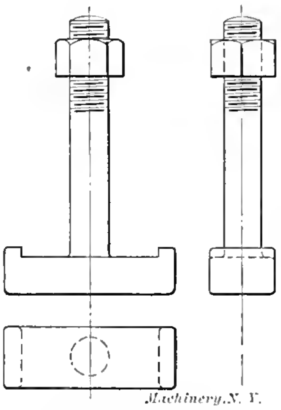


Fig. 6 Clamping Screw used with Clamp in Fig. 10.

Tools will give better service and satisfaction if hardened on both ends. The writer appreciates the fact that in recommending the hardening of the heads of tools he is laying himself open to criticism, as it is departing from all general rules and practice. Nevertheless, if the head of a tool is properly hardened, the tool will give at least five times more service than a tool with a soft head. In hardening the working end of such tools as swages, flatters, etc., the face, after being heated to the proper temperature, should be cooled in a stream of water rising straight from the bottom of the quenching tub. Care should be taken to hold the tool so that the stream will strike its center, which will insure the center being hard. After the tool is cold enough to carry water on the face, polish, and draw the temper in a hot fire until the edges are a light blue, leaving the center as hard as possible. If hardened in a bath without a stream, the edges are liable to be extremely hard and the center soft.

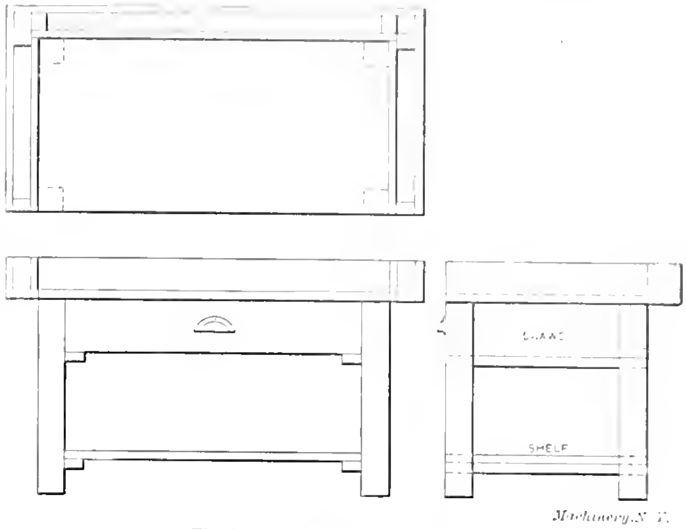


Fig. 7. Blacksmith's Tool Bench

When hardening the heads of tools, they should be heated to a cherry red about 1 inch of their length, dipped to a depth of about ⅝ inch in water until fairly cooled, and then the head polished and the temper drawn with back heat until the color just runs out. If much heat is left, dip slightly to check it, and leave the tool to cool off gradually in the air. Heads treated in this manner will neither chip off, nor crack, nor batter down.

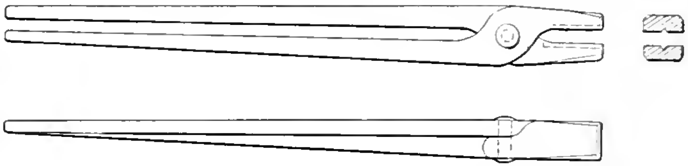


Fig. 8. Approved Type of Tongs with Flat Jaws.

Fig. 7 shows a tool bench which is of a suitable style for the blacksmith's tools. The rack around the top holds tools with handles; the shelf at the bottom accommodates bottom or anvil tools, and the drawer is used to hold such tools as are usually the personal property of the blacksmith, as well as orders, drawings, etc., which ought to be kept clean and out of the range of sparks. A bench of this style made of wood will give good service if the top edges of the rack are covered with light band-iron attached with screws. Every tool ought to have its own place on the bench, swages, fullers, etc., in consecutive arrangement, so that the blacksmith can put his hand on any tool at any time. It takes but very little time to put away a tool immediately after it has been used. If this is done every time, it will save confusion and lots of expressive language when it is wanted again.

The next tools to be considered are tongs. These are by no means the least important of the blacksmith's tools. In

order to do good work, it is of the utmost importance to have tongs which will hold the work firmly. In a great many cases tongs are poorly proportioned. For light work they are too heavy, and for heavy work they are too light. In making tongs, several things should be taken into consideration, such as the shape of the stock they are intended to hold, where to leave the most material to resist strain, and the parts most liable to wear out. For flat tongs the jaws should be heaviest near the joint, and taper toward the point. The point should be about half the thickness of the width of the jaw. The reins should be round on the edges and taper gradually from the joint to the tip, which will give them elasticity, and afford a comfortable grip for the hand. Care should be taken to leave no sharp corners around the joint, as it is there that the tongs are most liable to break. Flat tongs should have a small V shaped impression the full length of he jaw, so that they can be used to hold square stock cornerwise, or round stock. Fig. 8 shows a pair of flat jawed tongs of about the proper proportion for holding ½-inch flat, ½-inch square or ⅝-inch round stock. Barring accidents this style ought to give the maximum of service. This type of tongues can be used for stock of the smallest sizes up to two inches. For larger sizes of flat stock the tongs ought to have one box jaw, or a jaw with a cross section on the point with lips turned up, to prevent the work from moving edgeways. The tongs shown in Fig. 9 are the most convenient style for holding round or square stock, the V shaped jaws giving them a perfect grip on square work, and a bearing on four points of round work. This gives them an advantage over the circular jawed tongs commonly used for round stock, as these only have two bearings. The goose neck section between the jaw and the joint is also an advantage, as it will accommodate a burr or irregularity on the end of a piece of iron or steel which is usually found after it has been cut with shears or with a saw, while the bar is hot. Tongs of this shape can be used up to 5 inches capacity. For holding them upon the work, the style of link shown in Fig. 9 in enlarged scale in proportion to the tongs should be used. Being made narrow at the ends, it has the advantage of hugging the reins tightly, and having two bearings on each rein makes it less liable to fly off than the link with circular ends.

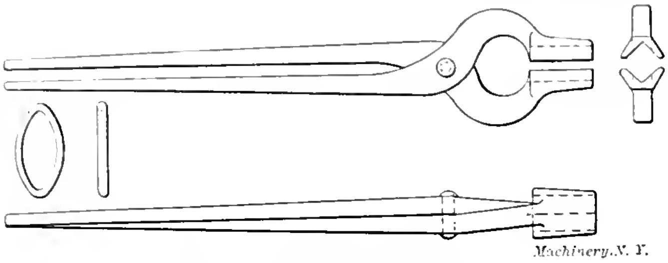
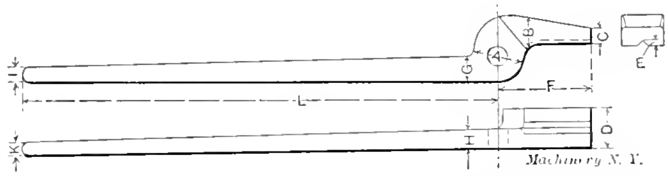


Fig 9 Tongs with V-shaped Jaws.

DIMENSIONS OF FLAT-JAWED TONGS.

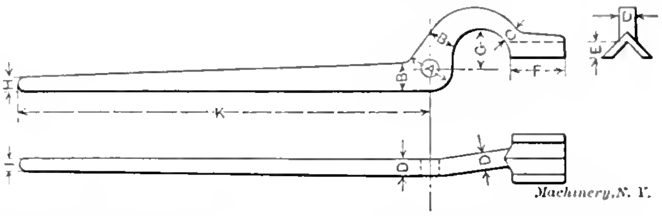


Nominal size of Tongs.	Diameter at Joint.	Thickness of Jaw at Base.	Thickness of Jaw at Point.	Width of Jaw at Point.	Depth of V.	Length of Jaw.	Width of Reins at Base.	Thickness of Reins at Base.	Width of Reins at Point	Thickness of Reins at Point	Length of Reins	Size of Rivet.
Inches.	A	B	C	D	E	F	G	H	I	K	L	M
0 – 1/8	5/8	3/8	1/4	3/8	1/16	2 1/8	1/2	5/16	5/16	1/4	14	1/4
3/16 – 5/16	3/4	7/16	5/16	5/8	1/16	2 1/4	9/16	5/16	5/16	1/4	15	1/4
3/8 – 7/16	7/8	1/2	5/16	3/4	1/16	2 1/2	5/8	3/8	3/8	5/16	16	5/16
1/2 – 5/8	1	9/16	3/8	7/8	3/32	2 3/4	11/16	7/16	3/8	5/16	18	3/8
3/4 – 7/8	1 1/8	5/8	3/8	1	5/32	3	3/4	1/2	7/16	3/8	20	7/16
1 – 1 1/8	1 1/4	11/16	7/16	1 1/8	3/16	3 1/4	13/16	9/16	1/2	7/16	22	1/2
1 1/4 – 1 3/8	1 3/8	3/4	1/2	1 1/8	1/4	3 1/2	7/8	9/16	1/2	7/16	24	9/16
1 1/2 – 1 5/8	1 1/2	3/4	1/2	1 1/4	3/8	3 3/4	1	5/8	5/8	1/2	26	5/8
1 3/4 – 1 7/8	1 5/8	13/16	9/16	1 3/8	7/16	4	1 1/16	11/16	5/8	1/2	28	5/8
2	1 3/4	7/8	5/8	1 1/2	7/16	4 1/4	1 1/8	3/4	11/16	1/2	30	11/16

For work over 5 inches, the style of clamp shown in Fig. 10 should be used. This clamp can be bolted firmly to the work whether it be round or square, and can be operated with the small clamps with handles attached to the shank in the same manner as would a porter bar. For heavy work, clamps are a great deal safer than tongs, and can be made to handle flat or irregular shaped pieces. For fastening the clamp to the work, the bolt shown in Fig. 6 is the most suitable, it having a cross head with lugs to keep it from turning, and it can therefore be tightened or unscrewed with one wrench.

In nearly every blacksmith shop there is work to be done which can only be accomplished with special tools about which it would be impossible to give any intelligent information without seeing the pieces to be made; but whenever the quantity is such that it will justify the making of special tools, it should be done. A former or a fixture will not only reduce labor and cost, but makes the work more uniform. It is no exaggeration to say that at the present time very few blacksmith shops give more than 75 per cent of their possible efficiency, and others not more than 50 per cent, simply for lack of tools, system, and good executive guidance. A little consideration and a little outlay of capital would be a good investment, as in the majority of cases it would raise the blacksmith shop from being a "drag" to one of the most remunerative departments in a manufacturing plant.

DIMENSIONS OF GOOSE-NECK TONGS.



Nominal Size of Tongs.	Diameter at Joint.	Width at Base of Goose-neck and at Base of Reins.	Width of Goose-neck near Jaw.	Thickness of Goose-neck and of Base of Reins.	Depth of Jaw.	Length of Jaw.	Depth of Goose neck from Center Line.	Width of Reins at Point.	Thickness of Reins at Point.	Length of Reins.	Size of Rivet.
Inches.	A	B	C	D	E	F	G	H	I	K	L
1/4 – 5/16	5/8	1/2	7/16	5/16	1/8	1	1/2	5/16	1/4	14	1/4
3/8 – 7/16	3/4	9/16	1/2	5/16	3/16	1 1/8	9/16	5/16	1/4	16	5/16
1/2 – 5/8	7/8	5/8	9/16	3/8	1/4	1 1/4	5/8	3/8	5/16	18	3/8
3/4 – 7/8	1	3/4	5/8	7/16	3/8	1 1/2	3/4	3/8	5/16	20	7/16
1 – 1 1/8	1 1/8	7/8	11/16	1/2	1/2	1 3/4	7/8	3/8	5/16	20	1/2
1 1/4 – 1 3/8	1 1/4	1	3/4	9/16	5/8	2	1	7/16	3/8	22	1/2
1 1/2 – 1 3/4	1 3/8	1 1/8	7/8	5/8	3/4	2 1/8	1 1/8	1/2	3/8	24	9/16
1 7/8 – 2 1/8	1 3/8	1 3/16	15/16	11/16	1	2 1/4	1 1/4	1/2	3/8	26	5/8
2 1/4 – 2 1/2	1 1/2	1 1/4	1	3/4	1 1/8	2 1/2	1 1/2	9/16	7/16	28	5/8
2 5/8 – 2 7/8	1 1/2	1 5/16	1 1/16	3/4	1 1/4	2 3/4	1 3/4	9/16	7/16	30	3/4
3 – 3 1/4	1 5/8	1 3/8	1 1/8	3/4	1 1/2	3	2	5/8	1/2	32	3/4
3 1/2 – 3 3/4	1 3/4	1 1/2	1 1/4	3/4	1 3/4	3 1/4	2 1/4	5/8	1/2	34	3/4
4 – 4 1/4	2	1 5/8	1 5/16	13/16	2	3 1/4	2 1/2	11/16	9/16	36	3/4
4 1/2 – 4 3/4	2 1/8	1 5/8	1 5/16	13/16	2 1/8	3 1/4	2 3/4	11/16	9/16	38	3/4
5	2 1/4	1 3/4	1 3/8	7/8	2 1/4	3 1/2	3 1/4	3/4	5/8	40	7/8

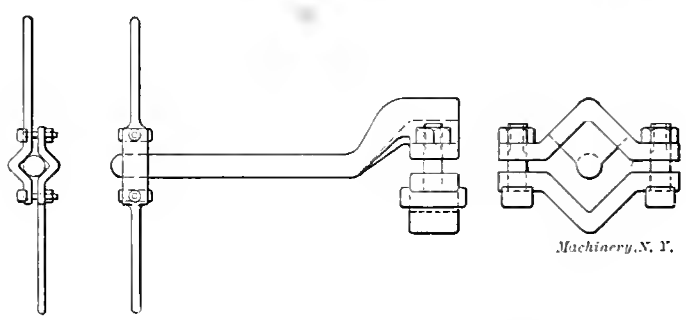


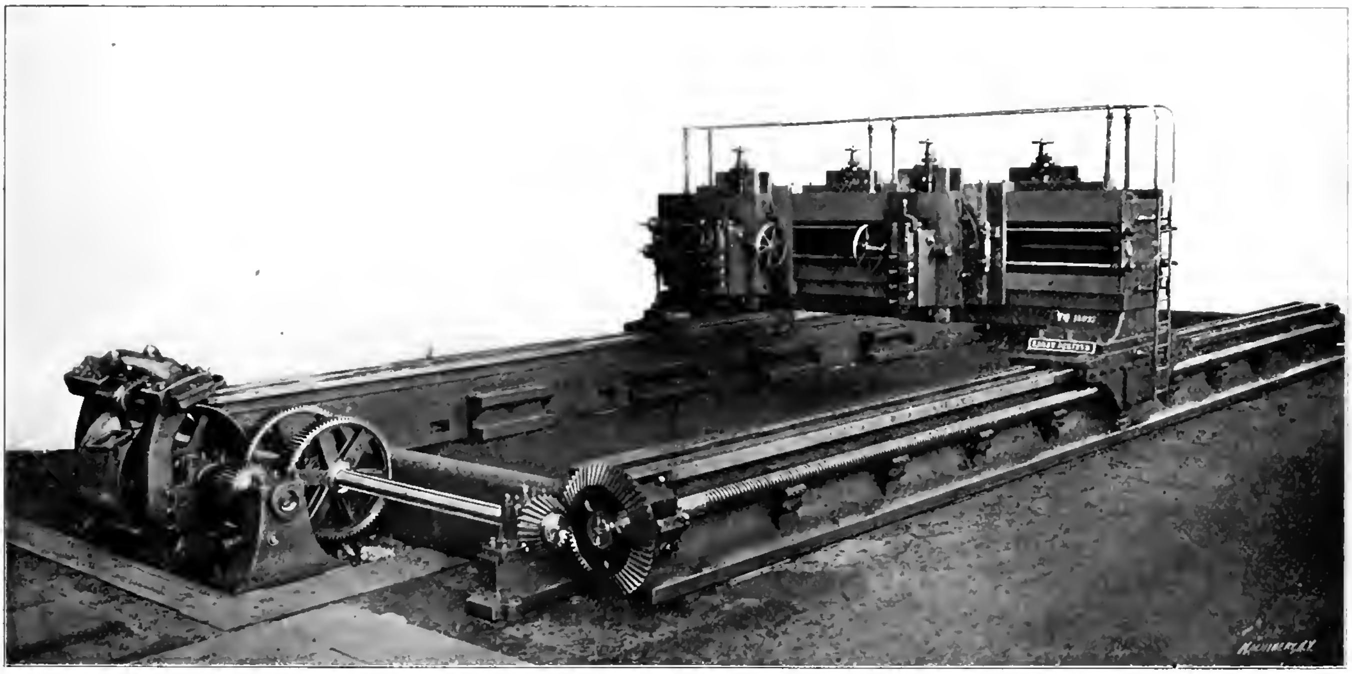
Fig. 10. Clamp for Handling Large Work in the Blacksmith Shop.

ERNST SCHIESS PIT PLANER.

We read with much interest your communication "An Alternative Planer Type Suggested" in your June issue, and your comments thereon. We would like to point out that the Société Anonyme des Etablissements Fetu-Defize, Liége, Belgium, is not, as might be inferred, the only firm building this sort of pit planer. We are building pit planers and have delivered machines built for similar purposes of 10 meters (32 feet 9¾ inches) length and 4 meters (13 feet 1½ inch) width, among others to Messrs. Schneider & Co. in Le Creuzot (three); Krupp, in Essen (two); Dillingen Hüttenwerke, Dillingen (two).

The accompanying illustration shows our machine which planes 8,000 millimeters (26 feet 3 inches) long, and 4,000 millimeters (13 feet 1½ inch) wide, and which is provided with four tool-posts. The side beds of the machine, each consisting of two pieces coupled together and bound at the ends by heavy cross ties, are made with flat guides for the cross-slide. The cross-slide is fitted with side strips on the inside edges for taking up the wear. The outside strips are to prevent side slipping of the cross-slide.

The drive is obtained through open and cross belts and steel spur and bevel gears connecting the two long heavy screws lying outside of the beds. These screws run in phosphor bronze bearings, and are provided with nuts filled with white hard anti-friction metal for driving the cross-slide. Two transmission shafts also run in phosphor bronze bearings. The length of the bed is 13,700 millimeters (45 feet, about).



Large German Pit Planer.

The machine is arranged to plane both forward and backward, and the cutting speed in both directions is 2 meters (6.56 feet) per minute for very hard material and 4 meters (13.12 feet) per minute for medium hard metals. The tool slides are self-acting and may be operated independently, either horizontally or vertically. The feed for each carriage is operated by means of a crank disk and movable connecting-rods. The horizontal feed motion of the main slides is so arranged that both slides can be operated together or independently in the same direction or in opposite directions, and the tool boxes can be set at any angle.

ERNST SCHIESS WERKZEUGMASCHINENFABRIK AKTIEN-
Düsseldorf, Germany. GESELLSCHAFT.

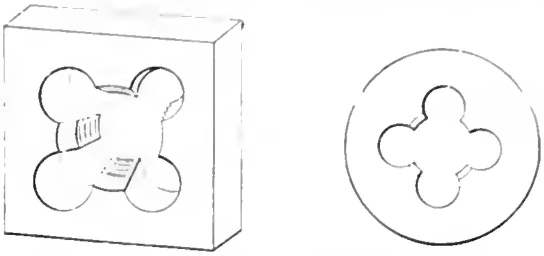
* * *

A new aluminum alloy has been patented in Germany by Walther Gosman, of the Krupp's Steel Works, of Essen-on-the-Ruhr, Germany. This alloy is composed of 87 per cent of aluminum, 8 per cent of copper and 5 per cent of tin. It is stated that the alloy casts better than the common aluminum and zinc mixtures, that it machines well, is homogeneous, and has a relatively higher ultimate strength.

THREADING DIES.

ERIK OBERG *

Threading dies may be divided into four general classes Solid dies, which may be either square or round, as shown in Figs. 1 and 2; adjustable split dies, which usually are round; spring screw threading dies; and inserted chaser dies, where the blades, provided with cutting teeth, are inserted in the body, and secured in some suitable manner.



Figs. 1 and 2. Square and Round Solid Dies

Solid Dies.

The solid die is used to a great extent on general work, either in cases where a correct size is not essential, or for roughing a thread before taking a finishing cut with an adjustable die. The solid die is not preferable to use when threads are to be cut requiring a high degree of accuracy. In the first place, the size when the die is hardened, cannot be depended upon to be exactly the size wanted, as dies are very apt to "go" more or less in hardening, and on account of their construction, apt to "go" in an irregular manner, one land closing up or departing more from the true axis of the thread than the others. In the second place, even if the die were correct from the beginning, there are no provisions for adjusting it to size when worn.

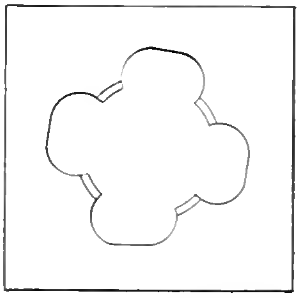


Fig 3 Large Size Square Solid Die, showing Form of Clearance Holes.

Solid Square Dies.

The solid die, as a rule, is of a square form. It is used principally for threading in bolt cutters, and for work of this kind answers its purpose well. It is also used for pipe dies, in which case the thread evidently must be tapered. As a tapered thread, in order to cut a thread smoothly and correctly, requires to be relieved in the angle, and, as the difficulties for relieving an internal thread like that of a pipe die, are very great, and it is not customary to

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* Associate Editor of MACHINERY.

do so, pipe dies and, of course, also all other taper dies, cannot be used for cutting the threads of taps, but can only be used for rough work on pipes and similar soft metal where a perfect thread is not essential.

Lands and Clearance Holes.

Solid square dies are always provided with four lands, excepting if very large, when five lands may be preferable. The width of the land should be about 1/12 of the circumference of the screw to be cut with the die, or approximately 1/4 of the diameter of this screw. The clearance holes should be laid out so as to provide for this width of land. The center of the clearance holes should be located a trifle outside of the circle which measures the diameter of the screw to be cut. Some makers of dies locate the center of the clearance holes exactly on this circle, but the clearance holes then become rather small, and are easily clogged with chips which may tear the threads of the screw being cut, and occasionally break the teeth of the threads in the die. In very large dies it is not possible to make circular clearance holes, as these would be required to be of too large a diameter in order to make the lands of the correct width. In such cases, two clearance holes are drilled between each two of the lands and connected with a straight surface, as shown in Fig. 3.

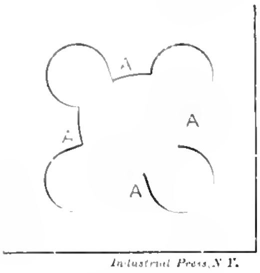


Fig. 4. Cutting Edges as Ordinarily Made.

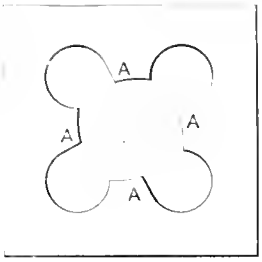


Fig. 5. Cutting Edges with Negative Rake.

TABLE I. DIMENSIONS OF SOLID SQUARE BOLT DIES.

Diameter of Thread.	Size of Square.	Thickness.	Diameter of Thread	Size of Square.	Thickness.
1/4	2 1/2	1/2	7/8	2 1/2	3/4
5/16	2 1/2	1/2	1	2 1/2	1
3/8	2 1/2	1/2	1 1/8	2 1/2	1
7/16	2 1/2	1/2	1 1/4	2 1/2	1
1/2	2 1/2	3/4	1 3/8	2 1/2	1
9/16	2 1/2	3/4	1 1/2	3	1
5/8	2 1/2	3/4	1 5/8	3	1
11/16	2 1/2	3/4	1 3/4	3	1 1/4
3/4	2 1/2	3/4	1 7/8	3 1/2	1 1/2
13/16	2 1/2	3/4	2	3 3/4	2

The chamfer on the top of the thread should extend for about three to four threads. It is necessary to relieve the dies on the top of the thread of the chamfered teeth, in order to make the die cut. If the die should be expected to cut a thread close up to a shoulder, the chamfer, of course, would have to be made proportionally shorter.

TABLE II. DIMENSIONS OF SOLID SQUARE PIPE DIES.

Nominal Pipe Size.	Size of Square.	Thickness.	Nominal Pipe Size.	Size of Square.	Thickness.
1/8	2	1/2	1	3	3/4
1/4	2	1/2	1 1/4	3	3/4
3/8	2	1/2	1 1/4	4	1
1/2	2 1/2	3/4	1 1/2	4	1
[illegible]	2 1/2	3/4	2	4	1
3/4	2 1/2	3/4	2 1/2	5	1 1/4
[illegible]	3	3/4	3	5	1 1/4

As the clearance holes when drilled do not produce a desirable cutting edge on the face of the teeth, the front face must be filed after the holes are drilled. They are, as a rule, filed radial, as shown in Fig. 4. When the dies are used wholly for threading brass castings, and various other alloys of copper, it is common in many shops to give the face of the cutting edges a negative rake, as shown in Fig. 5. However, opinions differ widely as to the proper rake to give to the lands of threading dies, and it is probably as well to make the faces radial in all cases. As a matter of fact, the dies will cut all metals ordinarily used in a machine shop to full satisfaction if made in this manner.

Dimensions of Solid Square Dies.

In regard to the sizes to which solid square dies should be made, the outside dimensions evidently depend upon the sizes of the holders in which the dies are used. The thickness of the die should preferably not be made less than one and one-quarter times the diameter of the screw to be cut with the die, but manufacturers of dies do not, as a rule, make their dies fully as thick. The average rule is to make the thickness about equal to the diameter, at least for sizes of screws larger than 3/4 inch diameter. In Tables I and II are given the general dimensions of dies as commonly manufactured, both for regular sizes and pipe sizes. These dimensions are, of course, only given as a guidance, there being no particular reason for making the dies in these certain sizes excepting that the outside dimensions being standardized, the number of holders necessary to use with the dies are reduced to a minimum.

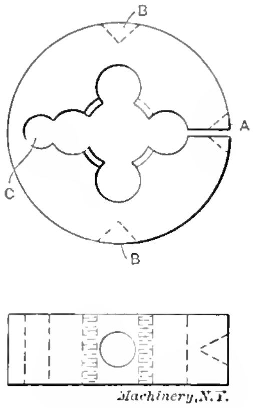


Fig. 6. Round Split Adjustable Die.

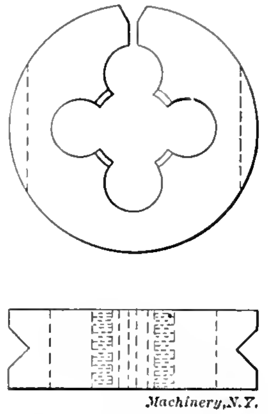


Fig. 7. Round Split Adjustable Die with Grooves for Adjusting Screws.

It is, however, necessary to call attention to the fact that, on account of the clearance holes, the size of the outside square must have some minimum relation to the diameter of the thread to be cut, so that the metal where the clearance holes are drilled does not become too thin. Even if strong enough to stand the strain incident to the thread cutting operation, a die with too thin metal at the clearance holes will spring badly out of shape in hardening and will become a very poor tool for its purpose. The outside size of the square ought not to be less than double the diameter of the thread to be cut.

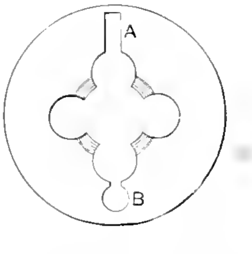


Fig. 8. Manner of Splitting Round Adjustable Die before Hardening.

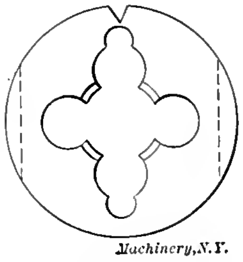


Fig. 9. Round Adjustable Die before Hardening.

Number of Lands.

While four cutting edges or lands are sufficient, at least for all dies up to four inches diameter which cut a full thread, it is necessary to provide more than four cutting edges in a die used for threading work in which part of the circumference is cut away. A greater number of cutting edges are here needed in order to steady and guide the die, and prevent the work from crowding into the side where the metal is cut away. When more than one-sixth of the circumference is cut away, it is not advisable to try to use dies for cutting the thread. The number of cutting edges should be in relation to the amount of the circumference of the work cut away as follows:

Fraction of Circumference Cut Away.	Number of Cutting Edges.
1/24	5
1/12	6
1/8	7
1/6	8

Split Adjustable Dies.

Split adjustable dies, as said before, are usually round, as shown in Fig. 6. The split permits the die to be opened, or closed up, for adjustment. The countersink *A* at the split is for the point of the adjusting screw. The countersinks *B* are for the binding screws, which close up the die to bear upon the point of the adjusting screw. Instead of countersinking at *A* and *B*, as shown in Fig. 6, it is cheaper, when making these dies in quantities, to mill grooves, as shown in Fig. 7. The grooves, as well as the countersinks, for the adjusting screws, are usually made 60 degrees inclusive angle, and those for the binding screws 90 degrees.

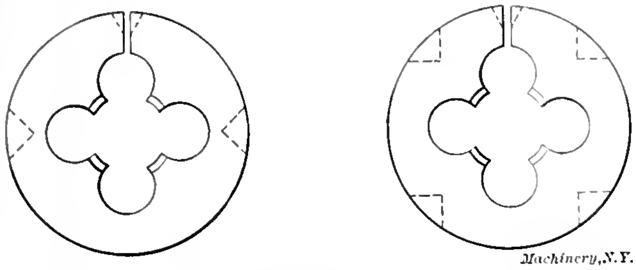
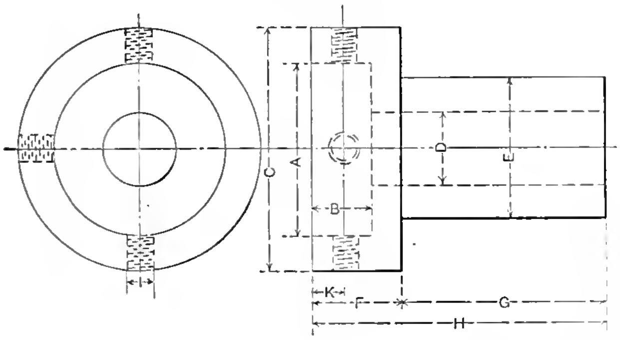

Machinery,N.Y.

Fig. 10. Comparison between Common Ways used for Locating Adjusting Screws.

In order to make the dies more easily adjustable, a small hole is often drilled outside of the clearance hole opposite the split, as shown at *C* in Fig. 6. If the dies made are few, they may be split before hardening, as shown at *A* in Fig. 8, with a saw or narrow file, but should not be split all the way through until after hardening, in order to prevent springing due to this process. When made in large quantities, a hole may be drilled outside of the clearance hole, where the split is to come, and the groove for the adjusting screw milled so as to leave a narrow bridge of metal between the hole and the bottom of the groove, as shown in Fig. 9. This bridge of metal is then removed after hardening by means of grinding with a thin emery wheel, or a bevel wheel with an acute angle.

TABLE III. DIMENSIONS OF DIE HOLDERS FOR USE IN ORDINARY LATHE.



Machinery,N.Y.

Fig. 11.

Diameter of Recess.	Depth of Recess.	Outside Diameter.	Diameter of Hole in Shank.	Diameter of Shank.	Length of Body.	Length of Shank.	Total Length.	Size of Screws.	Location of Screws.
A	B	C	D	E	F	G	H	I	K
0.632	1/4	1	3/16	1/2	3/8	3/4	1 1/8	5/32	0.135
0.821	1/4	1 1/4	7/16	5/8	3/8	3/4	1 1/8	3/16	0.135
1.009	3/8	1 1/2	9/16	1	9/16	1 1/8	1 11/16	7/32	0.197
1.511	1/2	2 3/16	13/16	1 3/8	3/4	1 1/2	2 1/4	1/4	0.260
2.013	5/8	2 5/8	1 1/16	1 3/4	15/16	1 7/8	2 13/16	5/16	0.322
2.515	11/16	3 9/16	1 3/8	2 1/4	1	2 1/16	3 1/16	3/8	0.354

Round split dies for sizes up to and including 3/16 inch are given only three lands. All other sizes are provided with four lands. When hardening these dies, draw to a blue in back of the clearance holes, in order to insure a good spring temper.

About three threads should be chamfered and relieved on the top of the chamfer, on the leading side of the die. Such dies as are intended for use in die stocks should be chamfered on both sides or ends, in order to permit the turning of the die and its cutting close up to a shoulder. In such cases the chamfer on the leading side should be about three threads as before, and on the back side from one to one and one-half thread. The thread which is to be cut close to a shoulder should, however, always be started with the leading side of the die, both because this side is provided with a longer chamfer and consequently possesses better cutting qualities, and because of the guide with which the die stock is provided on the leading side which is necessary to insure a straight thread.

There is some difference of opinion as to the best manner of arranging the binding screws for adjustable split dies. The common arrangement with two screws has been referred to, but an arrangement for four screws, as shown in Fig. 10, evidently will close up the various lands more uniformly, and the die will cut more freely. If adjusted so that the lands do not come at a uniform distance from the true axis of the die, all the lands will not cut, or, if they cut, will produce a thread that will be out of true.

TABLE IV. DIMENSIONS OF ROUND SPLIT ADJUSTABLE DIES.

Diameter of Thread.	Outside Diameter of Die.	Thickness	Diameter of Thread.	Outside Diameter of Die.	Thickness.
1/16	13/16	1/4	1/2	2	5/8
1/8	13/16	1/4	9/16	2	5/8
3/16	13/16	1/4	5/8	2	5/8
1/4	13/16	1/4	11/16	2	5/8
3/16	1	3/8	3/4	2	5/8
1/4	1	3/8	11/16	2 1/2	11/16
5/16	1	3/8	3/4	2 1/2	11/16
3/8	1	3/8	13/16	2 1/2	11/16
7/16	1	3/8	7/8	2 1/2	11/16
3/8	1 1/2	1/2	1	2 1/2	11/16
7/16	1 1/2	1/2	1 1/8	2 1/2	11/16
1/2	1 1/2	1/2	1 1/4	2 1/2	11/16

The outside dimensions of round split dies are usually made of certain standards to fit a few holders. Dimensions commonly used are stated in Table IV.

Die-holders.

An ordinary lathe die-holder is shown in Fig. 11, and dimensions for holders of this design for the dies in Table IV are given in Table III. A holder for a smaller size is also specified, as dies for small machine screw sizes are often made with an outside diameter of 5/8 inch and a thickness of ¼ inch. The dimensions cannot, perhaps, always be adhered to, but they will be of value as guidance when proportioning holders of this or similar kinds.

It will be noticed that the center line of the binding screws does not fully coincide with the center of the die in the longitudinal direction, but that the screws apparently are located 0.010 inch too far in. This is for the purpose of forcing the dies solidly toward the bottom of the recess, the screws exerting a wedge action on the dies in the countersinks or milled grooves provided for the point of the screws.

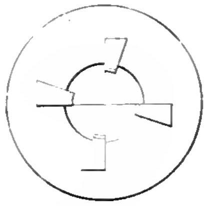


Fig. 12. Solid Inserted Blade Die.

Approximate formulas may be given from which well-proportioned holders for other sizes than those given in the table may be made. In the formulas:

d = the outside diameter of die,
A = diameter of recess,
B = depth of recess = thickness of die,
C = outside diameter of holder,
D = diameter of hole in shank,
E = diameter of shank,
F = length of body,
G = length of shank,
H = total length,
I = size of adjusting and binding screws, and
K = distance from end of holder to center of screws.

The following formulas give results, approximately, as stated in Table III:

$$A = 1.004\,d + 0.005 \text{ inch}$$

$$C = \frac{11\,d + 1}{8}; \qquad D = \frac{9\,d}{16}; \qquad E = \frac{3\,d + 1}{4};$$

$$F = \frac{3\,B}{2}; \qquad G = 3\,B; \qquad H = \frac{9\,B}{2};$$

$$I = \frac{d}{8} + \frac{3}{32}; \qquad K = \frac{B}{2} + 0.010.$$

Inserted Chaser Dies.

Inserted chaser dies may be of two kinds, such as have the chasers driven solidly in place, and such as have chasers which are easily removable, and can be replaced without difficulty. It is evident that the latter form is superior, but it is also the more complicated and expensive form.

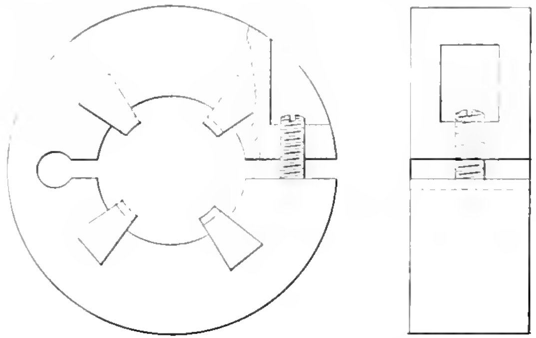

Industrial Press, N.Y.

Fig. 13. Adjustable Inserted Blade Die.

Inserted Chaser Dies with Fixed Chasers.

If we first consider the case of the dies with the blades solidly in place, we may safely say that it is not advisable to attempt to make very small dies with inserted blades, but for dies which are two inches in diameter, or possibly 1¾ inch, a ring of machine steel, having slots in which are inserted blades made of tool steel, is the simplest construction of an inserted blade die. The slots receiving the blade are made so that the front edge will be radial, as shown in Fig. 12. In this way there will be no difference in the cutting action of the inserted blade die, and a solid die having its cutting edges on the radial line. The slots should be of the dovetail type, that is, wider at the bottom than at the top, so that the blade is drawn into its seating surface, and prevented from being pulled out when in use. The first cost of a die made in this manner may not be any less than the first cost of a solid die, but the cost of new blades is less than the cost of a new solid die, and therefore, in the long run, this type of die should be cheaper. Besides, there is no risk of spoiling the dies in hardening, because only the blades are hardened, and these, of course, would not crack, at least not under any ordinary circumstances. The inserted blade dies are made either solid or adjustable. When made of the former type, they are threaded with a hob of exactly the same size as the screw to be cut with the die. When made adjustable, they should be tapped with a hob about 0.005 inch over size for a 20-pitch thread to about 0.015 over size for a screw having from 4 to 5 threads per inch. There are several methods for adjusting inserted blade dies, one of the simplest, and at the same time one of the best, is shown in Fig. 13, but it is claimed by many mechanics that better results are obtained if this class of die is provided with the same adjustment as has been previously described under the head of adjustable dies in the previous portion of this article.

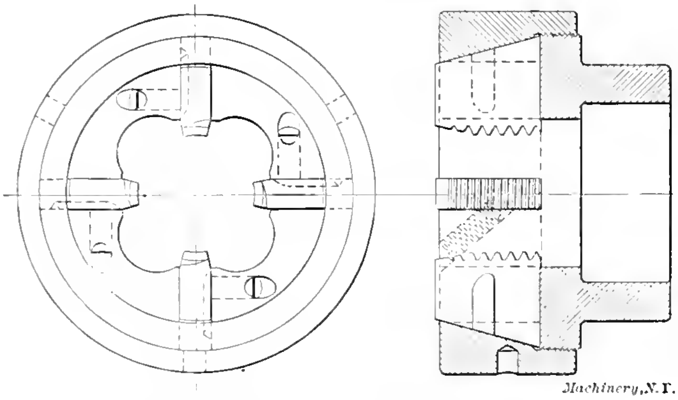

Machinery,N.Y.

Fig. 14. Inserted Chaser Die with Removable Blades.

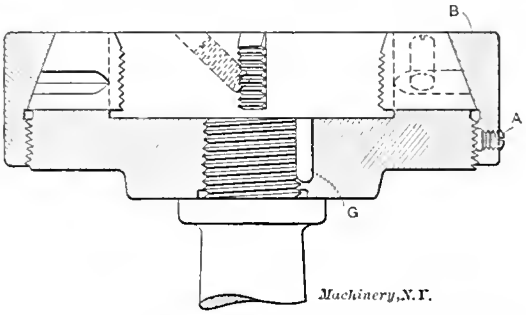
Inserted Chaser Die with Removable Blades.

A typical construction of inserted chaser die with easily removable blades is shown in Fig. 14. This die consists of four chasers or blades inserted in radial slots in a body or collet, the chasers as well as the collet being enclosed in a die-ring. This ring is beveled on the inside to fit a corresponding bevel on the back of the chasers. It can be screwed up or down on the collet, thus pushing the chasers in toward, or permitting them to recede from, the center. Screws are provided bearing in slots of the chasers for holding the latter in place after they have been adjusted by means of the ring.

TABLE V. OVER-SIZE OF TAPS FOR HOBBING SPRING SCREW DIES WHEN CUT STRAIGHT.

No of Threads per inch.	Over-size.	No of Threads per inch.	Over-size.	No. of Threads per inch.	Over-size.
4½	0.015	12	0.006	28	0.004
5	0.013	13	0.006	30	0.004
5½	0.012	14	0.005	32	0.004
6	0.010	16	0.005	36	0.004
7	0.008	18	0.005	40	0.003
8	0.007	20	0.005	48	0.003
9	0.007	22	0.005	56	0.0025
10	0.006	24	0.004	64	0.002
11	0.006	26	0.004	72	0.002

The chasers must, of course, be made in sets so that each is, so to speak, one-quarter of a thread ahead of the following one, or in other words, the teeth on the chasers must all form one continuous thread around the die. The die shown in Fig. 14 is known as the Woodbridge adjustable die. The shank is in one solid piece with the body. Another form of inserted chaser die is shown in Fig. 15. Here the shank is screwed into the body and secured to it by means of a pin *G*. The screw *A* serves the purpose of locking the die ring *B* to the body as soon as the chasers are properly adjusted; the chasers are secured the same as in the die previously described.



Machinery,N.Y.

Fig. 15. Another Type of Inserted Chaser Die with Removable Blades.

The object of inserted chaser dies is the adjustment possible, and the saving caused by being able to use the same body and ring for an indefinite period, the chasers only being replaced when worn. The chasers only are made from tool steel, the remaining parts being machine steel. As there is a considerable element of waste in being obliged to throw away a solid or adjustable die made from expensive steel whenever the cutting edges are worn away, the economy of replacing the cutting edges only is obvious.

Spring Screw Threading Dies.

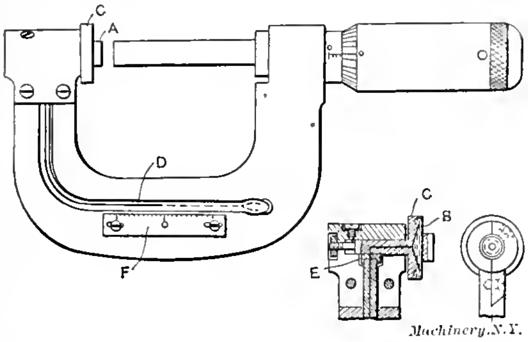
In the August, October, and November, 1906, issues of MACHINERY, three articles appeared dealing with the design and making of spring screw threading dies. In these articles, the commonly employed methods of making these dies were outlined, and some suggestions given in regard to possible improvements. In Table V is given the amount of over-size which the die tap is required to be when hobbing out spring screw dies, when threaded straight from the front of the die.

An article giving the method of determining the relative sizes of roughing and finishing spring screw dies was published in MACHINERY, March, 1907.

ITEMS OF MECHANICAL INTEREST.

SENSITIVE INDICATING MICROMETER.

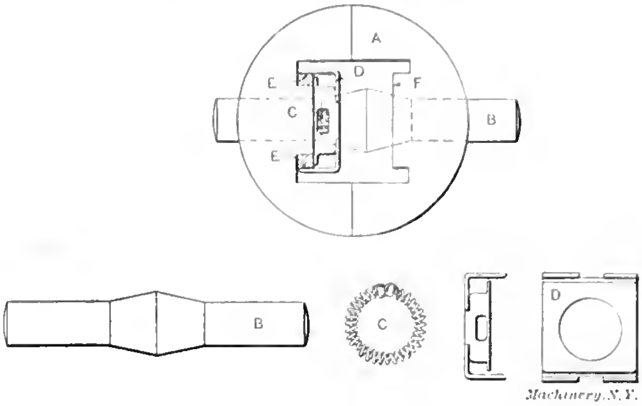
The accompanying illustration shows a micrometer which has been patented by the General Electric Company, of Schenectady, N. Y. The object of this tool is to avoid dependence on the sense of touch of the person handling the measuring tool. In the instrument shown, the accuracy of the reading is independent of the sense of touch or experience of the operator, and a correct reading can be easily detected by the eye by means of an indicator. The principle of the device is simply this: The stationary member or anvil *A* is attached to a circular diaphragm *B*, which is supported on its circumference in the head *C*. This head is cut away, so as to form a cone-shaped depression, which, in connection with the diaphragm forms a receptacle for mercury. The head *C* is provided with a stem, which fits into a bearing in the micrometer frame, and is slightly adjustable. A capillary tube *D* is partially imbedded in the frame, and has one end screwed to the stem of *C*, by means of a collar *E*. An adjustable scale *F* is arranged at the center of the frame. When measuring, the object to be measured will be pressed against the anvil *A*, until the mercury in the tube reaches the zero graduation on the scale *F*. For every piece measured the micrometer screw will be screwed down until the pressure on the anvil equals the standard pressure required for the mercury to indicate at zero on the scale. The tube, of course, must be made of glass, so as to make the mercury column inside visible to the eye. It is evident that very close measurements can be obtained in this way. One objection to the instrument may be that it must be held in a vertical, or nearly vertical, position when in use. The principle involved, however, may possibly be used for other micrometer measuring instruments, where the dependence on the sense of touch is objectionable.



Sensitive Indicating Micrometer.

INGENIOUS ELECTRIC SWITCH MECHANISM.

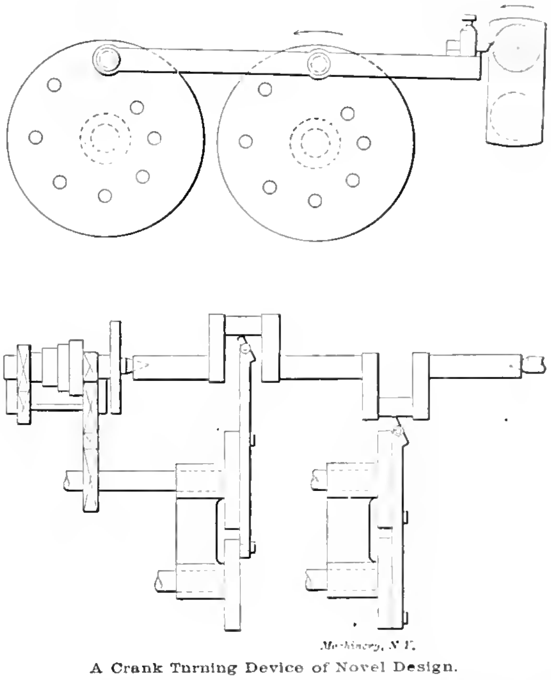
The accompanying line engraving shows an electric switch mechanism, the interesting feature of which is the simplicity of its action. In the top view the mechanism is shown assembled, and below are shown the three main details, the casing *A* not being shown here. Disregarding the casing, the switch mechanism consists practically of only three parts: first, a push bar *B* extending clear through the switch, having its largest diameter in the center, and shaped conically from the center for some distance towards each end, as clearly shown in the illustration; second, a coil spring *C* which encircles the bar previously mentioned in such a manner that the axis of the spring forms a circle around the bar; third, a moving contact piece *D*, forming a casing over the spring. When this contact piece is in the position shown in the upper view, it is in contact and forms a circuit at *E*, the contact pieces in the casing *A* being shown cross-sectioned for the sake of clearness. The action of the device is simply this: when the bar is pushed forward, the coil spring rides up on the conical surface until it reaches the center of the bar, all the time preventing the contact piece from releasing from contact at *E* until the spring has reached the central and highest part of the bar. At this moment it suddenly contracts and moves swiftly along the conical shape on the other side of the highest point of the bar, carrying with it the moving contact piece *B* and releasing it from its contact at *E*, bringing it against the other side of the casing at *F*. It is not possible to move the contact piece part way and let it slip back again, drawing an arc which burns the contacts and eventually destroys them. The contact piece must be either positively in contact at *E* or out of contact, resting against *F*. The simplicity of the mechanism makes it particularly interesting, and no doubt devices using the principle employed would be successful in automatic machinery for positive and instantaneous "knock-outs" and stops of various descriptions. The switch mechanism as shown is made by the Cutler-Hammer Mfg. Co., Milwaukee, Wisconsin.



Simple Electric Switch Mechanism.

CRANK TURNING DEVICE.

Patents have been applied for in Great Britain for the device working on the principle shown in the line-engraving herewith, intended for turning crank-pins, and pieces rotating around a central shaft in a similar manner. In the upper part of the figure, the general principle of the device is indicated, the lower part being a plan view showing diagrammatically its connection with the lathe to which it is applied. The principle of the device is easily seen from the illustration. The crank-shaft is mounted on its own centers in the lathe, and the working tools are given a reciprocating motion, vertically and horizontally, so as to coincide with, or follow, the motion of the work being turned. The motion of the tool is positive, and interdependent of the motion of the crank or shaft. In the lower part of the engraving, the device is shown in two positions, first when operating on one and then when operating on the other crank-pin of a crank-shaft having two pins. While not shown in the engraving, the two disks to which the tool holder arm is connected must be positively geared together, as otherwise difficulties are sure to be encountered. To what extent a device of this kind will prove practical for the purpose for which it is intended it is difficult to say.



A Crank Turning Device of Novel Design.

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SEPTEMBER, 1908.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

The fourteenth volume of MACHINERY, regular edition, was completed with the August issue, and the yearly indexes for the Engineering, Shop and Railway Editions will be ready in September. The reader who binds an index with his issues for the year will have a volume of mechanical knowledge without a parallel in smallness of cost and comprehensiveness of contents. Copies of the index are sent free; specify the edition wanted.

* * *

THE VALUE OF PUBLICITY TO INDIVIDUALS.

Once in a while some contributor who has sent us a valuable article, and to whom we think is due all the publicity resulting from its publication, objects to having his portrait and biography, and sometimes even his name, used in connection with his contribution. His objection usually arises from modesty and the lack of appreciation of the value to him personally of the kind of publicity afforded by a mechanical journal of large circulation. There are hundreds of able men in as many different shops in the country who are working for far less compensation, or at least under far less favorable circumstances, than they might, did some other employer (or, in fact, in many cases, even their own employer) know of their ability, and thereby feel warranted in offering them places of responsibility which they cannot now reach, simply because they lack the requisite advertising.

It is not enough that a man is an able man, that he does his work carefully and conscientiously, and that he is able to carry out the tasks given to him. To be really successful, it is also necessary that other people know of this ability and appreciate it; and one of the simplest and easiest ways for a person to become known among mechanical men is by presenting his work and his experience in the pages of trade journals. In this manner he reaches mechanical men all over the country, he develops his ability to think and write clearly and logically; and in some cases, too, he finds out his limitations, and thereby is given an opportunity to improve.

A manufacturer's product may be the most perfect in his line and still his sales may be far less than his competitor's, who, perhaps, turns out inferior work. The reason for the difference is simply that the former manufacturer does not advertise his goods adequately, or in a proper manner. In the same way, an individual may possess great ability, fitting him for authoritative positions, but nobody knows of him, simply because he lacks the requisite publicity. There are three stages, one might say, in a man's success; the first, to "make good"; the second, to let others know that he can make good; and the third, to continue to make good.

* * *

PRACTICAL KNOWLEDGE OF SALESMEN.

The practical knowledge possessed by salesmen of the construction and use of the machines which they represent and sell, is a factor that is not so fully appreciated as it ought to be. When a salesman does not possess any practical or technical knowledge regarding his machines, but is merely a good talker, he may be successful as long as he deals with people interested merely in the selling end of the business; but nearly always he will have to deal also with men who are mechanics in the first place, and who soon find out the shortcomings of the salesman, and realize that most of what he says is not the result of his own knowledge, or matters which he could himself verify, but is simply said because others have told him so. The practical man is at once prejudiced against dealing with a man of this type, and although the salesman may be both honest and able in his particular line, and represent the very best machines, his lack of mechanical knowledge may prove to be his undoing. It is therefore important, in order that the salesman may make a good impression upon his customers, that he should know in detail the mechanical construction and use of the machine he is trying to sell, and be able to point out, from his own experience, the reasons why it is superior to competing machines. Salesmen of this type are able to convince practical men, and they create a good impression. The firm employing such salesmen has in them one of its greatest assets.

* * *

THE ADVANCE OF ENGINEERING EDUCATION.

The new departure in engineering education, inaugurated two years ago at the University of Cincinnati, in the form of a cooperative course in engineering, appears so far to have proved an unqualified success. It is natural that it should be so, considering that the factors required in the training of an engineer have been taken care of by this course in a far better manner than by engineering schools in general. It should be remembered, however, that a cooperative course of this kind cannot be instituted by every technical school or college. The fundamental requirements are that the college be located in a city with a highly developed machine industry, and that the men in charge of these industries be favorably inclined towards the proposition, and willing to accept students for training purposes. But wherever the technical school is so located, there is little doubt that such a school will turn out a product superior to the average, and that it will receive applications from young men wanting a practical engineering training, in such abundance as to make possible a judicious selection of the raw material that is offered. This, at least, has been the experience of the Cincinnati school.

The advantages of the cooperative course, from a technical and mechanical point of view, can hardly be overestimated. This system of educating engineers is also likely to have far-reaching sociological results. It brings those men who in the future are to guide and superintend the work of others, in close contact with the very men they are to lead later on. It gives the students a clear conception of the conditions under which these men work, and should enable them as leaders to avoid a great deal of the friction that is often due simply to misunderstanding. This departure in engineering education should therefore be productive of results more far-reaching than even its inaugurators have anticipated. It has proved embarrassing in some cases to the old school of professors and teachers. They have found themselves out of place when confronted by young men who one week work in the shop, and the next week in the class-room, and who come there full of practical ideas. This experience will naturally force some instructors either to assume a different attitude toward practical education, or to make way for another class of instructors able to meet the demands of the times. The cooperative engineering courses are likely to be a regenerative force in our engineering education.

INCREASED USE OF HIGH-SPEED STEEL.

The main disadvantage under which high-speed steel has labored during the last few years, as regards its employment universally in the metal trades, has been its high cost. With the steel used merely as a cutting tool, this high cost would not be prohibitive, inasmuch as the increased production would well warrant the use of high-speed steel; but a large portion of every tool is used not as a cutting tool, but merely as a holding device, shank, etc., and it is rather expensive, particularly in large tools, to have these parts of the tool made of so expensive a material. Tool-holders of various shapes and kinds have been used, but for many purposes they are not as satisfactory as a solid tool. For this reason, attempts have been made to weld high-speed steel to shanks of cheaper materials, but in the past these attempts have been unsuccessful, the high-speed steel having refused to comply with any welding process intended to combine it by cohesion to either carbon steel or machine steel. An abstract of an article in an English contemporary in our Engineering Review this month gives a short review of a welding process which has been developed in England, and which is claimed to give satisfaction. Should it prove that this welding process is all that has been claimed for it, it is likely to revolutionize the use of high-speed steel, and in cases where now the expense of this material has been looked upon as prohibitive, it is likely to become universally used. It is to be hoped that the welding process, as outlined, is not merely a process developed for company promoting and stock jobbing purposes, but that it will prove to be of actual importance to the metal trades.

* * *

THE INCONSISTENCY OF SOME MANUFACTURERS.

JOHN B. SPERRY.*

Other manufacturers, besides machine tool builders, would do well to follow the suggestions offered in the editorial on "Obsolete Tools in Machine Tool Shops" in the July number of MACHINERY. The writer can call to mind several instances where manufacturers show their inconsistency in this respect. This can be best illustrated by a specific case, referring to a concern capitalized at $300,000, and manufacturing steam engines, air compressors, water in-takes operated by compressed air, air-lift systems, centrifugal pumps of all sizes, and several other kinds of machines for pumping purposes. This firm has a machine shop, foundry, wood shop, pattern shop, blacksmith shop, and ware-house—all modern buildings. These shops all receive their power from a central power plant equipped with a Corliss engine and a direct current generator. The machine shop is equipped with an electric traveling crane, while the foundry and blacksmith shop have jib cranes operated by hand. The concern has spent thousands of dollars for jigs in order to lower the cost of production. The shops are lighted by electricity, and the clock system of time keeping has been installed. Besides this, there is an excellently arranged stock department.

Contrasted with this is the equipment of the foundry. Since this firm manufactures air compressors, one would naturally expect to see some pneumatic tools in operation, especially in the foundry; but no, all the riddling and chipping is done by hand. Pieces that are too large to put in the rattler are brushed and cleaned up by hand. And to cap the climax, instead of using one of the firm's own air-lift pumps for the water system, there is an old power pump jack that keeps the water well oiled, and breaks down regularly once every two weeks.

Now this firm's trade in air compressors has fallen off considerably in the last two years, due, it is claimed, to the competition in that line. It is the writer's opinion that if this firm would practice what it preaches, it would be able to get in on the ground floor with the other fellow. The use of air hammers, air chisels, air brushes, sand blasts, emery wheels operated by air, air drills, riddles operated by air, and air lifts, would not only cheapen the labor cost, but the practical application of compressed air to the work of the machine shop, foundry, blacksmith shop, etc., would be an object lesson to the intending purchaser that would tend to hasten his decision.

This shop is not the only one that seems to be trying to make and sell something that the firm's officers do not seem to believe in themselves; there are others, and one does not have to travel far to find them. Without citing any more cases one might add that if the manufacturer would be consistent and make it a point to have practical applications of the machines or appliances that he manufactures, where they can be seen by a buyer, he will find it easier to convince the public of the utility and advantages offered by his product.

[In connection with the foregoing it may be interesting to relate an occurrence which took place at the works of a well-known machine tool building firm a few years ago. A Japanese, traveling in the United States for the purpose of selecting and buying some new machinery for a Japanese ordnance works, was taken through the shops by one of the members of the firm, and shown a new lathe brought out by the company. This guide, having a mental vision of a large contract from the Japanese government, became more and more enthusiastic as he explained the merits of the new machine, and, in particular, pointed out that no machine shop could afford to keep their old machines, when installing this new lathe would double the production, or nearly so. He explained to the Japanese that in America it was very common for manufacturers to throw out the whole of their old equipment, and install new machinery when its superiority had been proved. This particular machine, he said, was a machine of the type that would justify such action. The Japanese listened with a pleasant smile, and, according to the Japanese code of politeness, agreed with everything said. After having been taken all through the shops, and on return to the office, when the question of "making a deal" was brought up, the little Japanese quietly and pleasantly asked: "Now, if this machine that you have shown me, and the merits of which are so great as to warrant throwing out old equipment and installing a new set of machines, actually possesses all the merits you claim for it, how is it that you have only three of these new lathes installed in your own shop?" The reply is not recorded, nor is the sale of the machines.—EDITOR.]

* * *

SPECIFIC ADVERTISING.

The great advance in machine tool construction which has taken place during the last decade is strikingly demonstrated by a comparison of the advertising pages of a technical journal ten years ago and to-day; and such a comparison will show not only that there has been an advance in the building of machines, but also in the method of presenting the advantages of the machines to prospective customers. The same holds true of all catalogues and advertising literature of to-day. Years ago it was common for the maker merely to state that he had such and such machines to sell, that they were of accurate workmanship, built of the best materials, and in all ways the most perfect on the market, etc. To-day, while of course these generalities may still be included, we see a large amount of what we may call *specific* advertising telling exactly what the machine will do and in how short a time it will do it, and what tools are required to perform the operation. Samples of work carried out on the machine are shown, and complete details about turning out the work, the material from which it is made, and so forth, are given. This is the kind of advertising that appeals to mechanical men. To speak in generalities does not appeal to them, because judging only by general terms, one machine is as good as another; but when the actual facts are given, provided they are given honestly and correctly, a mechanic can judge for himself without hesitation about the merits of the machine. He has some definite data to deal with when making his comparisons. It appears that manufacturers are commencing to appreciate the value of this kind af advertising, because it is becoming more and more common both in catalogues and in trade journal advertisements, to show the work performed, and to give the exact information regarding the performance. It is likely that in the future this class of advertising will be even more common than now, and the mechanical trades will undoubtedly gain by it.

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ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

It is reported that a measure will be introduced at Ottawa for the reconstruction of the collapsed Quebec bridge. The construction work will be in the hands of a board of prominent engineers, and the Canadian government, it appears, is going to undertake the work as a government project.

According to *Indian Industry and Power*, a system of automatic signaling worked entirely by electricity is being installed on the Metropolitan railway in London. The new system provides for applying the brakes to the train automatically if the engineer should pass a signal set at danger.

Superheated steam locomotives appear to be so favorably considered by European railroads that at the present time hardly any express locomotives are ordered without superheaters. Recently 24 express locomotives for the Italian State Railways, built in Germany, were completed, all being furnished with Schmidt superheaters.

Beginning August 3, the last section of the Philadelphia subway was opened for traffic. This subway, which is run in connection with the new Market Street elevated railroad, gives an entire length of rapid transit through the city of about seven miles. The subway construction is of the very highest type, and the approximate cost of the subway portion alone is $20,000,000.

It appears that the authorities of the German State railways have concluded that incandescent gas lighting is superior to electric light in railway cars. No more cars are equipped with electric light, and the engineers, after long and exhaustive tests, have satisfied themselves of the value of the former system of car lighting, and are now changing over the equipment at the rate of 500 to 600 lights a day.

The British Admiralty has decided that in the future all small naval craft shall be constructed to use both coal and oil fuel. The oil-burning system has been used for a considerable time, and many of the destroyers and torpedo boats are designed exclusively for the oil-burning system. All the modern battleships and cruisers of the navy are also constructed to use either coal or oil.

During the year ending June 30, 1908, 1,506 vessels, with an aggregate tonnage of 588,627 gross tons were built in the United States. This is, so far, the largest annual output of the ship building yards in this country. The steel vessels built numbered 142, representing 417,167 gross tons, of which 75 were built for the Great Lakes, with an aggregate tonnage of 304,379 tons. The largest steamer on the lakes built during the year was very nearly 8,000 tons.

After several years of thorough testing and experimenting, the officials of the Burlington railroad have come to the conclusion that concrete ties are not satisfactory, and that the best solution of the railroad tie problem at present is to treat wood so that it will not deteriorate as rapidly as when in its natural state. According to the *Scientific American* it has been decided to construct a large plant for treating ties, bridge timbers, etc., with creosote.

In the May issue of MACHINERY, we mentioned that Professor Kamerlingh-Onnes, a Dutch scientist, had succeeded in solidifying helium. This statement, however, as we mentioned in a later issue, depended on a mistake made by Professor Onnes, he having been deceived by impurities in the helium. He has now, however, announced that he has been able to produce helium in a liquid state, boiling at a temperature of 7.75 degrees F. above absolute zero. He was not able, however, to solidify the liquid.

In a recent issue of the *English Mechanic and World of Science*, it is stated that at the June 15 meeting of the Academy of Science, Mr. Devaux Charbonnel gave particulars of a method of photographing sounds of the human voice, in such a manner that the photographic record could be read. Vowels and consonants are combined by means of the Blondel oscillograph. This extremely sensitive instrument impresses the sounds upon a photographic plate in the form of curves, which can, with a little practice, be easily deciphered.

According to the *Far Eastern Review*, a Chinese gentleman named Hu Chuen has obtained a patent on an improved method of wireless telegraphy, simplifying the methods hitherto in use. The system has been recommended by Chinese authorities for the reason that it makes use only of domestic Chinese materials of lower cost than imported articles, and it is also simpler to operate. At the test of the equipment at Canton it was pronounced a success. Detailed information as to the workings of the new system, however, are not as yet at hand.

The Society of German Engineers, at its annual convention held in Dresden June 29 and 30, and July 1, empowered its officers to negotiate with representatives of the Prussian State government, as well as the government of the German Federation, to make arrangements for the bringing out of the Technolexikon, which, as we have mentioned before in MACHINERY, the society found itself forced to give up about a year ago, on account of the great scope of the work, involving expenditures greater than the society considered that it could consistently make.

The much-advertised New York-Paris automobile race, which started from New York, over a route across the United States, Siberia, Russia, and Germany, to Paris on February 12, this year, was practically concluded by the arrival of the Thomas car in Paris on July 30. This race marks one of the most interesting events in the automobile history, and the fact that it was carried to a conclusion indicates the present state of the endurance of the automobile, and rather reverses the general opinion that the automobile is fit only for good and smooth roads in a country where the repair shop is near at hand.

It is interesting to note that the slide rule, which but lately has become universally used for calculations, was invented nearly 300 years ago. An article in *Zeitschrift für Vermessungswesen* calls attention to the fact that Gunter, shortly after his bringing out the trigonometric logarithm tables in 1620, placed logarithmic scales on wooden rules, and used a pair of dividers to add or subtract the logarithms. In 1627 these logarithmic scales were drawn by Wingate on two separate wooden rules, sliding against each other, so as to render the use of dividers unnecessary, and in 1657, or over 250 years ago, Partridge brought out the slide rule in its present form.

In view of the present agitation for the preservation of the natural resources of the United States, the methods employed by the Swedish government for the preservation of forest reserves as well as ore deposits are of special interest, and we have previously referred to the replanting of forests, the limitation of export shipments of iron ore, and the taking over of some iron ore deposits by the government. It is now reported that the Swedish government is still further pursuing the policy of actual ownership of ore deposits, the present parliament having passed a bill providing for the state purchase of the important Svappavaara ore fields in the northern part of the country.

In an editorial in *Teknisk Tidskrift*, attention is called to the mistaken idea of economy which manifests itself in the

use of cheap materials and cheap labor, rather than in a proper systematizing for using the given opportunities in the most economical way. Many a man thinks that when he can buy some belting for a few dollars less than he has been used to do, by selecting a secondary quality, he has accomplished a great saving, but loses sight of the fact that this mere temporary saving may be lost many times over, through frequency of repairs, faster wear, and disturbances in the running of the shop machinery. Still more serious, however, is the case when the "saver" selects the living material as the proper territory for his exploitation. The expression "cheap labor" is not clear, and it often is the cause of serious mistakes. It is self-evident, says the editorial referred to, that a poorly paid employe, as a rule, does not develop full energy, and that an efficient draftsman, for instance, if he is paid less than the common standard of wages for his class, will constantly give greater interest to the question, "How can I get out of here?" than to the problems which he is supposed to solve.

In an article in the *Engineer*, London, Mr. P. V. Vernon states that a good rule for the horse-power required to drive machine tools is to assume one horse-power for each 10,000 square inches of belt delivered to the machine per minute. This rule is based on a working belt pull of 39.6 pounds per inch of width tending to rotate the pulley, a rule which, it is stated, is justified by the author's experience, and which may be demonstrated as follows: 10,000 square inches of belt per minute = 10,000 linear inches of belt one inch wide per minute = 10,000 ÷ 12 linear feet of belt one inch wide per minute. As each inch of width of belt is assumed to carry 39.6 pounds of effective tension, the power transmitted will be:

$$\frac{10,000}{12} \times 39.6 \text{ foot-pounds} = 33,000 \text{ foot-pounds},$$

$$\text{or H.P.} = \frac{\pi DWn}{10,000},$$

in which formula, D = diameter of pulley in inches,

W = width of belt in inches, and

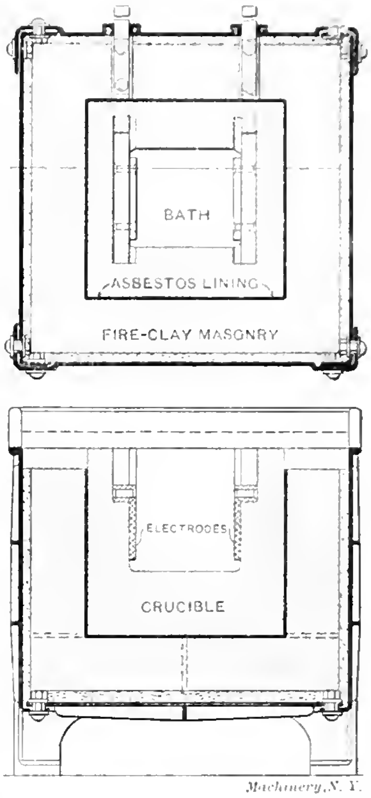
n = revolutions of pulley per minute.

A tight double belt may transmit twice the amount of power given by the above rule; but although the machine must be strong enough to resist the extra pull, yet it is not wise to provide for double the motive power where a separate motor is used, as most motors will stand as much temporary overload as a belt, and no belt will work well with a permanent overload.

A method for surface-hardening structural steel and steel rails is described in the *Mechanical Engineer*. The principle whereby this is accomplished is as follows: The steel ingot, when stripped from the mold, is enclosed in a receptacle lined with brick, the receptacle being about eight or ten inches larger than the ingot placed in it. Space is left between the ingot and the sides of the chamber, and when the ingot has been lowered centrally into the receptacle, the intervening space between the hot ingot and the sides of the receptacle is filled as rapidly as possible with dry powdered carbon or other carbonaceous material. This material is rammed in between the ingot and the walls, and when the receptacle is completely filled, the ingot is allowed to remain covered for a length of time depending on the amount of carbon to be absorbed by the surface. Several hours, as a rule, is necessary for obtaining the required results. The carbon penetrates into the surface of the steel ingot, and the whole process may be compared with the case-hardening of mild steel parts. The carburized ingot, when removed from the receptacle, is again heated and rolled into a structural shape, the finished article now presenting a hardened surface. It is stated that if it is desirable that only a part of the outer surface of the ingot should be hardened, so that when rolled down, the harder part may form the head of a steel rail, for instance, the part forming a web or flange still remaining soft, the hot ingot may be put into a receptacle, and suitable division pieces inserted so that carbon may be brought into contact only with the part required to be hardened. This process has been developed by Mr. Benjamin Talbot, formerly of Phoenixville, Pa., who is now living in England.

ELECTRICALLY HEATED HARDENING BATHS

In an article in *Page's Weekly*, the method of hardening small cutting tools adopted by the firm of Ludwig Loewe & Co., in their Berlin works, is referred to. The hardening process is carried on by means of electrically heated barium salt baths, the arrangement of the crucible and the electrodes being as shown in the accompanying engraving. By means of this process, it has been possible to harden large milling cutters in about half an hour, including the time for pre-heating, which takes the greatest part of the time. To bring the cutters up to a temperature of 750 degrees F. constitutes this pre-heating. After that, it takes only about a minute to bring an average-sized cutter to 1,400 or 1,500 degrees F., and then another minute to bring it up to about 2,370 degrees F., which is, by this firm, considered the right hardening temperature. The time stated above refers to average-sized and heavy milling cutters, whereas it only takes from 6 to 10 minutes to bring a small milling cutter to the right temperature in the electrically heated salt bath.



Machinery, N. Y.

Arrangement of Crucible and Electrodes for Electrically Heated Hardening Baths.

The advantage of electrically heated salt baths is stated as being the total absence of any scale on the tool thus hardened, and that the tools are not distorted in the hardening process. The bright appearance is retained by the hardened tool, so that it is sometimes difficult to tell from the appearance whether a tool has been hardened or not.

In regard to cooling the cutters, the firm of Ludwig Loewe has found that when high-speed steel tools are cooled in an air blast, any moisture coming in contact with the hot tool has a tendency to crack it, so that it becomes necessary to dry the air before it enters into the nozzles. It has also been found that it is absolutely impossible to cool a cutter which has a very heavy body and fine teeth in the air blast, as the heat from the central portion is not extracted fast enough, and therefore does not permit a sufficiently rapid cooling of the teeth to insure proper hardening. For this reason, the firm has adopted a method of cooling the cutters from the hardening heat of 2,370 degrees F. to a temperature of about 1,100 degrees F. by quenching in an electrically heated salt bath. After having been cooled to about 1,100 degrees F. in the bath, the cutters are allowed to cool down slowly in the air, and the whole process has the advantage of being cheap and reliable, as well as effecting a considerable saving in time.

It must, however, be understood that electrically heated barium salt baths are advantageous to use only when a large quantity of tools is to be hardened, because this method will otherwise prove expensive. It has also been remarked that the electrically heated bath is more advantageous for heavy than for small tools but it is not clear why the process should be thus limited to the former class of tools.

A NEW SYSTEM OF WELDING.

Engineering, June 19, 1908.

On account of the high price of high-speed steel, its use, particularly for heavy tools, has been rather limited in the past. All kinds of devices in the form of tool-holders have been adopted whereby a small tool made of high-speed steel performs the cutting, while the remainder of the tool, or the holder, is of cheaper material. Many attempts have been

made to weld high-speed steel onto mild steel, as well as onto high carbon steel, in order that a superior cutting edge may be presented to the work, while the cost of the tool is still kept down to a reasonable figure, the required size and stiffness of the tool being provided for by the body of cheaper material. All attempts to weld high-speed steel onto high carbon steel or machine steel have, however, until quite recently, proved futile. This is apparently due to the different coefficients of expansion of the different steels, high-speed steel having a low coefficient of expansion.

Lately a welding process, however, has been invented which is controlled by the Fusion Welded Metals Co., Ltd., 56 Victoria St., Westminster, London, by means of which it is possible to weld high-speed steel onto other steels. The operations are very simple. The welding of the two steels is performed by means of a thin film of copper. The copper is placed in the form of a feeder along the line of the joint. The parts to be welded are then surrounded by a reducing compound and are placed in a furnace where the temperature is raised to about 2,200 degrees F. The gas which is formed by the burning of the compound seems to affect the copper in such a way that the latter is reduced to a fluid as thin as spirits of wine, and in this condition it penetrates the molecular surfaces of the two classes of steel and produces actual cohesion and not merely adhesion. In fact, the weld becomes stronger than the remainder of the metal, so that if the two pieces being welded are forced apart, the line of fracture will follow the course of a new break rather than pass through the joint. The weld is so close that in some cases it is hardly possible to find a trace of the copper. A wide field of usefulness is predicted for this process. One application which has already been suggested, and where the process most likely will be most commonly used, is that of welding high-speed steel to carbon or machine steel bodies for the production of high-speed cutting tools at a moderate price.

A YEAR'S EXPERIENCE WITH A SUCTION GAS POWER PLANT.

J. C. Miller, in *Power and the Engineer*, May 26, 1908.

The author, in this article, presents the results of a year's operation of a suction gas power plant, stating the fixed charges in a way that will satisfy men who are prone to think of interest, depreciation, etc., as important elements in power cost. The engine under consideration was a single cylinder, horizontal 50 brake-horse-power, regulated on the hit-and-miss principle, and belted to the line-shaft. The gas was drawn from a suction producer, using anthracite pea coal. The plant was of English manufacture, and was well designed and constructed. The producer was equipped with the usual vaporizing apparatus for supplying steam to the blast, and with the usual coke scrubber and expansion box. The cost of the installation of the plant was $3,300. The table below gives the fixed and operating charges:

FIXED CHARGES	
Interest at 6 per cent	$198.00
Depreciation, repairs, taxes, insurance, 12 per cent	396.00
	$594.00

OPERATING CHARGES.	
Engineer at $2 daily, 300 days	$600.00
67¾ tons coal at $4.50	304.87
Oil and waste	48.00
Scrubber water	12.00
	$964.87
Total yearly charge	$1,558.87
Cost per horse-power-year of 3,000 hours, assuming an average rate of 50 horse-power	$31.17

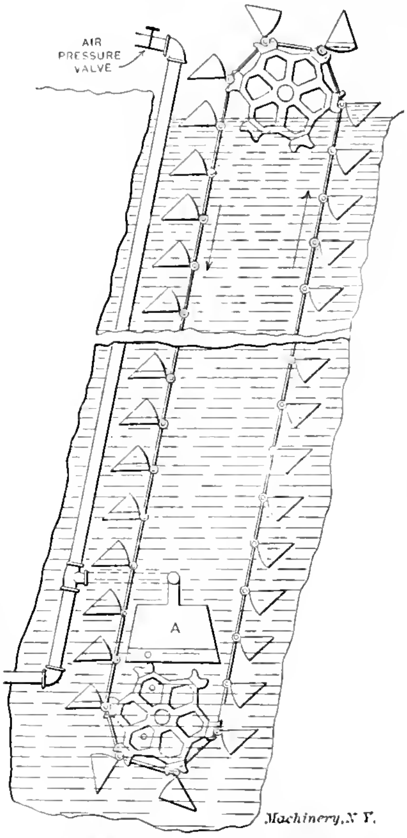
The repairs of the year were relatively small, consisting of new grate-bars in the producer, new coke in the scrubber, and small repairs to the connecting-rod and ignition equipment. The total cost of the repairs, in fact, was less than $10. In the fixed charges given above, 12 per cent has been allowed for depreciation, repairs, insurance and taxes, which was more than ample for the year in question. The cooling water was used over and over and therefore no charge is made for this item. In the item of attendance, the entire salary of the engineer is charged up against the plant, although he had ample time for other work, but little of his time being needed with the producer and engine after the plant was in operation. The coal used came from the Scranton district and cost $4.50 per ton, delivered. The coal consumed averaged 441 pounds per working day, so that it can safely be said that the consumption was only one pound per brake-horse-power.

The writer sums up by stating his conviction that only hydraulic power can surpass the present showing for economy. The cost as shown, corresponds with electric power delivered to the consumers at 1 1/3 cent per K. W., much below the lowest commercial rate to consumers using an equal amount of power.

NEW IDEA IN AIR COMPRESSION.

Joseph H. Hart, in *The Mining World*, July 25 1908.

The accompanying illustration shows a system of air compression which may become useful under certain circumstances. In the engraving merely the principle is shown, some mechanical improvements being possible of introduction in a commercial apparatus not being indicated. The construction of this device is very simple. It consists of an endless chain of buckets moving over two cog-wheels, the apparatus being almost entirely sunk under water. The buckets on the left-hand side turn their openings downward when moving in the downward direction, and are thus filled with air when they strike the surface of the water. During the downward movement of the buckets the air inside of them is compressed, as indicated by the double lines on the lower buckets on the left-hand side, the pressure on the air depending simply on the depth of the buckets below the surface of the water. When the bucket comes to the lower cog-wheel, it is turned around and the air escapes, being then collected into a hood *A* where it will be under pressure corresponding to the hydrostatic pressure of the water at the point at this depth below the surface. At the top of the mechanism the water is carried from the surface to the upper level of the wheel, and when the buckets are reversed, the water is dumped, and the buckets again filled with air. The raising of the water from the surface to the place where it leaves the buckets represents one of the losses of the mechanism. This loss remains approximately constant for all conditions, and expressed as a percentage of the total power required, it decreases as the depth of the device, and in consequence the compression, increases.



New Idea in Air Compression.

EDISON MONOLITHIC CONCRETE HOUSES.

Several months ago Mr. Thomas A. Edison aroused considerable interest in a proposed monolithic concrete construction for dwelling houses, the details of which he has worked out. The idea briefly is to mold a house complete, the same as an iron casting is made in sand, with the difference that in the Edison house scheme the mold is constructed of cast-iron forms, which are set up to make the house complete, even including the roof, porches, steps and everything required to complete a dwelling house. Mr. Edison had calculated that a workingman's two-family dwelling house of one-piece

concrete could be made in this manner for about $1,200; but, like many other schemes that appear promising on the face, this one does not appear as promising upon investigation.

In the first place, the cost of the cast-iron molds for a two-family house would be not less than $25,000, according to Mr Edison's own estimate, and the weight would be not less than 280,000 pounds. This, of course, means a very large initial investment and costly transportation of the molds from one building site to another. The size of the dwelling proposed to be built in this manner is 21 feet by 49 feet, with a height of 35 feet, not including the cellar. The walls will be 12 inches thick, decreasing to 8 inches on the second story. The roof is to be 6 inches thick, and the floors and partitions are 4 inches in thickness throughout. The structure will be reinforced with $\frac{1}{2}$-inch and $\frac{5}{8}$-inch steel rods. Water pipes, gas pipes, plumbing, ducts for wiring, and lining for chimney flues are set in position before pouring the concrete.

The concrete mixture proposed is one part cement, three parts fine sand, and five parts stone or gravel, fine enough to pass through a one-half inch sieve. In order to prevent segregation of the materials before reaching their destined position in the molds, it is proposed to add colloids, which, in common language, are certain clays that promote fluidity of the concrete and non-segregation of the constituents.

The scheme undoubtedly would prove unprofitable except where large numbers of houses were built on one plot and where the materials could be obtained at low cost. The investigation made by a disinterested expert appears to indicate that Mr. Edison's estimate of the weight of the molds and the cost of houses built in this way is too low. The cost of a house, with the present prices of labor and material, would be nearly twice the figure quoted, according to the *Cement Age*, and the weight of the molds would be considerably greater than 280,000 pounds.

The future of monolithic concrete construction for houses, factories and other structures depends very largely on the means developed for holding the materials in place during the setting period. It appears that the Edison plan is crude and very costly. The ultimate development of cheap concrete construction of the monolithic type would appear to require a combination of wooden forms and cast-iron molds made up so that a large variety of shapes can be produced with comparatively few forms.

CALCULATIONS FOR MAGNETIC CLUTCHES.

Engineering Digest, June, 1908.

The author of the article here abstracted presents the following formula for calculating the number of ampere turns of excitation required for an ordinary magnetic clutch, consisting of a thick disk with an annular space machined out of one face for the magnetizing coil, and provided with a flat-faced disk armature of the same diameter.

$$\text{Ampere turns} = \frac{9{,}500{,}000\ LBD\ \sqrt{H.P.}}{A\mu\ \sqrt{BN(D^2 + 8\ RB)}}$$

In this equation,

L = mean length of the magnetic circuit,
B = radial width of the annular pole face,
D = diameter of central pole face or hub of clutch,
$H.P.$ = brake-horse-power to be transmitted.
A = mean cross-sectional area of the path of the lines of force,
μ = permeability of metal, say 2,500 for wrought iron,
N = revolutions per minute,
R = mean radius of annular pole face, which, in turn,

$$= \frac{\text{outside diameter of clutch} - B}{2}$$

All dimensions are in inches.

As an example, assuming that $R = 4$ inches, $D = 2\frac{1}{2}$ inches, $B = 1$ inch, $L = 10$ inches, $A = 9$ square inches, $H.P. = 4$, $N = 100$, and $\mu = 2{,}500$, then the ampere turns equal

$$\frac{9{,}500{,}000 \times 10 \times 1 \times 2.5 \times \sqrt{4}}{9 \times 2{,}500 \times \sqrt{1 \times 100(2.5^2 + 8 \times 4 \times 1)}} = 340$$

To allow for the reluctance of the joint, this should be increased to, say, 400.

CASTING PIPES IN PERMANENT MOLDS

Paper read by Edgar A. Custer before the Franklin Institute
March 26, 1908.

A great deal of experimenting has been undertaken in the past in order to determine the requirements for permanent molds for making castings, that is, molds which could be used over and over again for producing the same parts. The purpose of the present discussion is to describe a method and apparatus using permanent molds which are not destroyed through the action of the hot iron, and in which cast iron pipe can be produced in which the supposed evils of unequal heating and cooling due to the use of permanent molds do not appear.

So-called permanent molds are not new. For many years, small iron castings have been successfully made in iron molds without great detriment to either casting or mold. These castings, however, have invariably been very small, and the process chilled them to extreme hardness, so that it was not possible to machine them. This limited the use of such molds very materially. Extensive experiments, however, have been undertaken by the Tacony Iron Co., Philadelphia, Pa., for producing cast iron water and gas pipe in permanent molds.

The ordinary process for casting such pipe is as follows: Iron flasks, a cope and drag, are rammed with sand over a metal pattern; a green sand core is introduced, and the cope and drag are clamped together. The pipe is then poured, with the pipe in a horizontal position, and after cooling, the pipe is removed from the flask and carried to the end of the floor where the cores are removed. Then it is carried to the cleaning room where the sand is rattled off, the gates and fins are removed, and after inspection it is ready for shipment. Altogether the pipe has to be handled ten times. In this process the loss is great, often reaching 12 to 15 per cent. In fact, with very few improvements, and these relating mainly to cores, soil pipe is made in precisely the same manner and with just as much labor per pipe as was the practice fifty years ago.

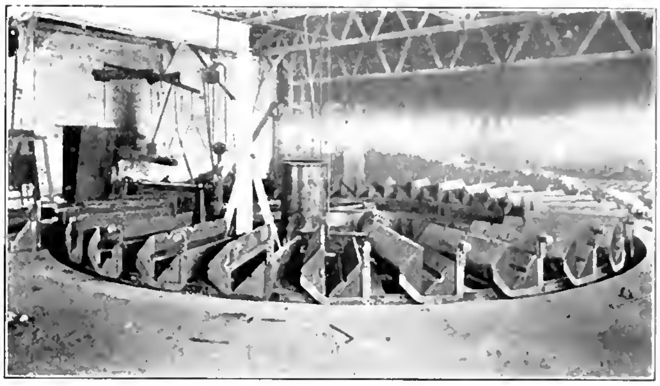


Fig. 1. General View of Machine for Casting Pipe in Permanent Molds.

Any process that would save the use of sand for the mold, and would produce pipe that could be easily cut, would naturally be very desirable. In addition, if it would be possible to produce a machine so that the work could be carried on continuously day and night, it would evidently be of great advantage for economical production. The experiments undertaken by the firm previously referred to made it possible to design a machine which would operate continuously, using permanent molds. These experiments showed that when pipes were cast in a mold every eight minutes, the temperature of the mold never raised above 450 degrees F., even if the operations were continued for hours. If, however, pipes were poured every two minutes, the temperature of the mold would rise rapidly, and at 900 degrees F. it would begin to warp. In order to comply with the requirements thus determined, the machine as described in the following was designed.

Machine for Continuous Casting of Pipes.

The machine consists of an angular table or ring approximately 40 feet in diameter, which carries 30 molds arranged at equal intervals. The table is constructed of two concentric rings of channel beams connected with 30 cross pieces or trucks, each of which has two wheels with roller bearings to

support the frame. The wheels run on concentric circular tracks laid in concrete foundations. The tracks are arranged on an inclining conical surface, and by this means the table will resist any movement other than rotating about its center.

Each truck or cross bar of the table carries a steel pin working loosely in a vertical hole and of such length as to allow about two inches of the pin to project below the bottom line of the truck, but admitting it of being pushed up until flush with the bottom of the truck. Under the table or ring, at two diametrically opposite points, are arranged two hydraulic cylinders which slide in ways similar to those of a planer, the pistons within the cylinders being held stationary, and the cylinders moved back and forth by the operation of a four-way valve controlling the admission of water alternately to each end of the cylinders. The stroke of the cylinders is of such length as to be slightly more than the spacing of the molds carried by the table. Projecting from the top of the cylinder is an inclined plane surface designed to lift the truck-pins, previously referred to, when the cylinders move in a direction opposite to the required motion of the table, and to allow a pin on each side to fall, after the inclined surface has passed. This occurs at or near the end of the backward stroke of the cylinders; and when the controlling valve is so moved as to cause the cylinders to move forward, the pins which have been lifted and allowed to fall are brought in contact with the projections on the cylinders, and hence the table is carried forward by the motion of the cylinders a distance equal to the spacing of the molds, and the cylinders are ready for another return or back stroke to engage the next pins, thus intermittently moving the table ahead one space at each cycle of the cylinders.

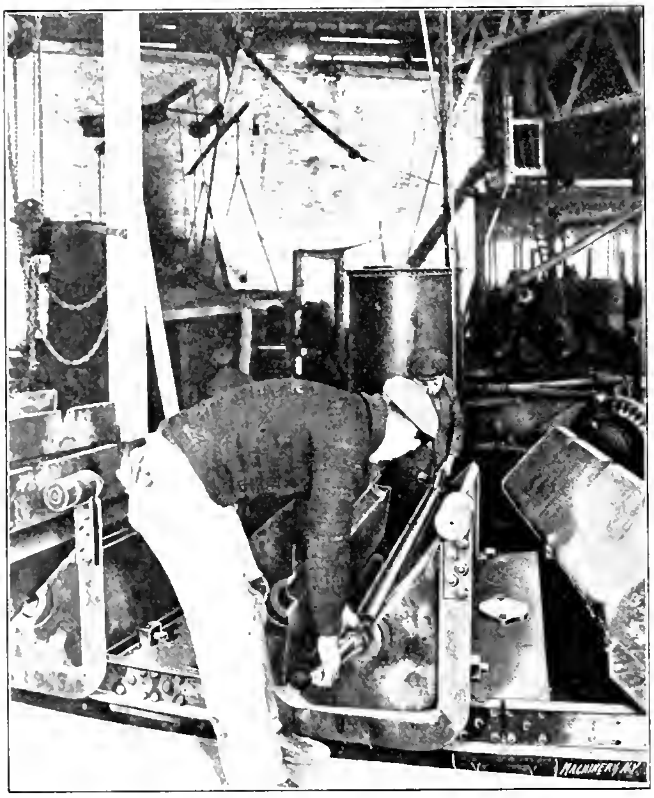


Fig. 2. Setting the Core

The center of the table is left open for the location of hydraulic pumps, operating valve reservoirs, etc., required in imparting motion to the table. The table makes one complete revolution every seven and one-half minutes, and consequently produces thirty pipes in that time, or two hundred and forty pipes an hour.

At certain points about the table are arranged closing and opening devices which are designed to close the mold, or bring the cope swing down to its place on the drag side, without shock, after the cores are set in place, and to open the mold or lift the cope after the pipe has been poured.

Between the closing device and the opening device is located a pouring device adapted to receive the molten metal from the cupola and pour it into the molds.

Description of Mold.

Each mold consists of a rectangular block of cast iron, approximately 18 inches wide and 18 inches high, by 6 feet long, parted on a diagonal line across the corners, and provided with hinges at the lower edge of the parting so as to allow the upper portion or cope to be swung up and back from the lower portion or drag. These molds weigh about 6,500 pounds complete. At the center of the mold is the cavity into which the metal is to be poured to form the pipe. Thus one-half of the pipe is formed in the upper and one-half in the lower portion of the mold.

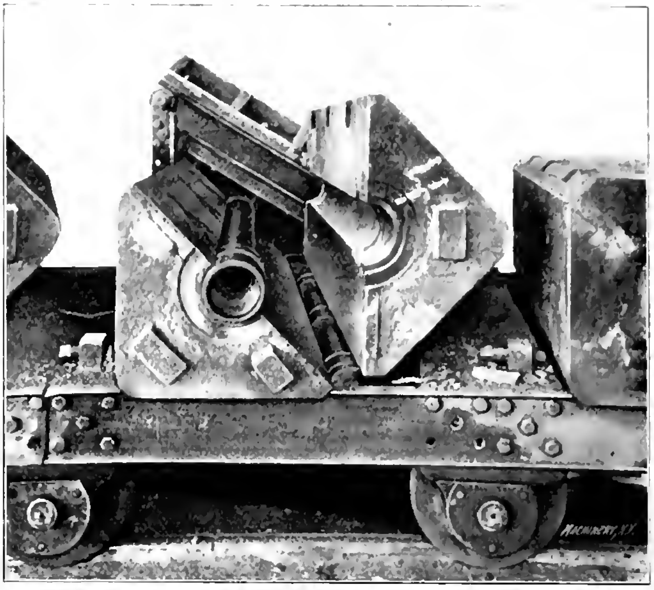


Fig. 3. Mold entering Closing Device.

Gates are cut in the face portion of the lower part or drag, of such size and shape as to receive the molten metal from the ladle and guide it into the mold. Three such gates are used, each dividing into two portions. Thus the cavity of the mold is entered at six points. The gates are so shaped as to receive the shock of the falling stream of molten metal at a point outside of the mold cavity, and convey it into the mold quickly but gently, so that the core is not damaged by a rush of molten metal against it. At the highest point of the barrel of the mold, a small groove is cut, extending throughout the entire length of the barrel. This groove, which is quite small, being only one-eighth of an inch wide and deep, is intended to receive any gases or air which may be trapped in the mold, and so avoid the formation of flat spots at the top of the pipe. The resultant ridge not being prominent is not an objection, but rather adds to the strength of the structure.

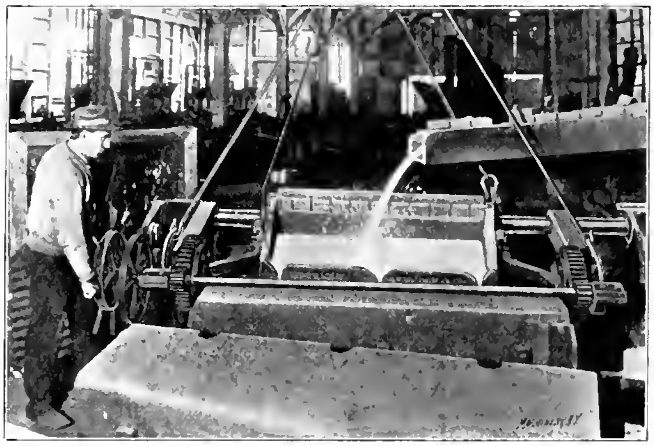


Fig. 4. Pouring the Metal.

On one end of each mold is carried an arm rigidly attached to the upper or movable half. This arm extends under the mold, and is of such form that when the mold is open it forms a rest for the movable half, holding it in such position as to allow of any work, such as setting cores, removing finished pipes, cleaning, etc. On the end of this arm is a steel roller

which is caused to travel down an inclined plane by the rotation of a table carrying the mold. This inclined plane is arranged to receive the roller at its higher position when the mold is open, and to guide it smoothly to its lower position, by this means closing the mold without shock or jar to disturb the core. This inclined plane constitutes the closing device. Each end of the mold is provided with rings or bushings which are used to support the core arbor in a precisely central position in the cavity of the mold, so that the pipe when finished shall have uniform thickness of metal at every point.

The core arbor consists of a cast iron hollow cylinder somewhat longer than the pipe to be cast and about three-quarters of an inch less in diameter than the inside diameter of the pipe. It is perforated throughout most of its length by small holes to allow any gases formed by contact with the molten metal to pass into the arbor and so have free vent to the air through the ends.

The core is made by placing the core arbor in the core machine, which consists of a support for the ends of the arbor, semicircular in form, and of a diameter to fit the arbor ends a shaking screen arranged to sift sand, and a guide to drop it upon the arbor, and a knife, so shaped as to form the sand to the outline of the inside of the pipe.

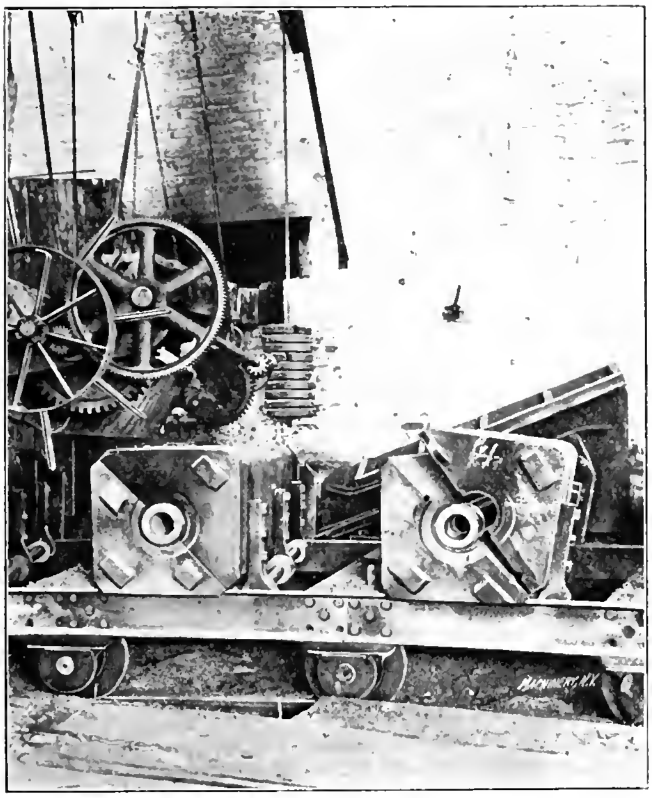


Fig. 5. Immediately after Pouring. Mold, entering Opening Device, partially opened.

The core arbor, after being thoroughly wet, is placed in the end supports and rotated by a crank-shaped piece of iron held loosely in one end by an operator. At the same time another operator shakes a sieve suspended over the arbor and previously filled with sand, saturated to the proper degree with water. This sieved sand is caused to fall directly upon the wet, rotating arbor and clings to it. The surplus sand is scraped away by a steel knife held at the proper distance from the arbor to make the finished core of the diameter and shape required. When sufficient sand is on the arbor to make a full and complete core (which requires about five seconds), the core is lifted from its supports and is ready for use. No further treatment of any kind is needed, and the core is placed in position in the mold, which is then caused to pass the closing device, bringing the upper portion down in place, and the mold is ready to receive the metal.

A ladle is provided to receive the metal as it flows from the cupola. As the table rotates and brings a mold, which has passed the closing device, into pouring position, the ladle automatically drops into position with the lips close to the pouring holes. The ladle is then tilted to pour by the operator, but in tilting it rotates around a center line which passes through the pouring lips, and hence the points of pouring do not move; and the streams of metal are guided directly from the pouring holes through the various gates into the mold, and fill it completely, compressing any air or gas which may be trapped into the groove provided at the highest point for that purpose. If no gases are trapped, which, strange as it may seem, is usually the case this groove is also filled with metal and forms a slight rib running the length of the pipe. When the pouring operation is complete and the operator tilts the ladle back, it automatically rises to a higher position, so that the next mold may pass under it and assume the pouring position.


Fig. 6. Mold open. Pipe Cast in Place.

The mold being now filled with metal, is held long enough to allow the metal to set, and is then opened by passing the opening device, which is just the reverse of the closing device, the roller on the end of the arm or mold being guided up an inclined plane, thereby lifting the upper half or cope side, and swinging it away from the lower or drag side. The pipe, which is still a bright orange color, is lifted from the mold and placed, after removal of the gates, with those previously cast, in piles, to cool slowly, when the core arbor is withdrawn and returned to the core machines to be used again. After removal of the finished pipe from the mold, the loose sand which falls from the core during the handling of the pipe, and any other dirt, loose gates, etc., which may be left in the mold are swept out by air blasts or hand brushes, and the mold is ready for another core and another filling with metal.

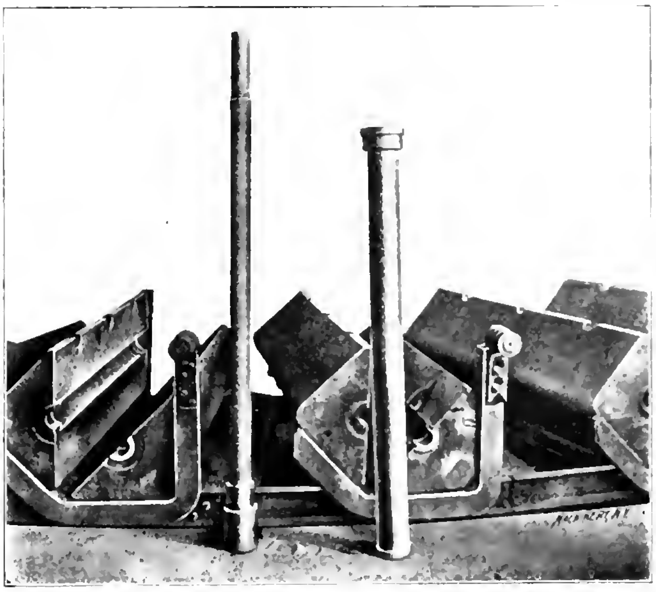


Fig. 7 Finished Pipe and Arbor Molds Open.

LOCK NUTS USED IN ENGINEERING PRACTICE.

R. B. LITTLE*

A great variety of different means have been devised for locking a nut in place, so as to prevent accidental loosening of the parts being held together by the tightening of a nut on its bolt. In the accompanying Supplement are shown twenty-seven different styles of locking arrangements, care having been taken to select those that are most commonly found in engineering practice. It is not necessary to explain all of the methods indicated at length; a few words relating to each type will suffice. Referring to the Supplement, Fig. 1 shows a locking device where the nut is locked to the bolt by means of a set-screw. A small plug of steel or brass is placed in front of the screw point, to prevent the screw from injuring the thread of the bolt.

Fig. 2 represents the U. S. Navy standard form of lock nut. It will be noticed that the first shoulder below the nut proper fits in the stock, while the second one is smaller and acts as a face for the set-screw to engage with. Also note that the set-screw is "dog-pointed," and that the nut proper never should come down flush against the stock; 1/32 inch clearance is allowed here for all sizes of nuts.

Fig. 3 shows a very good form. A shoulder is turned down on the lower side of the nut to the diameter across flats, and a groove is turned in this shoulder for the point of the set-screw. A collar fitting this shoulder is fastened by a pin as shown. A set-screw is then passed through this collar and engages in the groove of the nut. The thickness of the collar and shoulder should be about one-quarter the diameter of the nut plus $\frac{1}{4}$ inch, in good practice, and the pin which holds the collar should be one-eighth the diameter of the bolt plus 1/16 inch.

In the method shown in Fig. 4, a special nut with a slotted flange is required. This flange has six slots, and the dog which acts as a check is provided with an oblong slot. This arrangement gives a positive lock, and the nut can be locked at any position required. The thickness of the dog and the slotted flange should be about one-quarter the diameter of the bolt.

Fig. 5 is an excellent form. It is a combination of the spring and double nut arrangements shown in Figs. 10 and 11. The double nut may work loose under constant rattle and jar, but the split ring below has a tendency to absorb the jar. This form is used extensively in automobile frame construction.

In the method shown in Fig. 6, a small taper pin is put half in the nut and half in the bolt, one half-hole being put in the nut and six, or as many as desired, in the bolt. This allows of finer adjustment than one hole only. The taper pin should never be driven in too tight to prevent its being pulled out without difficulty when required.

Fig. 7 requires a specially made nut. It is made of stock one-half the thickness of the nut, which is doubled over on itself, as shown, and afterwards tapped. After this nut is screwed down tight in place, a little extra twist on the top half locks it very securely.

Fig. 8 shows an inner nut which is tapered and split. This inner nut fits in an outer shell which has a tapered hole. When the nut is assembled in place, the screwing down of the outer shell pulls the inner nut down in the taper hole, which closes the split in the side. This clamps the inner nut to the bolt. This form is highly recommended.

Fig. 9 shows the regular slotted or castle nut. When the nut is screwed down in place, a small hole is drilled through the bolt at the bottom of one of the slots, and a cotter pin is inserted.

Fig. 10 shows the old reliable form of nut and check nut, or double nut. The check nut is commonly made one-half the thickness of the nut proper, and should be placed on the under side as shown. This arrangement puts the stress on the thicker nut, as it should be because of the greater number of threads engaging it.

Fig. 11 shows what is known as Grover's spring. When the nut is screwed down tight, the spring is flattened, and its resistance keeps the nut tight on the bolt.

Fig. 12 shows the ear washer. After the nut is screwed down in place, the ear on the washer is bent up tight against a flat side of the nut, and a small pin keeps it from turning. This washer should be about one-sixth of the diameter of the bolt in thickness.

Fig. 13 shows a right-hand nut below, with a smaller left-hand nut above it, both screwing on the same bolt. All tendency of the larger right-hand nut to unscrew is counteracted by the smaller left-hand nut, which screws on tighter if the larger nut turns.

Fig. 14 shows a regular hexagon nut with a slot sawed a little past the center and about three threads from the top. After this nut is screwed down in place, give the part above the slot a little extra twist, the same as in Fig. 7, or hit it a light tap with a hammer, and spring the shelving part down a trifle. When the nut is to be removed, the top part may be sprung back again to place, and it is then easily unscrewed.

In Fig. 15 the same sawed nut is used as in Fig. 14, and a small screw is placed as shown. After the nut is screwed down, the small screw is tightened. This increases the friction between the threads of the bolt and nut by springing down the upper and thinner part.

Fig. 16 represents the lip washer. This washer has a small lip on the inside which slides in a groove in the side of the bolt. All tendency of the work below the nut to move is spent on the washer which cannot move because of the lip. This is a very good form, and is extensively used.

Fig. 17 shows a small lock fastened down by a cap screw, the flat side of the lock coming against the flat of the nut. In Fig. 18 the principle of locking is practically the same as in Fig. 17, except that the nut may be locked at every one-twelfth turn instead of one-sixth turn. This allows of much finer adjustment. The principle of the form shown in Fig. 19 is the same as in Figs. 17 and 18, except that the lock fits the corner of the nut. The method shown at Fig. 20 is exceptionally good where a circle or long row of nuts are to be locked. Fig. 21 quite closely resembles Fig. 18, except that the nut is locked on all sides. This form also admits of a one-twelfth revolution in locking. The locks shown at Figs. 17, 18, 19, 20, and 21 are known as stop plates.

In Fig. 22 an ordinary bolt and nut are used. The bolt is allowed to stick through the nut a short distance. The end of the bolt is sawed before the nut is screwed on. After the nut is screwed home, the end of the bolt is wedged out a trifle with a dull cold chisel. This locks the nut very securely, but by screwing the nut off, the sawed end of the bolt will be brought back to its original shape.

In Fig. 23 a small cap screw is screwed down so that its head is tangent to a flat side of the bolt. In Fig. 24 a taper pin is driven in firmly as shown, so that it enters partly in a groove in the side of the nut.

Fig. 25 shows an excellent method, but a special nut is required. The nut must have a slotted flange as shown. The small pin shown has a shoulder which comes up under the bottom of the nut, and behind the pin is a coil spring. By pushing this pin down flush with the surface of the work, the nut may be turned to any position desired, and the pin will spring back into place, thus locking the nut.

In Fig. 26 a small hole is drilled through the bolt, flush with the top of the nut. A piece of soft wire is run through the hole and wound around the bolt, as shown, to insure against its coming out. This form also answers very nicely where more than one nut is to be locked. The wire may be passed on through any number of bolts and its ends fastened.

In Fig. 27 a slotted nut is required. A groove is cut down the side of the bolt deep enough to contain a wire. The nut is screwed down with the wire in place in the slot in the bolt, and the wire is then bent over in one of the slots.

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* [illegible] Lansing, Mich.

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It is alleged that freight shipped from Cincinnati to Toledo, *via* the Erie and Miami Canal often is received in a shorter time than when sent by rail. This, if true, confirms the statistical average of railway freight movement of only about 25 miles per day, a rate of progress considerably less than that achieved by the canaller traveling by daylight only. A canal boat hauled both day and night can easily make 60 miles per 24 hours.

GAGE FOR TESTING THE PLANING OF A TURRET MACHINE BED.

The large bed casting shown machined and mounted on its supports in Fig. 1, is that of the Libby turret lathe, built by the International Machine Tool Co., of Indianapolis, Ind.* In this machine the head-stock and bed are one solid casting, so that particular care has to be taken in planing and boring to have all parts come to the right dimensions, as the machine is built on the interchangeable plan, and no alterations from the drawings are allowed for the sake of making a faulty casting "finish out." One of the special tools used to place the making of the bed on an interchangeable basis, is the gage shown in place on the ways in Fig. 1. This gage is used for testing the planing of all the sliding surfaces of the casting, in their relation to each other and to the center line of the spindle.

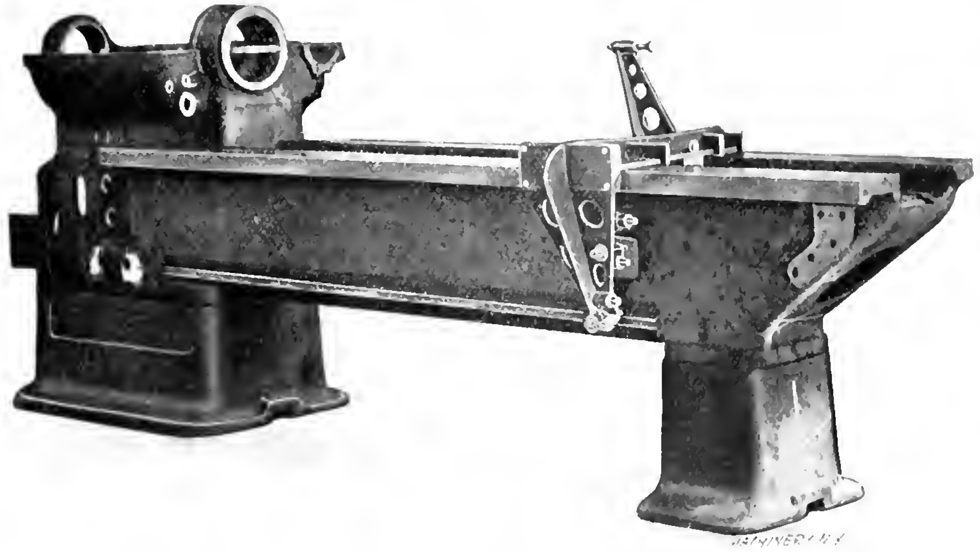

Fig. 1. A One-piece Turret Lathe Head-stock and Bed, with the Gage by which the Planing is Tested; the Center in the Vertical Arm must coincide with the Center Line of the Spindle.

After the casting has been cleaned and made ready for machining, the first operation is naturally that of "laying out." The reference line is the center line of the spindle. It is located in the usual way, by prick-punch marks in cross pieces inserted in the spindle boxes. This center line is so located that the spindle boxes will clean out, the ways finish to the right horizontal and vertical distances from the center line, and all other planed surfaces and bored holes come to the proper dimensions. When this laying out is completed, the bed is placed on the planer table right side up, with the axis of the spindle carefully lined so that it is parallel with the ways of the planer. Roughing cuts are then taken over the top and front edge of the casting at the points marked *A* and *B* in Fig. 2, which shows a cross section of the bed. This operation determines the lay-out of the bed, and if there are any surfaces or holes which do not finish out to dimensions in the subsequent operations, the piece is spoiled.

The casting is next turned over on the planer and mounted on parallels so that the head-stock clears the bed, being clamped on surfaces *B* and *B*, and lined up with surface *A* parallel to the ways of the planer. The base *C* is now planed to the finished dimension. The casting is then again reversed and clamped to the planer platen on this finished surface *C*, with edge *A* lined up with the ways of the table; all subsequent planing operations are completed without further shifting of the work.

The next finishing operation is the surfacing of *A* and *B*. To test this operation, the gage shown on the bed in Fig. 1 is used. The general form of the gage is perhaps more readily seen in the succeeding illustrations, Figs. 3 to 7. It will be seen that it rests on surface *B*, and when in use is aligned by its bearing on the vertical surface *A*, against which it is held by a clamp screw (best seen in Fig. 7) which bears on surface *D*. When these surfaces *A* and *B* are properly finished, and the gage is aligned as described, the center mounted in the upper arm must coincide with the prick-punch mark in the cross piece of the front spindle box, from which the primary lay-out was made.

These gaging surfaces, *A* and *B*, having thus been finished, the next operation is the laying-out of the succeeding cuts. Vertical surfaces *D*, *E* and *F* are located by scribing on the top surface of the bed lines gaged by the corresponding surfaces *D*, *E* and *F* in Fig. 3, these surfaces being carefully machined to the dimensions given on the drawing of the work. *D*, *E* and *F* may now be roughed and finished, the final testing of the accuracy of the work being effected by clamping the gage on the bed in its proper position, and testing the surfaces completed to see if they match up with the corresponding surfaces on the gage.

At *G* in Fig. 2 is the surface to which is fastened, by means of a clamp entering the dove-tail *H*, the casting which carries the series of stops used for limiting the movement of the turret slide. At *G* in Fig. 3 will be seen a hardened plunger, carried by a steel bushing mounted in the gage, and provided with a cross pin, projecting through an L-shaped opening in the bushing. This plunger, which is forced downward by a spring, may be released so that the lower end rests on the surface *G* of Fig. 2. If this surface is properly located, the upper end of the plunger and the upper end of the bushing in which it is contained will be flush with each other, both having ground surfaces. By this means, the accuracy of location of surface *G* is tested. When the plunger is not in use, the operator's finger on the cross pin raises it, and swings it into the horizontal portion of the slot, thus holding it into its upper position. For locating the dove-tail slot, block *H* in Fig. 3 is provided. It may be slipped into a slot on the under side of the gage, and used for scribing the lines used for locating the rectangular groove, which is first planed to the proper depth in the casting. This rectangular groove is then finished out to the desired angle on each side by tools held in the swivel head of the planer. The accuracy of the finishing of each side of the slot is gaged by block *H'* in Fig. 3, which, when placed in the dove-tail groove, with the bevel on either side, must accurately enter the same slot in the gage in which block *H* is shown in the figure.

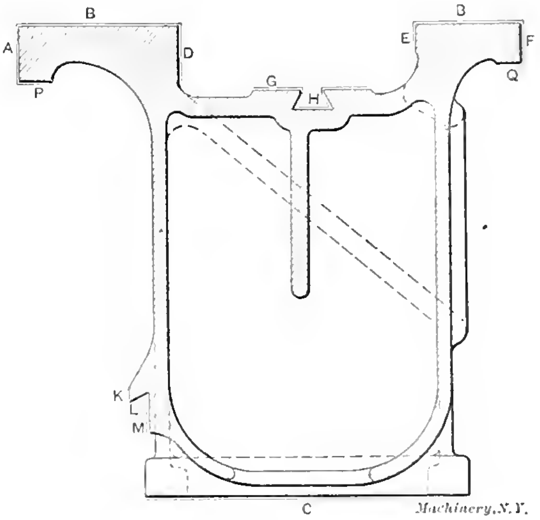

Fig 2. Cross-section of the Bed, the Surfaces to be Finished are Indicated by Double Lines.

As may be seen in the various illustrations (see Fig 4, for instance) the gage is provided on the front side with an arm which projects downward, and carries the various reference surfaces, gage pins, etc., required for properly testing the

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* See the New Machinery and Tools section of the March, 1908, issue of MACHINERY.

machining on the front side of the bed. In the cross and turret slide carriages of this machine, there are three revolving parts which only just clear the rough surface of the bed. These clearances are made small, to reduce the overhang of the carriage as much as possible, so that the operator may get close up to his work. The gage is provided with pivots *I*, *I* and *I*, on which may be mounted cast iron disks *J* and *J* (see Fig. 4). When mounted on these pivots, these disks exactly correspond in position and diameter with the revolving parts which have to clear the bed, and if the operator slides the gage from one end of the ways to the other, and these disks clear, he may be sure that in the finished machine the carriage parts will also clear. If they interfere, the casting must be trimmed in the planer. The lower and smaller of the two disks *J*, after being tested in the position shown, is tried again on the middle pin *I*.

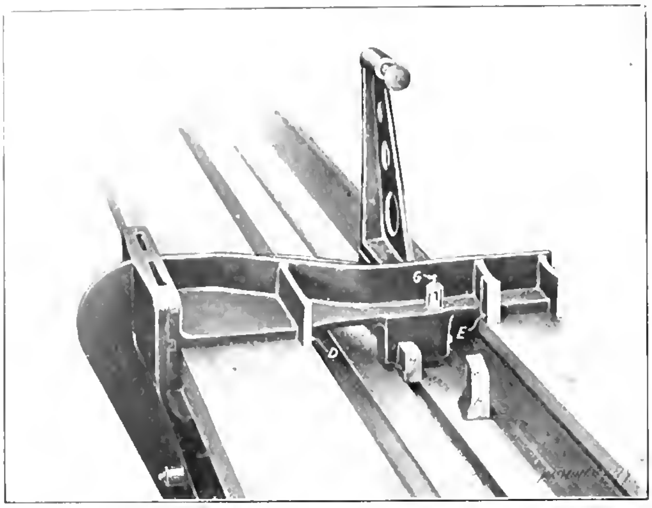


Fig 3. Block and Gages for Laying Out and Testing the Dove-tail Slot.

As those of our readers who are familiar with this machine know, the cross-slide carriage is mounted on the bed in a very peculiar way, being supported entirely by surfaces *D*, *B*, *A*, *L* and *M*, in Fig. 2. It does not extend across to the ways on the rear side of the machine. This construction allows the cross slide to clear practically the full diameter of the work capable of being swung over the ways, so that while the work is in place, the slide may be moved clear back past it and the chuck by which it is held, allowing the turret slide to be brought close to the work. It is evident, then, that surfaces *L* and *M* must be finished with reference to surfaces *A*, *B* and *B*. They are gaged as shown in Fig. 5, where a spring plunger *M* is shown, exactly identical in construction with *G* in Fig. 3, which is released from its locked position and forced down by a spring against the surface in question. If this surface is right, the ground end of the plunger and of the bushing contained in it will be flush with each other. To measure surface *L*, an angular face is provided at the lower extremity of the arm, as shown, on which the straightedge *L* in Fig. 5 may be laid. If this accurately lines up with the corresponding surface of the casting, the planing is right in this respect.

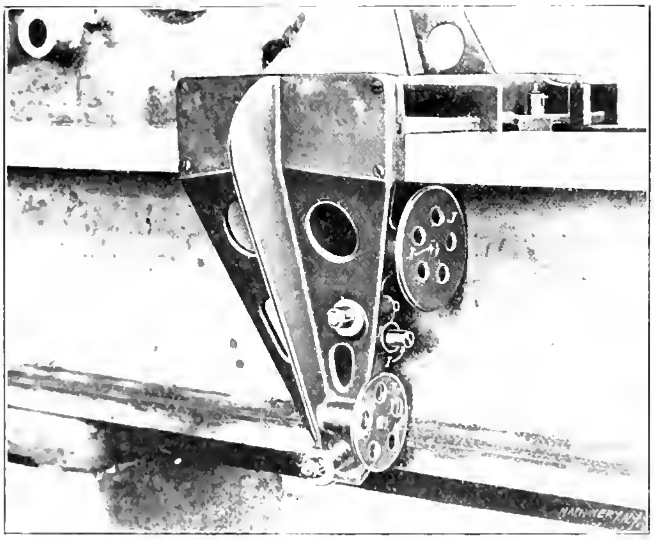


Fig 4. Testing the Bed for Clearance for Revolving Parts in the Apron.

There are finished pads on both the front and back sides of the bed, not shown in Fig. 2, which support the various feed and rapid-traverse shafts. These must also be machined to the proper distance horizontally from reference surface *A*. The spring plunger *N*, identical in construction with *M* and *G*, is used for the front surface. This is shown applied to this surface in Fig. 1. For the pads on the rear, a gage *O*, Fig. 6, is used, which, when held as shown against the finished face of the bed, must just make contact with a plug set into the rear end of the fixture.

When all the tests described have thus been made, it may be assumed that the work is correct, so far as the planing is concerned. Surfaces *K*, *P* and *Q* are good enough if made to careful scale measurements.

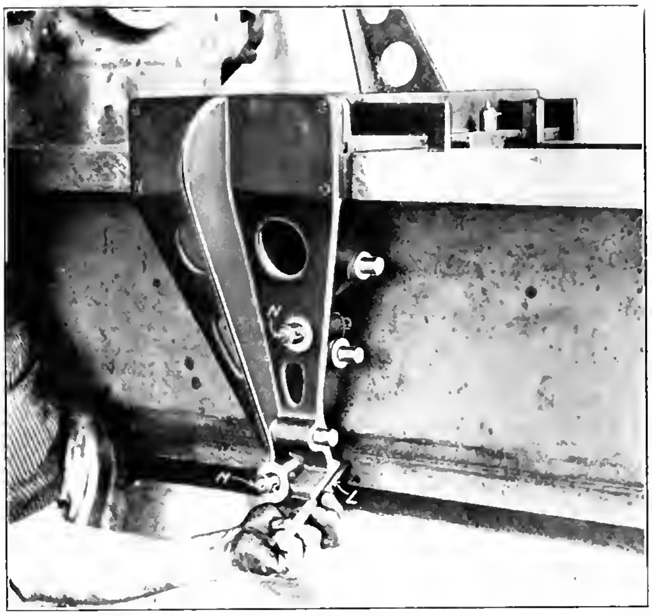


Fig. 5. Testing the Bevel Bearing Surface for the Cross-slide Carriage Support.

It will be seen that this gage simplifies to a remarkable degree the inspection, the laying out, and machining of these castings. The foreman, for instance, if there is a question about the accuracy of the workmanship in a particular case, can put the gage in place and take all the measurements inside of a very few minutes. It can be imagined that the device under these conditions is a great incentive to accurate work.

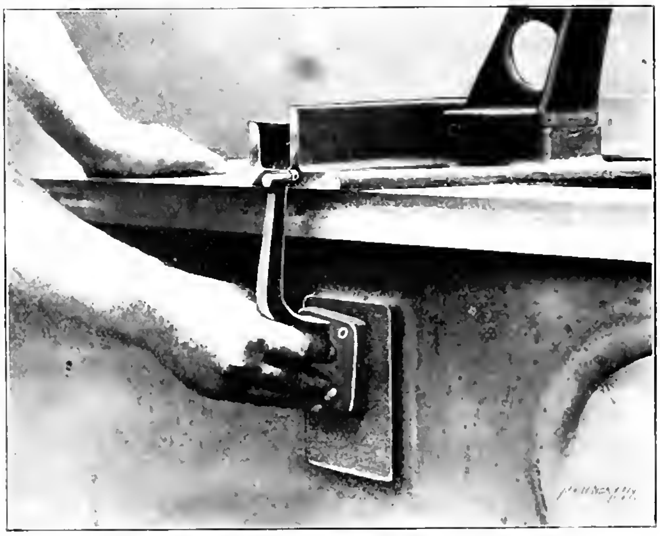


Fig. 6. Testing the Planing of the Pad for the Bracket of the Quick-motion Shaft.

A practical man will readily understand that the advantage of working so closely to figures as is required by a gage of this kind, does not consist in cheapening the actual

cost of the planing or inspection. The cost of planing, in fact, is doubtless increased by its use, owing to the higher grade of workmanship which it requires. The advantage is seen when it comes to assembling and fitting up the machine. The main casting is always the part that is most difficult to build on an interchangeable basis. With the aid of such devices as the one we describe, carrying throughout the whole casting the system of close working to figures, the time of assembling and fitting is greatly reduced. This is what counts, as it saves a large share of the most costly work that goes into the building of a high-grade machine tool.

Fig. 7. The Gage mounted on its Truck, by which it is carried where needed.

The possibility of saving a lot of time in the assembling, at the expense of a comparatively small loss of time in the manufacturing, is one that is not always appreciated.

A tool that is as useful as the one we have just described merits the best of treatment. In Fig. 7 we show the gage as it looks when at home. As may be seen, it is comfortably mounted on a special truck, which may be wheeled from point to point in the shop, as the case may require. The various supplementary devices shown in the preceding illustrations are carried in the box body of the truck. It is certainly encouraging to see a faithful servant so well looked after.

* * *

THE SELF-RELIANCE OF JIM WEST.

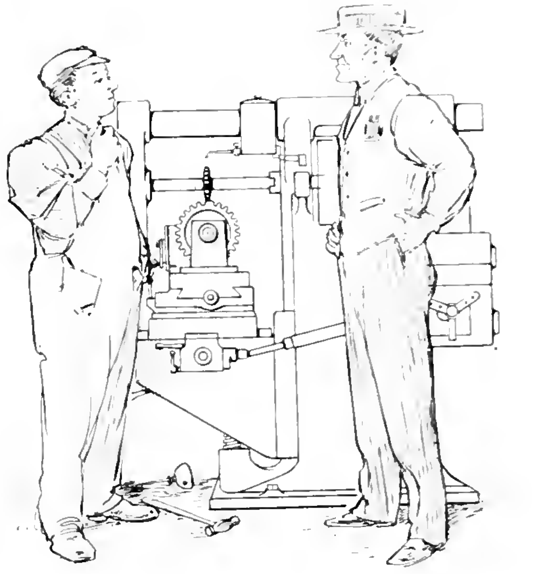
GREBO.

A modicum of self-reliance and self-esteem is a pretty good thing for any man to have, but in the days when a man is very hard up for a job, it has occurred that his estimate of his own ability has been somewhat above par with results disastrous to his self-esteem and reputation.

Some years ago Jim West concluded that the only way to get a job was to put up what is commonly called a big bluff, and start in as a machinist. Now Jim had not worked in a machine shop except for about two weeks in a little shop somewhere in Indiana seven years before. He had tried the job in the belief that he wanted to learn a trade, but he soon tired of shop work because a clerking job seemed more suitable to a young gentleman of his refined tastes and lady-like manners. He had not prospered in the clerking business, and being out of a job and hard up, he remembered that the machine shop did not seem so bad after all. Stranded in a city where there were many shops and a scarcity of machinists, he concluded to take a chance and hire out as a machinist—on the strength of his two-weeks' shop experience! Now the city where Jim found himself stranded was the Queen City of the West, the center of machine tool building where a machinist usually can get a job if he can anywhere. He applied to the superintendent of one of the large shops, and upon being asked if he was an experienced man he replied without hesitation in the affirmative. The "super" quickly let him understand that the shop really did not need any more help, this information being conveyed to properly cool off the applicant's expectancy of a bulky weekly pay envelope, but finally admitted that if Jim had any experience in cutting spur gears on a milling machine, he might employ him. Jim saw that his expected job would go "glimmering" if he did not convince the "old man" that gear cutting was his specialty, and he did not hesitate to state his qualification in very emphatic and convincing language. The "super" was given to understand that no gear-cutting job existed that he could not do in proper form.

Now in justice to Jim we must say that it was not his intention "to draw a long bow," but when a man is hard up and he feels quite uncertain where the money for the next week's board bill is coming from, a slight stretching of the truth may seem excusable that under ordinary circumstances would not be approved of.

Jim was told to go to work the next morning, and was placed in charge of the foreman of the milling department. A lot of gear blanks were turned over to him, together with a drawing and a few verbal instructions. Jim did not understand the situation very clearly, but he started to work. He busied himself for some time with the drawing, first scratching his head behind the right ear and then behind the left, and then finally concluded that he had better make friends with the man operating the next machine. He frankly confided how matters stood, and the man taking pity on him, showed Jim in as unostentatious a way as possible how to set up the work, start the machine, manipulate the feed and work the index head. Jim started to work, taking great pains with the first gear. He indexed tooth after tooth carefully, and about noon he found that he had a space left that did not seem quite big enough for two teeth, but that clearly was too large for one tooth. He realized that here was a case where judgment meant more than experience(?), and in order to show that he knew what he was talking about, he called on the foreman, showed him the situation, and said: "What would you think to be best—to put in two small teeth or one big one in the space that I have left here? Personally, I would say that two small teeth would work the best." The foreman looked at Jim steadily for what seemed like a long time, swelling up as though he were about to explode, but he was a wise foreman and did not cuss. He simply said, "I wish, Jim, that you had given me your opinion about the two small teeth before you commenced to cut this gear. It would likely have saved you and me a lot of trouble. The next time that you hire out as an all-around machinist, be careful about giving your personal opinions unless you know what you are talking about. Perhaps you might be able to hold your job down a little longer than five hours if you do" That ended Jim's experience as a machinist in that shop.



"Two small teeth or one big one?"

MACHINE SHOP PRACTICE.*

PLANING AND LAYING OUT A BLANKING DIE.

When constructing a die, the degree of accuracy with which it is made, and the general finish, will depend somewhat upon the amount of work that it will be required to do, or the number of pieces to be produced. When this number is comparatively small, the most inexpensive die that will do the work properly should be made. Dies of this class are known as "emergency dies," as they are quickly made, and are not constructed to withstand long and continuous usage. When, however, a die is to be used incessantly for a long period, or, perhaps, until it is worn out through use, the materials used, and the quality of the workmanship, should be of the highest possible grade, and every detail brought as near perfection as possible. If the design of the die is at all complicated, it should be so constructed that the parts subjected to the greatest wear can be replaced, thus avoiding the necessity of making a new die.

The selection of a high grade of steel for dies is of paramount importance, and though such steel may be somewhat expensive, the increased efficiency of the die will more than compensate for this expenditure. In the Shop Operation Sheets accompanying this number, a simple form of blanking die is shown. This die, when in use, is held in place in a bolster, or die-bed, by the dove-tailed sides of the bolster, and by a key which is driven in between one side of the die and the bolster. The latter is bolted to the table of the power press. It is not necessary to have a bolster for each die, for by making the die-fitting standard, a number of dies of nearly the same size may be used in the same bolster. In order that this may be done, the beveled sides of the die blanks are planed to an angle of 10 degrees, this being the standard angle to which the dove-tailed seats of the bolster are planed.

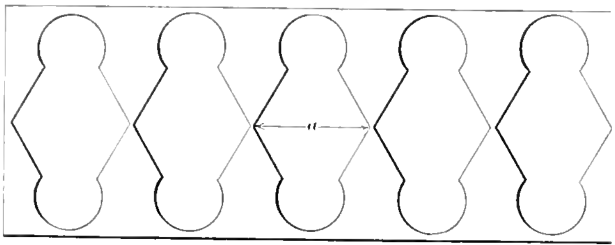


Fig. 1

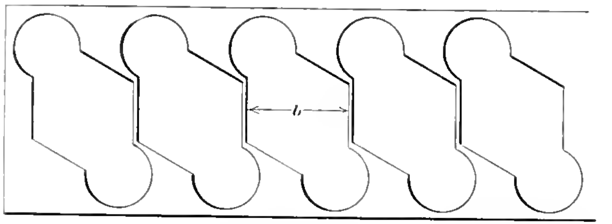


Fig. 2 *Machinery,N.Y.*

Figs. 1 and 2. Illustration of the Saving of Metal Effected by cutting the Blanks diagonally from the Stock.

The Shop Operation Sheet explains the various steps in connection with planing and laying out a blanking die. The die proper should be finished before the punch-plate or stripper, as these are laid out from the die itself. A piece of high-grade, annealed steel, long enough to make several dies, should be selected, and cuts taken on both the top and bottom surfaces, the top surface being finished smooth. The piece is then set up on the planer as shown, with the finished, or top side held against a beveled parallel strip, which, in turn, rests against an angle plate which is fastened to the planer platen. One edge of the piece is then planed. This finished edge is then placed next to the platen and the opposite edge finished. If one side of the parallel strip is at an angle of 10 degrees with the other, it is evident that the beveled edges of the die blank will have a taper of exactly 10 degrees. Care should be taken to see that the finished side of the blank bears on the platen at both ends, after it is clamped in place, in order that the beveled edges be made parallel. There should be no trouble in this connection if all chips have been carefully removed, as the blank, when pressed against the taper parallel will tend to move downward. A piece of thin paper, placed beneath each end of the work, will, however, enable one to determine whether or not the work is bearing properly on the platen.

After the steel strip is planed to fit the bolster, a piece of sufficient length for the die is cut off, and the die is ready to be laid out. Before this is done, however, a templet or master blank should first be made. Sheet steel is used for this purpose, the thickness of which will depend somewhat upon the size of the templet; for comparatively small work, steel about 3/32 inch thick will suffice. The outline of the templet should be laid out very carefully, and finished, by filing, to conform exactly to the required shape and size of the hole to be cut in the die blank. As the die we are considering is a plain blanking die, it will only be necessary to make a templet having the required outline of the blank. If, however, the die were to be of the blanking and piercing type, the location of the holes to be pierced in the blank would be laid out on the templet to facilitate locating them in their proper place in the die.

After the templet is accurately finished, the top surface of the die blank should be brightened with a piece of coarse emery cloth, and the surface prepared for laying out by either applying a solution composed of one part bluestone, and ten parts water (sulphate of copper), or by heating the die blank as described in Operation Sheet No. 74. The surface will then be either coppered or blued, depending upon the method employed, and on such surfaces all lines made by a sharp scriber will be bright, and made plainly visible by the contrast with the darker background.

The templet, or master blank, can now be used for laying out the die. It is first clamped centrally on the face of the die blank by the diemakers' clamp shown; then by following the outline of the templet with a sharp scriber, its shape is transferred to the face of the blank. Before locating the templet, however, the most economical way of cutting the blanks from the stock must be determined, that is, the way to obtain the greatest number of blanks from a given weight of stock. It will be seen then that the way in which the die is laid out will depend, to a great extent, on the shape of the blank. The die shown in Operation Sheet No. 75 is laid out in the way best adapted to most blanking operations, that is, so that the blank is cut at an angle of 90 degrees with the edge of the stock, but while this layout might be considered typical, it is not the most economical one for the particular shape of the blank shown. In this case, it is more economical to cut the blanks diagonally, with reference to the edge of the stock, as shown in Fig. 2. By comparing this illustration with Fig. 1, which shows the scrap from a section of stock which has been blanked in the usual manner, the saving in metal by diagonal blanking is apparent, as a much narrower strip of stock can be used. More blanks can also be obtained from a given length, as will be understood by noting the difference between the dimensions *a* and *b* in Figs. 1 and 2. When thousands of blanks are to be produced, the saving in metal that is effected is considerable.

When the shape of the blanks is such that there would, unavoidably, be a considerable amount of metal between the punched holes, the stock can, at times, be cut to a better advantage by so locating the stop, or gage pin (which regulates, by its position, the amount of metal left between the punched holes) that sufficient metal is left between the holes to permit the strip being turned around and again passed through the press. If a large number of blanks are to be made, however, a double blanking die would be preferable. The most economical layout can often be determined easily and quickly by cutting out a few paper templets, using the steel master blank as a gage, and arranging these in various ways until the best method of blanking is ascertained.

After the outline of the templet has been transferred to the die blank, the centers of the holes to be drilled for the purpose of removing the core, should be located. In the October issue, the way in which this core is removed, and the hole finished to conform to the master templet, will be explained.

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* With Shop Operation Sheet Supplement.

LETTERS UPON PRACTICAL SUBJECTS.

PUNCH AND DIE FOR UNIFORM IRON BLANKS.

The accompanying engravings show a punch and die for the production of two 0.014 inch thick iron blanks, having almost identical outlines and proportions, and required to be produced in equal numbers. The blanks to be cut are shown in Fig. 2, together with a central piece of scrap resulting from the blanking operation. In addition to the blanking out of the pieces, two small holes, not shown in Fig. 2, are pierced at one end. By examining the design of the punch and die in Fig. 1, it will be seen that the tool is essentially made on the compound principle, the blanks being pierced and cut out complete in both the upper and the lower die at the same time, and simultaneously ejected from each, together with the central portion *A*, Fig. 2, or, in other words, one of the parts required, *C*, is cut out by the upper half of the die, or what is commonly called the punch, and the other blank, *B*, is cut out by the lower half of the tool, or what would be called the die. In Fig. 2, the pieces cut out have been shown with differently inclined cross-section lines, in order to more plainly indicate the work done by, and the action of, the tool illustrated. The three laminations—the two pieces to be cut, and the central piece of scrap—slide by gravity from the face of the die into a box at the rear of the press, the press being tilted for this purpose. The die, as will be seen, is made on the sub-press principle, four pins being used in each of the corners to properly align the upper and lower dies, thereby lessening the liability of accidentally shearing the edges, and at the same time insuring quick and accurate setting, which cannot be obtained conveniently by any other method. The tool is placed in an inclinable, overhanging, open-backed power press, running at 80 strokes per minute.

The general principles on which this die works are so simple that by comparing the shape of the pieces to be cut, as shown in Fig. 2, with the layout of the die in Fig. 1, no explanation can make the general working of the die any plainer than the engravings themselves. The construction of the die, however, may be of some interest. The holders consist of flat castings, machined where necessary, having four bosses, one at each corner, for the sub-press pins, and having projections or ribs cast where there are no outside cutting edges, for the purpose of strengthening the holder, and providing a backing for the sections. The tool steel pieces which form the cutting edges of the dies, are planed, drilled and tapped, and the piercing holes reamed slightly tapered, after which these sections are hardened and finished all over by surface grinding. Prior to the hardening of the cutting sections, however, grooves are planed transversely in them as shown in the small section between the plan of the upper and lower die in Fig. 1. These grooves are ½ inch wide and ⅜ inch deep; they are planed on the under sides and serve to decrease the tendency of the ends of the long steel pieces pulling away from the holder and rising up, thereby destroying the assembled condition of the punch and die, and making refitting of some parts necessary.

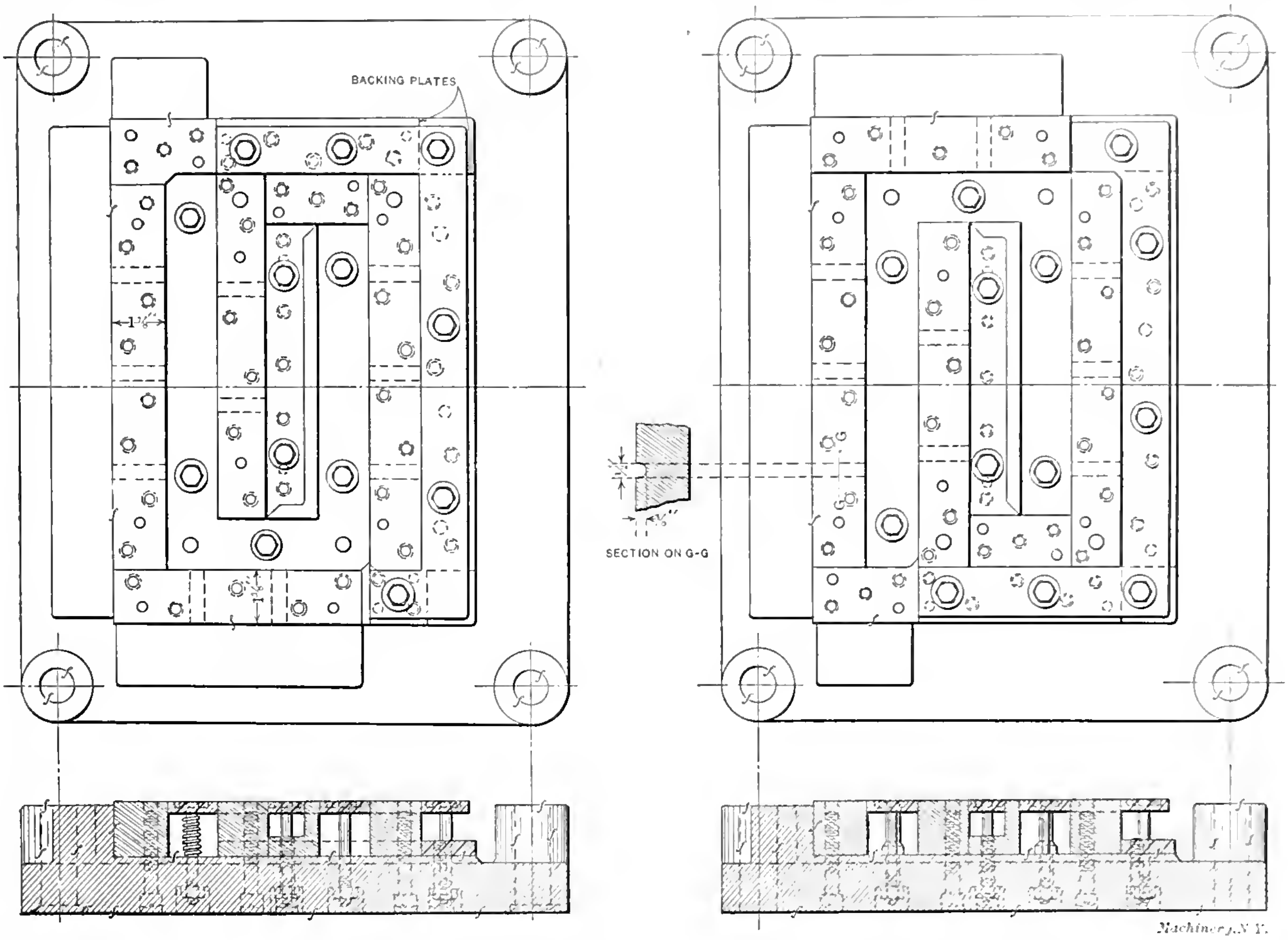


Fig. 1. Plan and Section of Upper and Lower Portions of Die for Cutting Pieces B and C in Fig. 2.

The constant impact common to blanking operations affects the long hardened steel members in these dies to a marked degree. After about ½ inch has been ground away on the top by repeated sharpenings, the long pieces will strain the threads on the screws which secure them to the face of the body of the die, and due to this strain, the long pieces will warp, the ends usually rising up. The grooves on the side next to the holder may not be an absolute cure for such undesirable conditions, but they tend to eliminate these troubles to a considerable extent. If the sections should warp in hardening, they may be straightened and replaced in their respective locations on the holders by peening on the top, care being taken not to strike near to the cutting edge. The steel parts of the upper and lower die having outside cutting edges are held in position not only by the screws coming through from the back, but also by ½ inch thick backing plates, doweled and screwed firmly to the holder.

The strippers are made of ½-inch boiler plate, and are planed on the outer face. They are forced to the top of the dies by coil springs made from ⅛-inch wire, and their movement is limited by the heads of ⅜-inch hexagon screws. The nuts on the lower ends of these screws are prevented from turning by a groove filed in the side with a small round file, and pins driven into the counterbored seats, fitting with their ends in the grooves. All adjusting of the strippers is done from the top of the dies. It will be noticed that stripper plates are provided for the sheet outside of the die, as well as for the parts which are cut out by the die. When the die was first designed, no stripper plates were provided for the outside, as the sheet iron from which the blanks were cut did not seem to require any stripping on the outside edges; but it was noticed that when the die was in operation, the outer edges of the stock sometimes bent down at quite an angle when the tool was cutting, resulting in unsatisfactory work when cutting blanks from the stock at places where the fit was slightly imperfect. The outer edges of the die also dulled more quickly than the inner edges, where strippers were used from necessity. By adding outer strippers to the die to clamp the stock, the troubles mentioned were overcome, and better work was turned out at the same time as the intervals between grindings became longer. Several years of experience have proved that when cutting sheet metal in large dies, it is by far the best practice to clamp the stock when cutting. When the stock is not so clamped, it is very liable to have a tendency to spread the die by straining the outer sections, or to cause other troubles.

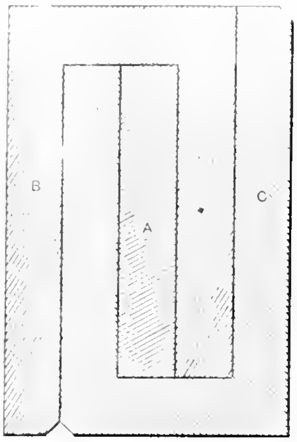


Fig. 2. Pieces B and C, cut by Die in Fig. 1, and the Scrap Piece A resulting from the Operation.

The piercing punches are driven into the holders, which is sufficient to hold them securely in place. Openings in the press ram flange are provided to allow the piercings to escape. In connection with this die, especial attention should be called to the small amount of scrap resulting from cutting out both of the odd-shaped blanks at once, the scrap for each two blanks being only the piece *A* in Fig. 2 and, of course, a narrow strip on each side of the stock used.

ENGINEER.

FORGING AN EYE-BOLT.

Some time ago the writer had occasion to make some 1¾-inch eye-bolts, that is, eye-bolts having 1¾-inch shank, for generators, and with the tools at hand he found it a rather difficult job. In the first place a 2 by 4 inch machine steel bar was hammered down enough for a shank about 2 inches in diameter. The piece was then cut off about 4 inches from the shoulder, and a 2-inch hole punched in the center, which hole was thereafter increased to 3 inches. The corners were then cut off, as shown at *B* in Fig. 2, and the inside and outside corners around the hole were removed in order to procure a circular section at this place. The result was a fairly good-looking job, but the time it required to make the forging was too great, it having required about three hours to make the first eye-bolt, and when the time was cut to 2½ hours, it was considered as doing well.

The writer, however, was not satisfied, and asked the superintendent for permission to make a forming tool, but, for some reason, this was refused. But later, receiving an order for as many as 12 eye-bolts, he undertook to make the tool "on his own hook," the superintendent having gone away for several days. The tool was made, and the time was cut to three quarters of an hour on each eye-bolt, and by using the furnace, they could be made in one-half hour each. It took the writer and a helper about five hours to make the forming tool, and there was four hours machine work on it, making a total of nine hours or a total cost, including shop cost, of about $11.00. Considering the cost of the first eye-bolt to be in the neighborhood of $4.00, including the shop cost, the writer thought that the saving in time more than paid for the tool. In the following is described how the tool was made.

One of the best of the eye-bolts previously made was filed up smooth and well rounded for the purpose of forming the tool. A ring was also made of 1¼-inch round machine steel, 3¼ inches inside diameter, as shown at *A*, Fig. 2, intended for making the first indention in the tool. After this, two pieces of locomotive driving axles were obtained, and two pieces or plates made, 7 inches square by 2½ inches thick. The corners of these were hammered, as shown in Fig. 1. The two pieces were heated, and the ring placed between them, and then hammered together. After this, a piece of 1½-inch round steel was used for forming the groove for the shank as shown at *A*, in Fig. 1. The plates were then again heated, and after having removed the scale, the eye-bolt was put in place between them, and once again the plates were hammered together, after which the edges were worked up with a bob-punch to get them sharp. Then the eye-bolt was put between the plates again for the final blow.

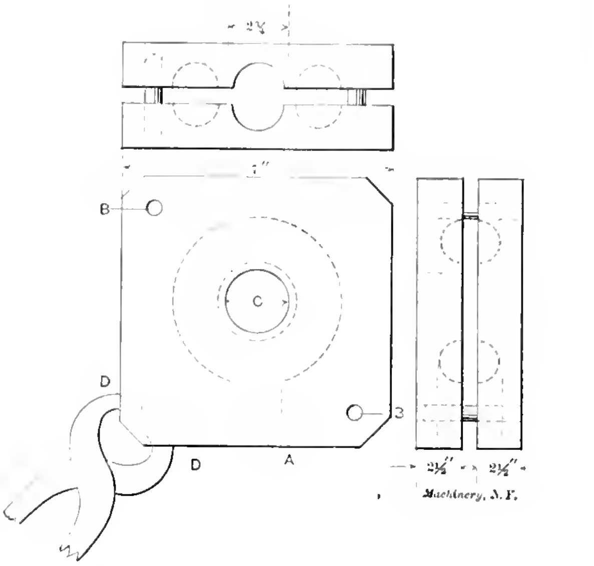


Fig. 1. Former or Die for Eye-bolt Forging.

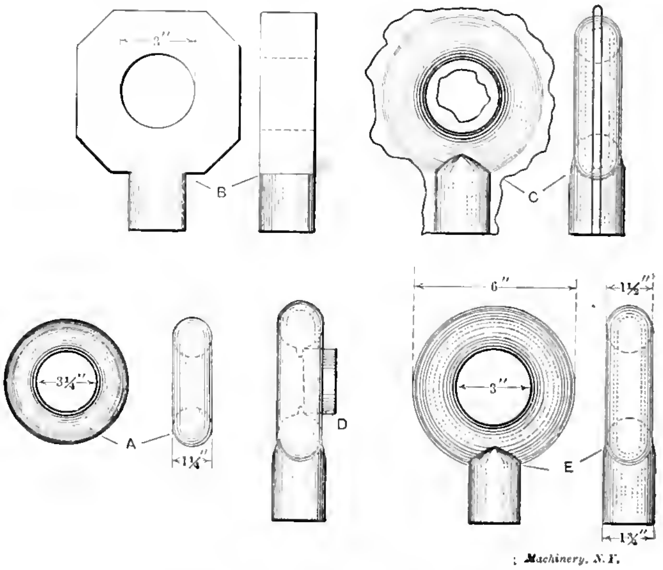


Fig. 2. Successive Steps in Forging an Eye-bolt.

When the steel plates had cooled off, two holes were drilled at opposite corners, as shown at *B* in Fig. 1, while the eye-bolt still remained in place. The plates were then bolted together, and a hole drilled through the center, as shown at *C* in Fig. 1. This hole was bored out to 2¾ inches diameter. The bolts were then taken out, and the holes at the corners drilled for ⅞-inch pins, which were then driven into the bottom part, with the ends tapered slightly on the outer end, so as to enter the holes in the upper part of the tool. The pins were of such length that when the dies were placed together, the pins

were below the surface of the dies. Finally holes were drilled in one corner of the upper die at *D*, Fig. 1, to fit the jaws of the tongs for handling it.

The blank forgings are now made in the same way as before, and as shown at *B* in Fig. 2. The blanks are placed between the forming dies, and these are hammered together, and when the eye-bolt is taken out, the surplus metal will be found around the outside of the eye-bolt and in the hole, as shown at *C*, in Fig. 2. This fin is cut off from the outside, and the eye-bolt is then again heated and placed in the die for a final blow. Then a short piece of steel, 3 inches in diameter and about 1½ inch long, as shown at *D*, Fig. 2, is placed on the die of the steam hammer, and a light blow will clean out the inside edge of the eye-bolt, leaving it finished as shown at *E*, in Fig. 2, excepting for cutting the shank to the proper length.

Decatur, Ill. GEORGE T. COLES.

A ROLLING OPERATION ON TYPEWRITER PARTS.

There are a great many interesting operations, common enough in some shops, which the workmen in other shops seldom or never hear about. A shop which has many things of interest and value to the wide-awake machinist is the Remington-Sholes typewriter factory. One of the many interesting operations carried out in this shop is a process for rolling a head on a stamped punching. The process may not be new, but it is certain to be of interest to many of the readers of MACHINERY. In Fig. 1 is illustrated a small detail for a typewriter in full size; at *A* is the piece as cut in a die from stock about 3/32 inch thick. This part is cut in the sub-press die *B*, in Fig. 2. The piece shown at *C*, Fig. 1, is the same part with a head rolled on it. It will be noticed that there are some fins around the edge of the rolled or formed portions. At *D*, in Fig. 1, the piece is shown trimmed off, the trimming being done in a sub-press die, as shown at *E*, in Fig. 2. The stem of the piece is inserted in the slot in the lower die shown at the top. It is clamped by means of the eccentric lever shown at one side, the trimming being done by the upper half of the die.

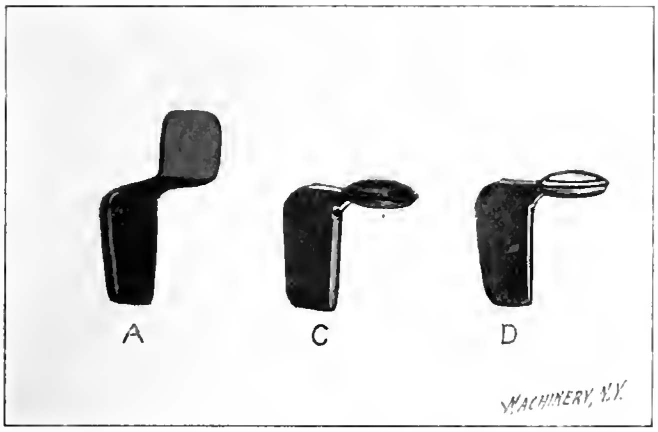


Fig. 1. Part Stamped and Rolled to Shape, at Various Stages of Completion.

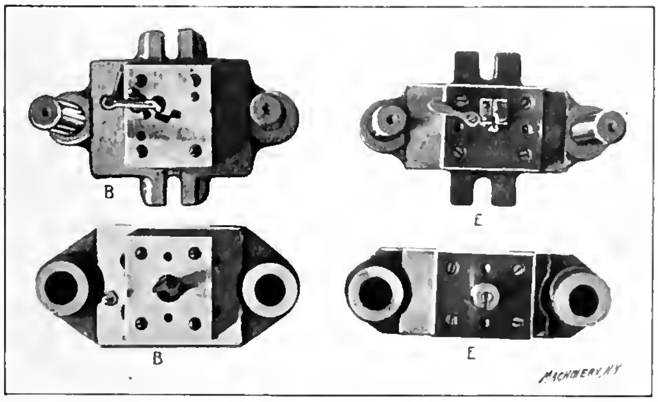


Fig. 2. Sub-press Dies used for Stamping and Trimming Part in Fig 1.

It would be very difficult, if not entirely impossible, to do a satisfactory forming job of this type in a punch press. The work is done in a special rolling device, the elementary principle of which is shown in Fig. 3. The heads *F* and *G* of the device rock up and down about pivots, as shown, between the positions indicated in the full lines and the positions shown in the dotted lines. The piece to be formed is held in a die between *F* and *G*, and the heads, as they rapidly move up and down, gradually are fed toward each other, thereby rolling the metal into the shape indicated. The appearance of one of these heads, *G*, is shown in Fig. 4. ETHAN VIALL.

Decatur, Ill.

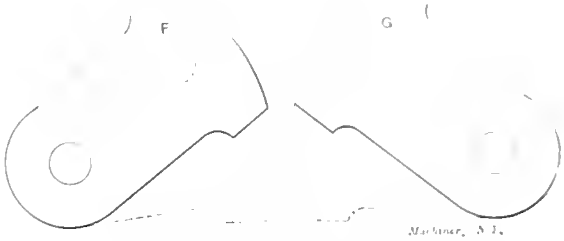


Fig 3 Principle of Rolling Device.

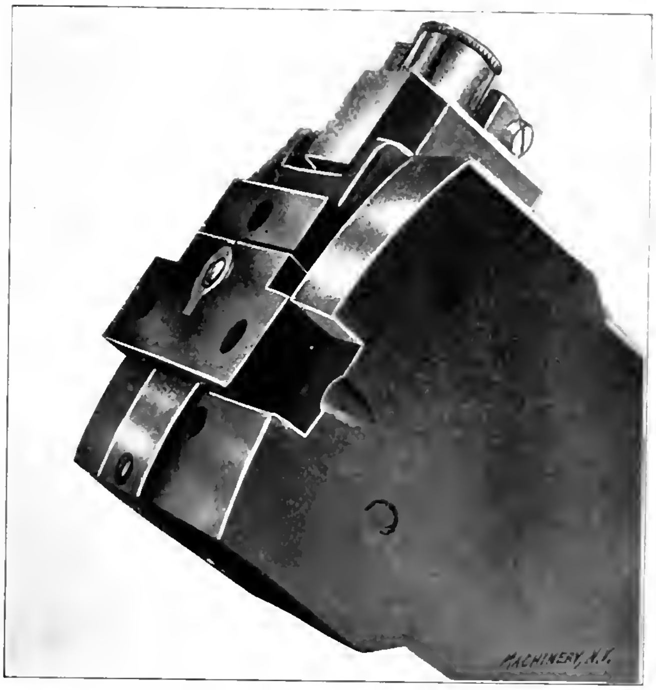


Fig. 4. One Head of Rolling Device, showing Construction of Work Holder.

MAKING BLUE-PRINTS WITHOUT A FRAME.

It may not have occurred to many of the readers of MACHINERY that blue-prints of small size can be made without a blue-printing frame. An ordinary window can be used if the sun shines through it, and a blue-print can be made in any window. An ordinary thick bath towel is placed behind the print, the tracing being placed against the glass. The towel should be folded into two or three thicknesses and arranged so that no wrinkle or uneven part lies against the print. A small drawing board may then be placed against the towel, but it is better to tack the towel at its corners to the board. It is also advisable to attach the tracing to the printing paper by small gummed stickers, to keep them in the proper position and to prevent sliding. Ordinary stickers cut into narrow strips will be sufficient, and need engage only a narrow surface on both the paper and the tracing, to serve the purpose. The print can then be frequently looked at without disturbing the relation, and can be easily torn off without injuring it or the tracing. Fragments of the stickers are easily scraped off. The printing paper and tracing can be held by a blank projecting edge against the window while the towel and board are being pressed against them. Any suitable means for holding the board in place may be used.

Another improvised printing outfit used by the writer consists simply in spreading the towel evenly upon the floor where the sun can strike it, placing the printing paper and tracing upon it, and then merely covering these with a thick

plate of glass. When first laid down, the glass may be pressed downward with considerable pressure, after which its weight alone will be sufficient to keep the paper smooth. This will be the case if two or three thicknesses of bath towel are used. This plan works perfectly for sheets 10 × 15 inches and below, this being the size used by the writer. Larger prints could doubtless be made in this way if weights were put upon the corners of the glass.

Another very practical way of making small prints is to use a smooth board with a slightly curved face. A tack placed in each corner of the tracing and print will cause them to snugly lie against the curved surface of the board, making a sharp and clear print. No glass is needed. C. E. BURNAP.

Battle Creek, Mich.

TO SET OVER TAIL-STOCK TO TURN A TAPER.

In these days of taper turning attachments, it is not often that one has to set over a tailstock to turn a taper. Sometimes, however, this has to be done, and the methods usually given are not only clumsy and troublesome, but almost invariably end up with the statement that no account has been taken of the effect produced by the uncertain depth to which the center holes have been drilled. It is not conducive to one's respect for the author of a rule, after figuring out by proportion how much to set over a tailstock to turn a taper of 0.650 inch on a piece 3 21/32 inches long, to be told that this is only approximate and the exact setting must be determined by trial. As a better method, and one which not only eliminates all figuring, but also gets rid entirely of the uncertainty of the center holes, I venture to offer to the readers of MACHINERY a method which I have used for some time in the instrument shop of the Emerson McMillin Observatory.

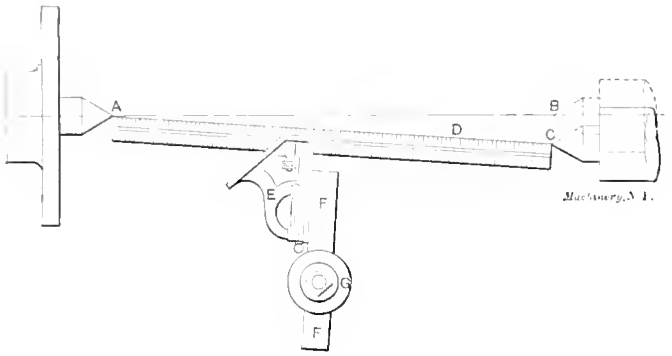


Fig. 1. Method of obtaining Setting for Taper Turning; First Step.

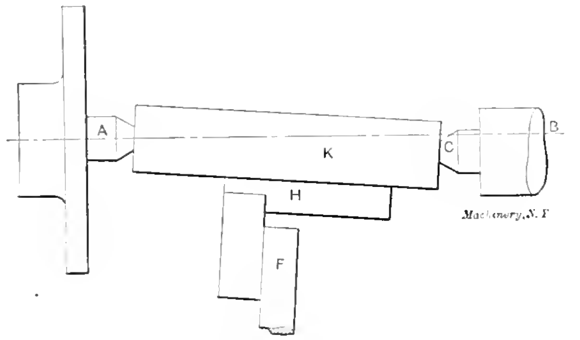


Fig 2 Setting the Tail-stock for Taper Turning Second Step

The piece to be turned should first have its ends faced off [illegible] smooth cut taken over about two or three inches [illegible] the centers being accurately in line. Then take [illegible] of the lathe and move the tail-stock until the [illegible] the centers are exactly one foot apart, as shown [illegible] tail-center *B* being dotted. Then, in any conve[illegible] over the tail-center exactly one-half the required [illegible] that is, the distance *B C* should be [illegible] per foot. A piece *F*, which has [illegible] on at least three sides, should [illegible] tool-post *G*. This piece should be about the [illegible] used in the lathe. A machinist's [illegible] one foot long, and preferably with a sliding head, should be held against the side of *F* and this latter turned in the tool-post until the edge of the blade *D* "cuts" the points of the centers *A* and *C*. The piece *F* should then be clamped, care being used to prevent changing this adjustment in clamping. It is evident that the side of *F* will now make an angle with a perpendicular to the axis *A B* of the lathe, which is equal to half the angle of the required taper. Now move up the tail-stock, and place the piece to be turned (*K*, Fig. 2) between the centers. Then hold a small square *H* against the piece *F* and set back the tail-stock until the blade of the square shuts out the light when held against *F* and brought up to the piece *K*. Should *K* be longer than one foot, obviously the tail-stock should be set over more instead of being set back. If care be used in each step of this process, a taper three or four inches long, when tried with a chalk line along its side, just as it comes from the lathe, will show a bearing for its entire length. While it has taken some time to describe this process, I do not think it takes over three minutes in actual practice to set over a tail-stock to turn a given taper after the work is ready. H. C. LORD.

Columbus, Ohio.

HOME-MADE TOOLS FOR DIE-MAKERS.

A few home-made tools are shown in the accompanying engravings. The construction of these tools is very simple, and they will make a desirable addition to a die-maker's collection. During several years experience as die-maker, the writer has noted with considerable interest many different methods of locating round piercing punches in a punch holder, the means employed differing as widely as the men who used them, ranging all the way from the crude method of transferring through the die by means of a twist drill, to the accurate master plate which is in almost universal use in the watch-making factories.

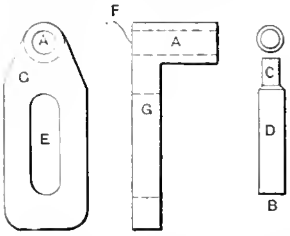


Fig. 1. Device for Locating Holes for Punches in Punch Holders.

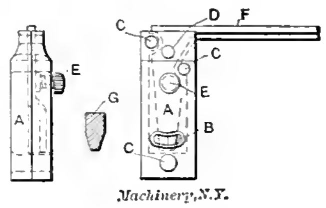


Fig. 2. Die-makers' Square or Protractor.

In Fig. 1 is shown a device which the writer has used considerably for locating the punches for small open dies, with the best results. The bracket *G* is made from tool steel, and the hole *A* is ground so that it is accurately at right angles with the face *F*. This can best be done on the face-plate of the bench lathe, using a revolving steel lap charged with diamond dust or carborundum. When using the tool for locating small round punches in the punch holder from the die, a piece of drill rod is first turned up, as shown at *B*, so that the diameter of the portion *C* equals the size of the hole in the die, and the part *D* is a close sliding fit in hole *A*. The piece *B* is then pressed into hole *A*, and the end *C* of the pin is placed in the hole in the die. One of the punches, that has previously been put into the punch-holder, is now permitted to enter its corresponding hole in the die, and when this is done, scribe lightly through the elongated hole *E* with a bent scriber on the punch-holder. After this, the die and bracket *G* are removed and a hole drilled and tapped in the punch-holder for a clamping screw in the center of the scribed outline. No great accuracy is needed, as the slot *E* should be enough larger than the screw to admit of considerable side-play, and the screw can be placed anywhere within the length of the slot. After having drilled and tapped this hole, the die and punch are again assembled, and carefully levelled up with parallels. The bracket *G* is placed on the punch-holder, and the screw in slot *E* is put in position and tightened, thereby binding the bracket to the punch holder, a bent screw-driver being used for tightening up the screw, if it has a slotted head. It is evident that the end of pin *B* which locates hole *A* of the bracket *G* now being clamped to the punch holder, is exactly in the position which the punch should

occupy in the finished tool, because end C of pin B enters the corresponding hole in the die. All that therefore remains now is to place the punch-holder on the face-plate of a lathe, indicate the pin, in the usual way, so as to insure the hole being bored central, remove the locating bracket, and bore the hole for the punch. This method, of course, leaves a small threaded hole in the punch-holder, but this can easily be plugged up. Should it, however, be objectionable to have a tapped hole in the punch-holder, the bracket may be held to the punch-holder with a little solder on each side, care being taken that the bracket is held down firmly to the holder when the solder is applied.

In Fig. 2 is shown a die square, which, when carefully made, is a very handy little tool. As will be seen, the blade can be adjusted from a 90-degree angle, or a perfect square, to an angle slightly larger or slightly smaller than 90 degrees. This tool is used for measuring the clearance of dies. By this means the die maker can measure the angle of clearance without the use of a regular protractor, and he can set this tool to the angle required for different jobs. The body part A is made of tool steel in two pieces, each side being recessed to accommodate the blade F. One side has a slot cut through it at B, which is bevelled and graduated. The rivets C shown serve to hold the two parts of the body together. The blade F is made of tool steel and is pivoted on the pin D, and locked by means of a knurled screw E, the point of which rests on a hardened disk, to prevent marring the blade. The projecting part of the blade is bevelled, as shown in the enlarged section at G, to allow the light to be more readily seen under it when in use.

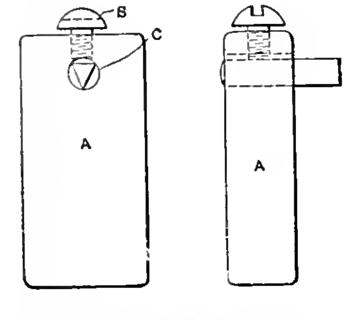


Fig. 3. Tool for Cutting or Scraping the Edges of Thin Templets.

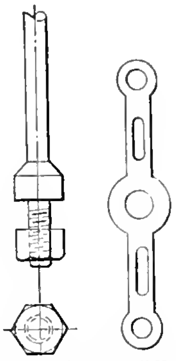


Fig. 4. Handy Holder for Thin Templets.

The tool, Fig. 3, is used in squaring up the edges of thin templets. The body part A is of tool steel having the corners nicely rounded, so as to be convenient for handling. A hole is drilled and tapped in the end for the screw B, which holds the pin or cutter C in position. This cutter is milled off on three sides, and is then hardened, and afterwards ground in the bench lathe, using a tool-post grinder with a cup wheel. When the cutting edge gets dull, the screw B is loosened, and the cutter C is turned around one-third of a revolution, so that the next cutting edge can be presented to the work. When all the edges are dull, the tool can again be ground on all the three sides.

The tool shown in Fig. 4 is a simple templet holder for small templets, which does away with the soldering on of a piece of wire, in which operation one usually manages to get part of the solder over the edge of the templet, which, whether left on or filed off, does not add to its accuracy. Another advantage of this holder is that when using a templet which is thin, and therefore has a tendency to spring, washers can be roughed out approximately the shape of the templet, only a little smaller, and the templet can be placed between them and the nut screwed up to hold the templet between the washers. It can then be held firmly in a flat position. As an example may be shown the templet at the right side in Fig. 4, which is very thin, and would be difficult to work through a die in the ordinary way, but by making two washers or guides, not illustrated, of approximately the same shape as this templet, it may be held straight and flat. When the washers holding the templet are long and narrow, as in the present case, it is well to bend them a little before binding with the nut, so as to prevent the ends from lifting up when the nuts are tightened.

Roy Plaisted

Philadelphia, Pa

SPECIAL SHOP CAR FOR CURVES OF SHORT RADII.

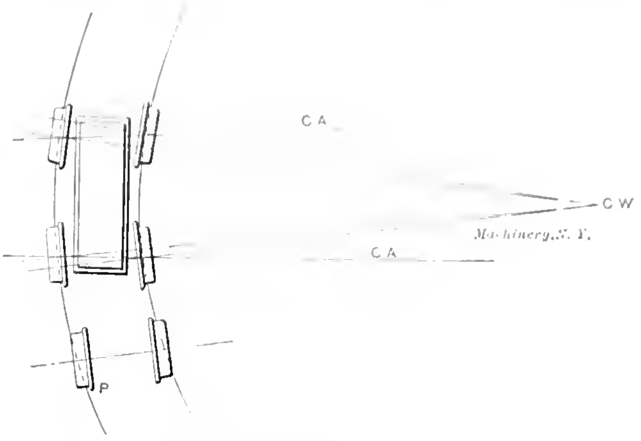


Fig. 1. Action of Car-wheels shown in Fig. 2 when on a Curve of Short Radius.

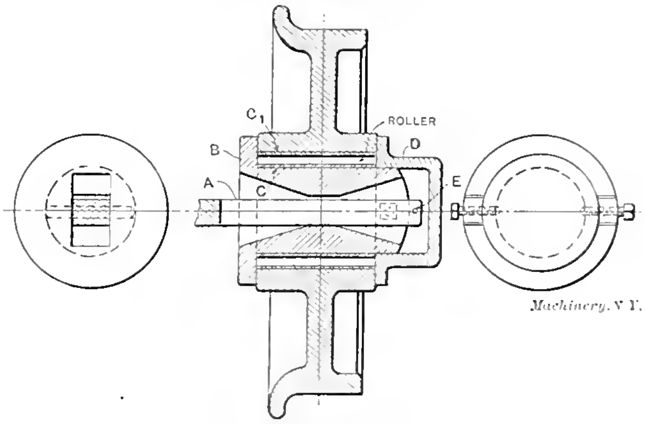


Fig. 2. Construction of Car-wheels for Curves of Short Radii.

In manufacturing establishments, where small cars are used for transferring material and other supplies from one point to another, it is common to have turn-tables for changing the direction of the cars. Under these conditions, the car must be run onto the turn-table with some care, especially when the wheel base of the car is as long as the turn-table will admit, and much time is often lost in placing the car and swinging the turn-table to bring the car into position to take the new direction. For this and other reasons, curves instead of turn-tables are preferable, but in a manufacturing plant it is obvious that the curves must needs be of such short radius that cars of special construction are necessary. The object of this article is to describe a car that was especially designed to meet these requirements, *viz.*, a car that will automatically adjust itself from running on a straight track to running on a curved track of short radius, say twelve feet, and which on passing the curve readjust itself again to straight running. The accompanying illustration, Fig. 1, shows a car of this type with wheel flanges on the inside of the rails. The dotted lines marked *CA* show the direction of the center lines of the wheel axles which are rectangular in section, and rigidly fixed to the frame of the car with their depths perpendicular. The dotted lines *CW* show the direction of the center lines of the wheel-bearing sleeves. These sleeves are malleable castings cored parallel and an easy working fit (all the way through) in the up-and-down direction, but in the forward and rear direction the cored axle-seat is only parallel for about one-sixth of the length of the sleeve. This short parallel part of the axle-seat in the sleeve is directly above the center of the rail, and from each end of this short parallel part to each end of the sleeve, the cored axle seat flares, in both forward and rear directions, an amount depending on the radius of the curve the car is intended to traverse. This short parallel part must be loose

enough on the axle to let the sleeve swivel the full amount which the flared parts permit.

Now, if the car is pushed or pulled forward or backward, the axle is forced against the short parallel part of the axle-seat, and if the car is on a straight track, the wheel bearings will stand parallel with the axles. When a curve in the track is reached, and the flange of the wheel comes in contact with the rail, as shown at *P* in the engraving, Fig. 1, the wheel will force the sleeve to swivel, and the short parallel part of the axle-seat in the sleeve will be thrown out of line with the axle, but will always have a tendency to come back into line, and will do so as soon as the car reaches a straight piece of track.

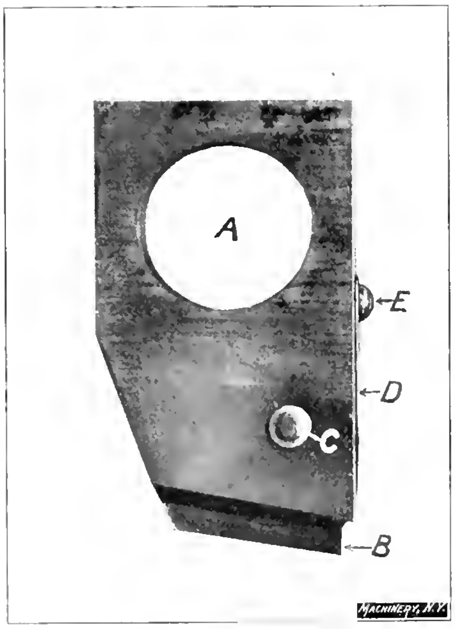
In the detail construction in the engraving, Fig. 2, *A* is the axle, *B* is the wheel-bearing sleeve, *C* is a thin steel casing split lengthwise and pressed on the sleeve with the split at the top, and C_1 is a thin steel bushing in the wheel-hub. (If C_1 is split, it must be done spirally.) The part *D* is a cap with two set-screws in it to keep the wheel in place on the sleeve; *E* is a pin driven through the end of the axle between the end of the sleeve *B* and the inside of the cap *D*. The end of the sleeve *B*, where the pin goes through the axle, is convex in the forward and rear directions, the radius of the convexity being the distance from that end of the sleeve to the center of the short parallel part of the axle-seat. When the pin in the axle is against the highest part of the convex end of the sleeve, the end of the axle should clear the inside of the cap *D* by about one-eighth inch. JAMES T. GRIMSHAW.

Detroit, Mich.

TOOL FOR GRADUATING.

A very good tool for graduating work in the milling machine, when the index head is used for spacing, is shown in the engraving below. The tool is held stationary on the arbor in the same manner as a regular milling cutter, and the work is moved back and forth under it, the table stops being used to get the correct length of stroke. The body of the tool is made of machine steel, ½ inch thick, 1½ inch wide, and 2¾ inches from the top to the cutting point. The hole *A* is bored for a 1-inch arbor.

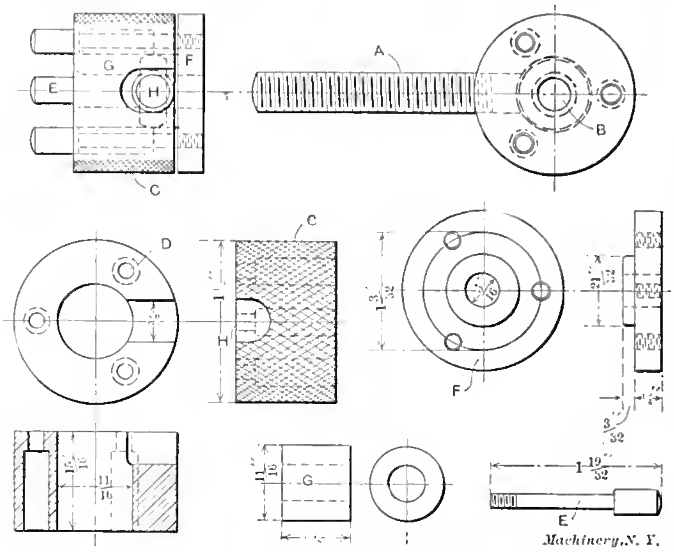
The cutter blade *B* fits freely into a slot milled in the machine steel body. It is made of ¼ x 1-inch tool steel, hardened and tempered, and the cutting edge is ground to a 60-degree angle. The cutter is also ground at an angle of 80 degrees to the front edge of the body for clearance. The pin *C* which holds the cutter in the slot is of ¼-inch drill rod. The spring *D* at the front of the tool, which keeps the cutter in proper position when cutting and allows it to ease-up when backing out, is ¼ inch wide and 1¼ inch long, and is held by a small screw *E*. Rapid, clean work can be done with this tool without danger of breaking the point. ETHAN VIALL.



Tool for Graduating.

INTERESTING DRILL JIG.

The drill jig described in the following is so simple in its construction, and so easily manipulated, that I think it will be suggestive for improvement in drill jig design to some of the readers of MACHINERY. In the upper part of the line engraving the jig is shown assembled, with the piece *A* to be drilled in place in the jig. In the lower part are shown the details of the device. The piece to be drilled is turned and threaded in the screw machine, from bar stock, and the spherical head slab-milled in the milling machine. The hole to be drilled is the hole *B* in the head. The main body *C* of the jig is knurled to permit a good grip in handling, and is bored to 11/16 inch diameter, which corresponds with the diameter of the spherical head of the piece to be drilled. The three small counterbored holes *D* permit of the introduction of the feet or plungers *E*, around which are placed small helical springs. The stems of these feet *E* pass beyond the body *C*, and are threaded on the upper ends, the threaded portions entering into the cover *F*. The jig is now complete except for the bushing *G*, which, of course, is hardened, and made of tool steel. This bushing is pressed into the body *C*, and is just long enough to leave, when it is pressed down flush, sufficient room for the flattened head of eye-bolt *A*. The slot at *H* allows clearance for the stem of *A*, which latter provides a very convenient handle when drilling. In the event of a piece with a shorter stem being used, a small handle can be driven or threaded into the side of the body *C* to hold it while drilling.



Drill Jig of Simple but Interesting Design.

With the feet *E* resting upon the drill press table, and the thumb and fore-finger on either side of the body *C*, press downward in order to remove the piece; then, after inserting a new blank, the pressure on the body *C* is released, and the small helical springs bring the body *C* up against the cover *F*, thereby holding the work securely. The jig is now turned over, and, using *F* as a base, the hole is drilled through the work from the bushing *G*. C. H. RAMSEY.

Paterson, N. J.

AUTOMATIC LATHE STOP AND TELL-TALE.

I have seen one or two devices around the shop for automatically stopping the lathe, or warning the operator when the tool had reached the end of its cut, which were very primitive in design, but served the purpose well.

One way of stopping the lathe is to hang a weight on a cord which is attached to the shipper and which passes over a rod on a level with the bottom of the shipper. The weight is set on the back V of the lathe in such a position that when the carriage has reached the end of the cut, it will push off the weight, which will cause the shipper to be pulled over, thus stopping the machine. This device is used mostly on lathes with jobs running half an hour or so, and where the operator is running some other machine.

Another arrangement used by the piece workers on roll turning, where they do not stop the lathe at all, is a telltale. It is a strip of sheet steel fastened by one end to the carriage and set in such a position that when the tool has reached the end of the cut, it will rub against the faceplate, making a noise like an old style watchman's rattle, thus notifying the operator. PAUL W. ABBOTT.

Lowell, Mass.

PUNCHES AND DIES FOR CAN ENDS.

I was much interested in Mr. Washburn's description of his toggle drawing punch for can ends (see February, 1908, issue of MACHINERY), as I have been closely connected with the can business for a few years. I like the toggle punch for shallow, unembossed, push-through work, but for the general line of can tops and bottoms I prefer a single action combination die, as there is usually some embossing to be done in addition to the cutting and drawing of the bottom; a top with an opening is also usually required on fruit and vegetable or "packers'" cans. This opening is used for filling, and is later closed with a cap. It has been found that a lip on the mouth of a can end is essential to rapid and economical production, as it makes the entrance of the body into the ends more easy, and also maintains a good tight fit so as to make a good joint with the least amount of solder.

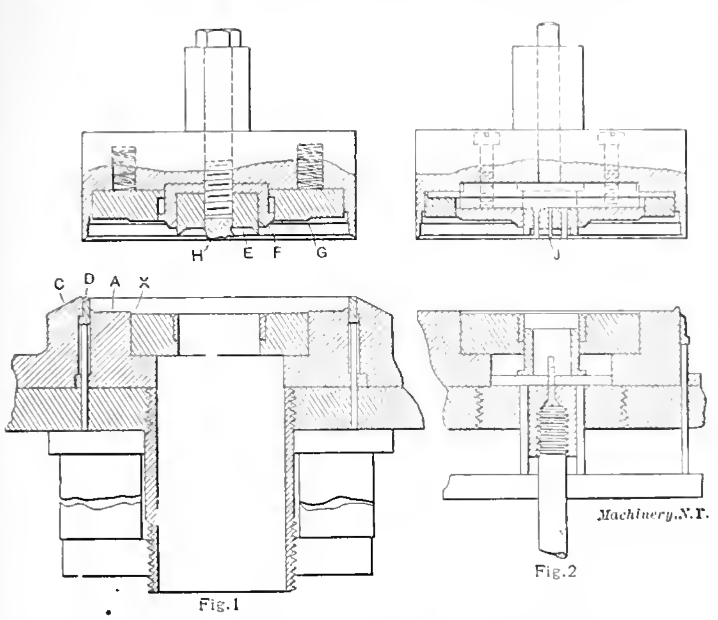


Fig. 1 Fig. 2

Figs. 1 and 2. Punches and Dies for Can Covers and Bottoms.

The style of punch and die that produces a large portion of the can ends used by packers and supplied by the so-called can trust, is shown in Fig. 1, and might be termed a single action, cutting, drawing, and embossing combination. In addition to the operations mentioned, the "single" dies, and especially those of odd sizes, are further combined so as to make bottoms and tops with various size openings ranging from 1⅜ inch to 3¾ inches in diameter; and even after this was accomplished the blank from the 1⅜-inch opening was bumped up into a roofing tag.

The gang dies are of identical construction, and are part of a line of machines that make a can and make three tops and three bottoms at each stroke; the sheet of tin is turned over to cut three more of each at the next stroke; then the stock goes to another gang press that makes six can caps and ten smaller caps for bottles. By this time the sheet is so well decorated with holes that it can be handled only with a pitchfork. This scrap is shipped to a detinning plant. The blanks from the can top openings are worked up under other presses, usually automatic. Some sheets make as high as twenty-four tops and bottoms and a relative number of smaller pieces.

The engraving above of the die will probably need some slight explanation. Center block *A* is made the same diameter as the outside of the can body, as this part determines the smallest possible diameter of the inside of the can end. The center block is bored out to receive die centers made for different size openings, and as these all come within the diameter of the panel *X*, the height of all must be alike at this point, though the contour may vary inside the diameter of the panel. It is my practice to make the contour of the die centers lower than the rest of the bottoms, which makes it possible to run out tops as required, and by removing the punch only and changing to punch centers adapted to bottoms, as shown, bottoms can be made without changing the die or setting the die or press, which results in a considerable saving of the die setter's time when only one or two dies are available.

It will be readily seen that it is not necessary to have solid die centers or center blocks for bottoms, as the punch center determines the convexity and the size and shape of the panel, provided the die center does not interfere. Sometimes tops are required without the panel; then the die center is raised an amount equal to the height of the panel, and the punch center shortened an equal amount, and a separate knockout used. The part *C* is the cutting edge, and *D* the pressure ring which can have a bevel of from 20 to 25 degrees, as a shallow draw has so little tendency to wrinkle, and because such wrinkles can be ironed out with a high pressure from the rubber barrel, there being little danger of bursting the end.

The cutting edge of the punch is bevelled to fit the ring, which permits considerable upsetting before it is necessary to refit. This cutting edge of the punch is 5/16 to 3/8 inch ahead of the embossing or bottoming point; this feature permits the die maker to upset and fit the punch to the cutting edge and ring without sinking back the entire interior of the punch, which means a great saving of time, when one considers that the punch can be fitted eight or ten times before sinking back. The diameter of this portion is made 0.010 inch to 0.012 inch larger than the proper size up to within 3/32 inch of the knockout, then bored the proper diameter to draw the metal to the size of the center block; this double diameter draws, makes the end too large, and then redraws most of it to the proper size, leaving the lip flared out slightly, as shown exaggerated in the views of the tops and bottoms—a small detail that saves thousands of cans and many pounds of solder, and results in a higher speed of production. The forming punch *F* forms the metal around the hole blanked by punch *E*, while *G* forms the bead and panel and acts as a knockout through the springs as shown. The punch parts are held by a cap-screw, and a bit of soft rubber *H* insures the shedding of the blank.

In the roofing tag combination, the blanking punch is fitted with a pick-up piercing pin *J* (Fig. 2) pointed to burst a hole instead of piercing it, and slightly reduced in diameter so as to pick up the work. Knock-off pins are provided, and they and the knockout ring are operated by a ⅜- by ½-inch bar actuated by the pin shown in the shank of the punch. The punch center and ring are slotted to make room and give action to the stripping bar. The die space is filled up with a forming post, forming and stripping ring and stripping pins supported by the threaded plug screwed into the die plate. The ring is intended mainly to hold the blank control on the down stroke, so the center pins are some little shorter than the others. A stud instead of a pipe now supports the rubber barrel, as there are now no blanks to go through. This seems like a lot of work to save a small piece of tin, but I know of one factory that makes 25,000,000 of these blanks yearly. I want to call attention to the difference between these two punches: The knockout in Fig. 1 begins to strip the work an instant after it is formed, and the work lies on the die but falls with the movement of the stock, the press being inclined as usual. With the style shown in Fig. 2 the work is picked up almost to the top of the stroke before falling, hence it is out of the way and permits easier movement of the stock. The roofing tag must be picked up high enough to drop clear of the die; if it drops in the die the next piece will be spoiled.

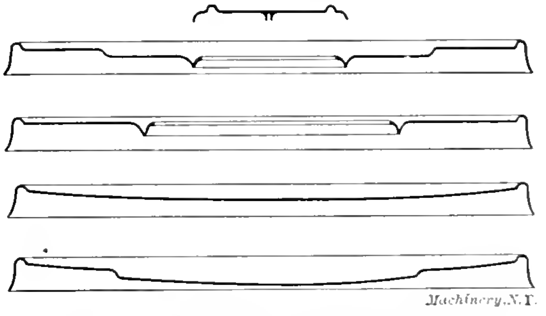
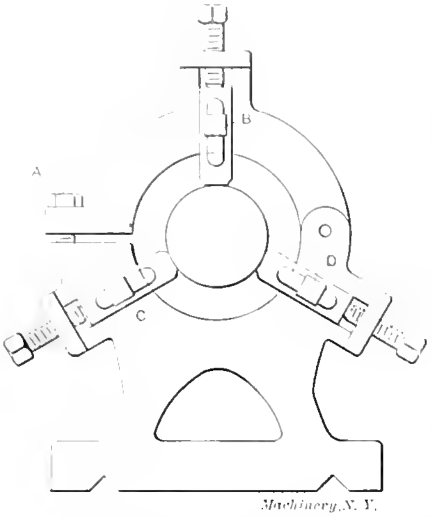


Fig. 3. Plain and Paneled Can Tops and Bottoms

SIRIUS.

SETTING THE STEADY-REST.

After reading Mr. J. J. Voelcker's remarks in the May issue of MACHINERY, relating to the use of the steady-rest, I would say that his remarks are very good as far as they go, but one of the most important suggestions has been left out, which is necessary to make the subject more complete. This important point is that of setting the steady-rest. It seems to be quite common among machinists simply to set the steady-rest by screwing down the jaws upon the work until they have what they think is a running fit between the work and the jaws. This, of course, is a very poor way, especially for finished work, and would, as Mr. Voelcker says, need emery cloth, with the cloth side next to the work, in order to prevent marring the finished surface. Even then, however, there is a liability of scratching the work if it has to be run for any length of time, because the steady-rest is set too positive to allow for expansion of the metal by the heat due to friction. The writer has always found that the best way to set the steady-rest is that indicated in the accompanying illustration. Referring to the engraving, the binding screw *A* should be screwed down with the fingers. This gives the workman a chance to adjust the tension of the jaws on the work every few minutes, and especially when filing the work, this gives very good results, as the nut can be adjusted according to the expansion of the work. It is admitted that emery cloth is a good thing to use in most cases, but there is no need of it if the precaution mentioned above is taken, providing the jaws have ordinarily smooth faces. The nuts on the bolts *B*, *C*, and *D*, for adjusting the jaws themselves, should be tightened positively with a wrench as soon as the work has been set central.



Setting the Steady-rest.

New Britain, Conn. J. W. DICKINSON.

DIE-HOLDERS FOR MARKING MACHINE.

In the manufacture of tools requiring a great many different marks to designate the different parts, the cost and up-keep of the dies is no small item. Having this in view, the idea of dies or type to lock in a form was submitted [illegible] marking machine, and the holder, Fig. 1, [illegible] s and an alphabet, were made, in which [illegible] in detail), were held in place by a [illegible] fastened by screws *C*. This holder [illegible] *B* would break at *D*, and, there [illegible] from side play, the type would [illegible] this, the holder shown in Fig. 2 [illegible] and insert *E* are held from side [illegible] milling away the tongue of the center piece, as shown by dotted lines, while screw *H* takes up end play. To change the type in the holder, Fig. 1, it was necessary to remove screws *C* and take off *B*. To change in the other holder, screws *G* are removed, when the side can be taken off leaving the type and insert free. With this holder an average of 750 impressions, of from 2 to 25 letters and figures each, are made daily on annealed tool steel. With three sets of figures and an alphabet, the range is very large, and can be increased at a fraction of the cost of separate dies for each mark. Our range, at present, embraces over 200 different marks.

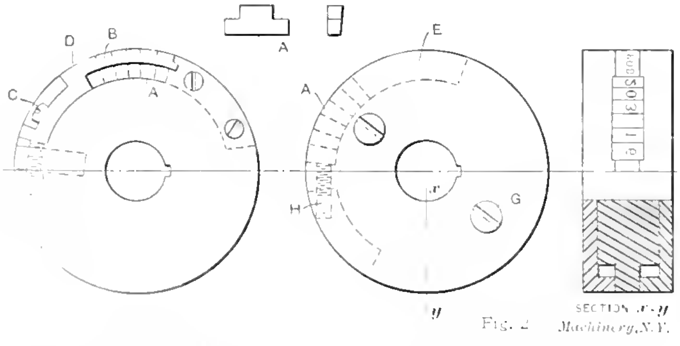


Fig. 2

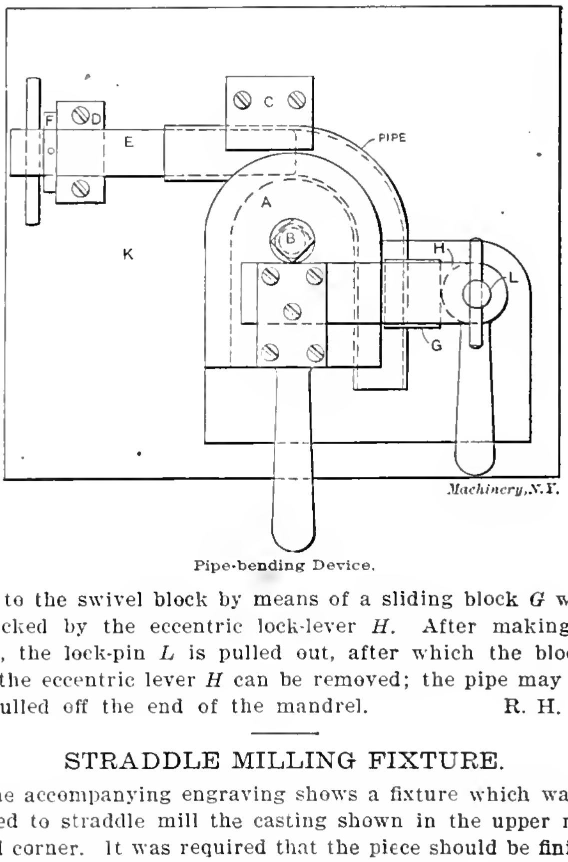
Two Types of Die-holders for Marking Machine.

Muscatine, Iowa. F. P. HEBARD.

PIPE-BENDING DEVICE.

The illustration shows a pipe-bending device which will be of value to anyone wishing to bend pipe without the trouble of filling it with sand or other materials. The mandrel *E* is held on base *K* by the steel block *D*. Stop collar *F* is set and pinned on the mandrel in such a position as to allow the end of the mandrel to project slightly past the center line of swivel block *A*, which is pivoted at *B*, and rounded out for the pipe. The backing block *C*, which also fits the pipe, is set so as to allow the pipe to slide over the mandrel *E*, and keeps it from buckling while it is being drawn off the mandrel.

The pipe is shown in the illustration after having been bent at right angles. Before making the bend, the swivel block *A* is set in a position parallel with the mandrel *E*, and the end of the pipe is then placed on the mandrel. It is held to the swivel block by means of a sliding block *G* which is locked by the eccentric lock-lever *H*. After making the bend, the lock-pin *L* is pulled out, after which the block *G* and the eccentric lever *H* can be removed; the pipe may then be pulled off the end of the mandrel. R. H. M



Pipe-bending Device.

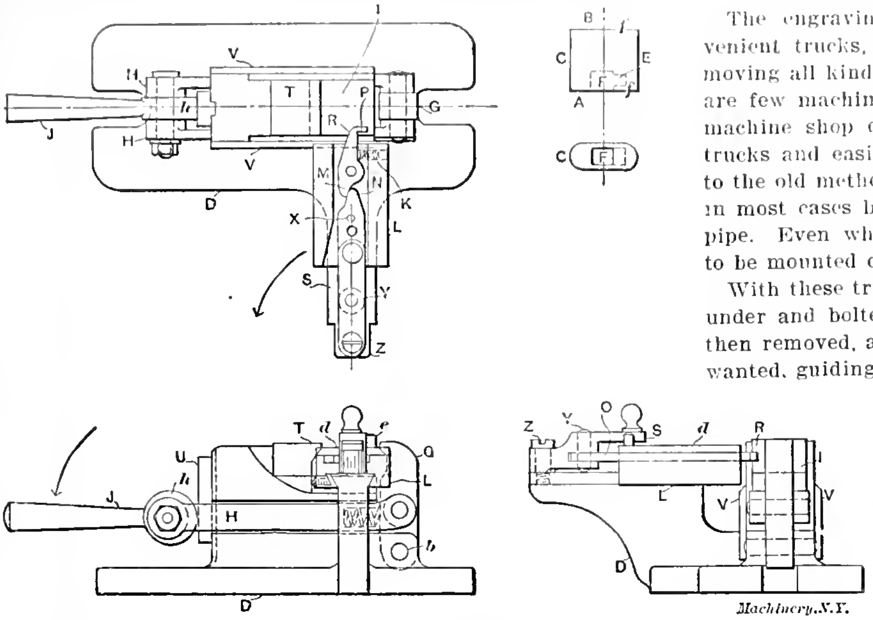
STRADDLE MILLING FIXTURE.

The accompanying engraving shows a fixture which was designed to straddle mill the casting shown in the upper right-hand corner. It was required that the piece should be finished on the two ends *A* and *B*, and that these ends should be approximately square with the side *C*, which is rough. It was important that the top surface *A* should be a certain distance from the side *E* of the cored hole *F*, and that the length from *A* to *B* should be kept constant. It was decided to use a hand miller for the operation, finishing one piece at a time.

The fixture consists of a base *D* of cast-iron, planed off on the bottom, and having a key to fit the slot in the milling machine table and holes in the ends for the usual holding down bolts. The flat side of the work rests on the hardened tool steel plate *I*, and the side *C* is pressed against the jaw *T* by the clamp *G*, thus locating the work square with the cutter spindle. The work is held down by the action of the beveled surfaces of the jaw *T* and the clamp *G*, acting on the upper round corner of the work. The clamp is pivoted at *b* to the

base of the fixture, and is operated by the eccentric *h* through the two connecting rods *H* which are attached one on each side of the clamp. The base is cut away to allow clearance for these connecting rods, and the hardened tool steel plate *U* is let into the back of the base for the eccentric to work against. The side plates *V* are fastened to the sides of the base to keep out the dirt. A coil spring forces the clamp *G* away from the work when the eccentric is released.

To keep the distance between *E* and *A* of the work constant, it is necessary to gage from the surface *E*, and the locating piece must enter the hole *F*, which is less than 7-16 inch square. The locating piece must also be withdrawn a sufficient amount after the work is properly located and clamped, in order to clear the cutter. The edge *P* of the locating piece *R*, which is pivoted to the slide *L*, rests against the surface *E* of the work. The slide *L* is dove-tailed on the bottom to fit the base of the fixture. One end of the lever *O* is pivoted to the slide at *X*, and the other end to the center *Y* of the arm *S*. This arm *S* is pivoted at one end *Z* to the base of the fixture, and has a small knob in the other end to serve as a handle.



Milling Fixture of Ingenious Design.

The plate *d* is placed over the slide to keep out the dirt and also carries the stud *e* to limit the movement of the arm *S*. A small coil spring *K* keeps the end *M* of the locating piece *R* in contact with the lever *O*.

To operate the locating mechanism which is illustrated in the position in which it is just at the time the work is clamped, the arm *S* is turned 90 degrees to the left in the direction of the arrow. This moves the end of the lever *O*, pivoted at *Y*, to the left, and the opposite end *N* of this lever to the right. By the action of the coil spring *K* on the locating piece *R*, the end *M* follows *N* to the right, and the opposite end *P* moves to the left away from surface *E* into the square opening of hole *F* of the work. The action of the arm in moving through an arc of 90 degrees also pulls back the slide, since the lever *O* is pivoted to it. When the arm *S* moves through the first few degrees, the slide has no appreciable backward movement, while the lever *O* has a comparatively large movement at the end *N* to the right. This difference, caused by the location of the pivot points of the moving parts, is such that the end *P* of the locating piece is first moved to the left, away from the surface *E*, into the square opening of hole *F* of the work, before the slide starts back. The latter part of the movement of arm *S* pulls back the slide enough so that part *R* will clear the cutters.

In locating the piece, the opposite action, of course, takes place; the first part of the movement of the arm causes the slide to advance, and the last few degrees movement causes it to remain practically stationary, while the end *P* of the locating piece *R* is moved to the right. With the locating mechanism withdrawn and the clamp *G* loosened, the operation is as follows: The work is laid on the plate *I* and up against the jaw *T* and held there with the left hand, while with the right, the arm *S* is swung through an arc of 90 degrees to the position in the engraving. The work is then moved until the surface *E* comes in contact with the locating piece, and the operator, with his right hand, throws the eccentric lever *J* downward in the direction of the arrow, which causes the clamp *G* to grip the work tightly, thus holding it down, and holding side *C* square with the cutter. The arm *S* is swung in the direction of the arrow, pulling the locating mechanism out and away from the work. The table is fed towards the cutters in the usual manner.

In operation, this jig proved to permit very rapid manipulation, and the quality of the work was all that could be desired

Orono.

TRUCKS FOR MOVING MACHINERY.

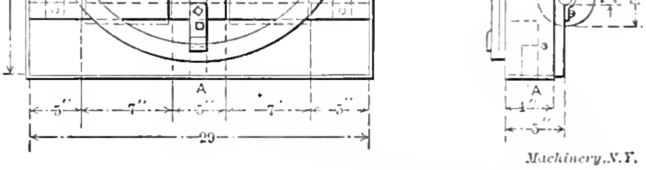
The engraving, Fig. 1, illustrates one of the most convenient trucks, or "dollys," as the shop men call them, for moving all kinds of shop machinery, that I have seen. There are few machines, such as are usually found in the average machine shop or factory, that cannot be mounted on these trucks and easily moved wherever desired, without resorting to the old method of rollers and a crowbar or two—the rollers in most cases being short lengths of shafting, or even steam pipe. Even when rollers are used, the machine usually has to be mounted on skids.

With these trucks, the machine is jacked up, the trucks run under and bolted fast to the legs. The jacks or blocking is then removed, and two or three men push the outfit wherever wanted, guiding the trucks by means of short iron bars placed in the holes shown at *A* in the line engraving Fig. 2. The body of the truck is made of five pieces of oak, 29 inches long and 5 inches square, securely mortised and bolted together, and bound on the outside by a band of iron 3/16 inch thick and 4 inches wide.

The four rollers, placed as shown, are made of cast iron, and are 6¾ inches long, 5 inches in diameter, and revolve on a piece of 1¼-inch shafting firmly strapped to the frame. This arrangement of four rollers makes turning the trucks much easier than would be the case with two long rollers. It also admits of a much more rigid frame.

On top of the framework is mounted an arrangement similar to the "fifth wheel" of a wagon. Firmly fastened to the upper half of the wheel is a piece of heavy channel iron about 4 inches wide, with a channel 2 inches deep. On top of this, two pieces of iron, ½ inch thick, 5 inches wide, and 10 inches long, with slots in them 6 inches long, are riveted. Blocks of hardwood, with slots to correspond to those in the plates, are fitted into the channel. The rivets, running through these blocks, prevent the bending of the plates where the slots weaken them, and also make a much more solid job with little additional weight. The slots in the plates allow the bolts, which are inserted from below, to be adjusted to accommodate different widths of legs. The wood blocks are slotted all the way out on the inner ends so that the bolts may be taken entirely out, if necessary.

Ethan Viall.



Figs. 1 and 2 Truck for Moving Machinery.

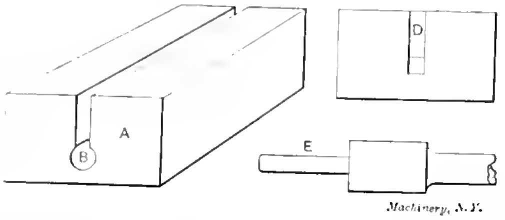
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A DRILLING KINK.

We had a number of pieces similar to *A* in the engraving below to machine with a slot having a round bottom or hole *B* through the entire length. No milling machine was available for the job at the time. The slot had to be somewhere near central with the hole, and this is the way we did the job. The block was first planed square all over, then a slot was planed out to the proper depth. Piece *D* was set in the slot as shown to form a square hole and act as a guide for the long pilot *E* of the counter-bore. The four sides of the square hole, one of which was formed by the inserted piece *D*, guided the counter-bore central with the slot and at the right distance from the bottom of block. In this way we did a very satisfactory job.

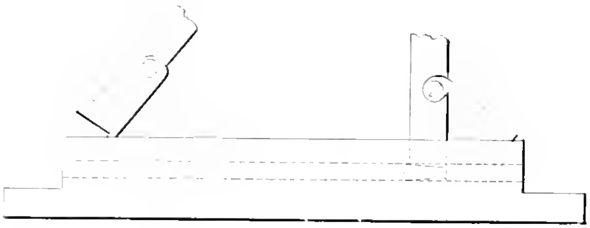


Machinery, N.Y.

E. S. WHEELER.

LATCH FOR LIFTING PLANER TOOLS.

Every machinist knows that when planing T-slots the tool has to be blocked or else lifted on the return stroke. The former process is hard on the cutting edge, and if the clapper be a heavy one, the latter is tedious for the planer hand, with the ever-present risk of a momentary lack of vigilance on his part and the resultant ruined tool or work. To obviate both blocking and lifting the tool, I made some latches, as shown in the engraving, and applied them to the slotting tools. They need no explanation, and can be used wherever the work permits the tool to swing clear at each end. For a case where the slight rubbing of the latch on the return stroke is undesirable, a pad of fiber is put on with two number 0 screws.

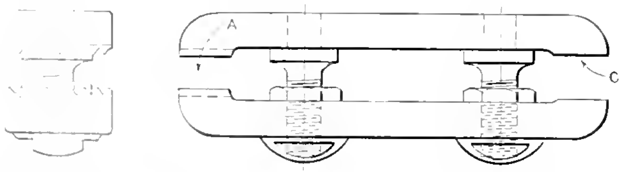

Machinery, N.Y.

DONALD A. HAMPSON.

Middletown, N. Y.

A HANDY SCREW THREAD GAGE.

When cutting threads on screws and bolts, whether by threading dies or in a lathe, much time is wasted by gaging the threads with either a nut or a ring thread gage of the ordinary type. In the case of a piece held between lathe centers, in order to gage the thread with the ring gage, it is necessary to remove the piece from between the centers. The Dresdner Bohrmaschinenfabrik A.-G., Dresden, Germany, is making a gage for measuring the threads of screws, which serves the same purpose as a ring gage, but saves the user considerable time. This gage is shown above. The end marked *A* fits over the threads, and the end marked *C* is supposed not to pass over the threaded screw, when threaded to the right size. Thus, not only can the size of the threads be tried, but at the same time the gage acts as a limit gage.

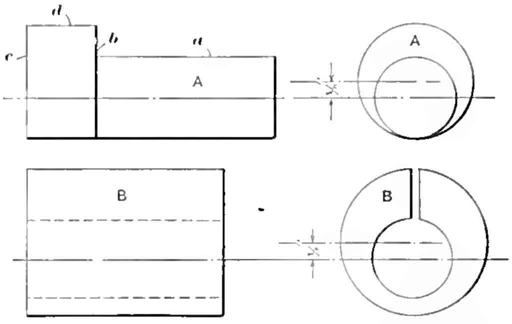


Machinery, N.Y.

OSKAR KYLIN.

TURNING AN ECCENTRIC.

The job shown at *A* below, is one which I have to do quite often, and the following is the best way I have found of doing it. First I made a split collar *B*, the outside diameter of which was turned to fit a collet chuck. In making the eccentric, a piece of steel ⅛ inch larger than the finished size is used. This is chucked in a three-jawed chuck with about ⅛ inch throw, and the end *a* turned to finished size. The side *b* is then faced, and the piece is cut off, allowing enough to finish the face *c*. The piece *A* is then inserted into the hole in the collar *B*, which is held in the collet chuck, and the surfaces *d* and *c* finished.



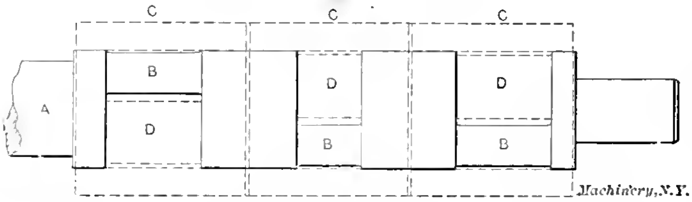
Machinery, N.Y.

ORIGINAL.

ONE WAY OF DOING A DIFFICULT JOB.

A rush order came to our department for a dozen shafts such as shown in the illustration. The immediate hurry, combined with the doubt that the order would ever be duplicated, made it imperative that some method should be devised to make them right away, regardless of whether or not a little more time and thought would enable us to do the work in a way more satisfactory in the long run. The additional tools we had to make cost so little and worked so well, that I think a description of how we finished the shafts will prove of interest to the readers of MACHINERY.

The shafts *A*, which were 8¼ inches over all, were first laid out with care, with two of the crank-pins *B* directly opposite the third one. The larger part of the shaft was finished to 15/16-inch diameter, and the crank-pins *B* turned to 5/16-inch diameter. The latter were first roughed out as much as they would stand without supports, and then the shafts were all finished to size. Here is where our special tools came in. These consisted of four tool-steel bushings nicely reamed to fit the shafts, and, in addition, three plugs of ½-inch round stock, two of which were ¾ inch, and one, ½ inch long. The three smaller bushings *C* were heated to a dull red and dipped in oil to prevent them from stretching when in use. The crank-pin on the left was first turned to size, then a plug *D* was squeezed in, and a collar, which was a nice snug fit, forced on. The relation the collar and plug have as a support for the shaft while the next crank-pin is being turned can now be readily seen. In this manner the three pins were finished, each time a collar and stud being added. When they were all turned, one large collar took the place of the three smaller ones, the plugs *D* still remaining. Then the part *A*, and the two ends, were turned. The shafts, when examined, were found to be true, besides being finished in good time considering the nature of the turning.



Machinery, N.Y.

PEDRO.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

411. SOLDERING KINK.

When soldering, and no acid is handy, a common tallow candle will answer the purpose. JOHN B. SPERRY.

Aurora, Ill.

412. CHALK PREPARATION FOR TRACINGS.

Mix thoroughly one pound of pulverized chalk with one-quarter pound of borax. Rub some of this mixture into a chamois skin, and rub the tracing carefully with this. This preparation is superior to pure chalk. REX MCKEE.

Joliet, Ill.

413. MARKING FLUID FOR BLUE-PRINTS.

The following receipt for marking fluid for blue-prints has given me satisfaction. The fluid is composed of potassium oxalate, 1 ounce; gum arabic, 1 dram (60 grains); water, 6 ounces; cobalt-blue to color.

Staten Island, N. Y. WILLIAM H. DAVID.

414. CEMENT FOR ARC LAMP CARBONS.

The short ends of old arc lamp carbons may be cemented together to form rods which burn quite well, and are no more brittle than ordinary carbons. The cement required is made by mixing potassium silicate and carbon dust to a consistency of a thick paste. The ends of the short carbon pieces are faced off square, and, after application of the paste, are pressed together by hand. O. G.

415. USEFUL SALVE.

While a great many shops now have facilities for attending to shop accidents, the necessity is often felt by the mechanic working in a small shop, or outside, for a useful salve to be applied to wounds in case of accident. The writer has made the following salve himself, has used it, and knows that it is far in advance of most articles for sale in drug stores at ten times the price. The ingredients are as follows: Two parts of swallow oil, five parts of petrol wax, two parts eucalyptus, and two parts of beeswax. ARDEN.

416. TO REMOVE RUST FROM SMALL STEEL PARTS.

Rust may be removed from small steel parts such as screws, nuts, pins, etc., when they are not badly pitted, by dipping them into a dilute solution of sulphuric acid. To prepare the acid bath, pour the acid little by little into a bowl partly filled with water. After each addition of acid, try one of the rusted parts, and continue trying until the proper strength is obtained to eat the rust off clean. Better results will be obtained in this manner than by working to a set formula. Let the parts remain in the acid bath until cleaned of rust, then remove and wash in soda water, and then in benzine. Finally dry the parts and brighten in sawdust.

S. W. GREEN.

417. PREVENTING SERIOUS RESULTS FROM INJURIES FROM RUSTED OBJECTS.

Everyone knows how a small wound caused by rusty pieces of metal oftentimes develops blood poison, or lockjaw. The following old-fashioned but infallible "first aid to the injured" may therefore be of value to remember. Ordinary brown sugar is heated on the surface sufficiently hot to produce a smoke, and the wound is held in this smoke for several minutes. No serious results will follow after this treatment, and all soreness will be taken out of the wound even though the application takes place some time after the accident. The smoke given off by burning woolen rags is equally effective, and, as they are more often available, particularly to a man "off on a job," to keep this simple remedy in mind may be well worth while. DONALD A. HAMPSON.

Middletown, N. Y.

418. WHITE LEAD AND TALLOW OF EVEN CONSISTENCY AT ALL TEMPERATURES.

In order to keep white lead and tallow soft in winter and summer alike, so that it can be applied with a brush to finished parts of machinery before shipping them, and for use in fitting keys, etc., prepare a mixture composed of five pounds of white lead and fifteen pounds of tallow. Heat this in a suitable receptacle, and stir until the ingredients are thoroughly mixed. Then remove the mixture to a cool place, and add two quarts of linseed oil, continuing to stir the composition until it becomes cold, as otherwise the white lead will settle to the bottom. This mixture will always remain of the same consistency at all temperatures. R. S. F.

419. ZINC PAINT FOR OIL WELLS.

Persons having occasion to paint oil wells of bearings, or any surface coming in contact with either hot or cold oil, will find a zinc paint consisting of 25 pounds oxide of zinc, 3 gallons gloss oil, and 1 quart linseed oil, cut with turpentine, and bleached with ultramarine blue, to be one of the best coverings ever made. The surface to be covered should be absolutely free of all greasy or oily substances; if proper care is taken, the paint will not crack and will retain its pure white appearance indefinitely. The paint can be blown into water jackets of bearings, filling the sand holes, and as it dries rapidly, will be found excellent for the purpose.

ELECTRO.

420. BROWN-PRINTS.

The following solution will change the color of blue-print paper to a dark brown: Borax, 2½ ounces; hot water, 38 ounces. When cool, add sulphuric acid in small quantities until blue litmus paper turns slightly red, then add a few drops of ammonia until the alkaline reaction appears, and red litmus paper turns blue. Then add to the solution 154 grains of red crude gum catechu. Allow this to dissolve, with occasional stirring. The solution will keep indefinitely. After the print has been washed in the usual way, immerse it in the above bath for a period of a minute or so longer than necessary to obtain the desired tone. An olive brown or a dark brown is the result. JOHN B. SPERRY.

Aurora, Ill.

421. BLACK FINISH FOR STEEL.

The pieces to be blackened should first be polished with No. 120 emery cloth. After polishing, the surfaces should be cleaned carefully, and then the work placed over the fire and drawn evenly to a second blue. Then, the work is dipped in lard or sperm oil, from which it is immediately removed, and all loose oil shaken off. This prevents the forming of blisters. An old piece of rubber, for instance a piece of old garden hose, is then placed on the fire, and as it burns, the work is held over the flame and smoke that comes from the rubber, until it is covered with a thick coat of black soot. The work is then removed from the fire, and permitted to cool off slowly. When cool, it is rubbed with an oiled cloth. All this must be done in one heat. E. W. NORTON.

Tarrytown, N. Y.

422. TO SAVE BURNED OR OVER-EXPOSED BLUE-PRINTS.

Blue-prints that have become burned or over-exposed, may be saved by the use of the following formula: Make a saturated solution of bichromate of potash, and keep a supply on hand in the blue-print room. If a print becomes over-exposed, wash it in the usual manner in a tank or tray of water, after which place it in another tray which should contain a mixture of two parts water to one part of the saturated solution of bichromate of potash. Allow the print to remain in the tray containing the solution until it shows a deep blue color and the white lines are clearly defined (which requires but a few seconds), after which the print should be thoroughly washed and rinsed in clear water. The proportion of the bichromate of potash may be increased or diminished as the occasion requires. This solution also acts equally as well when applied to white-prints made from vandyke negatives. Prints, as well as expense, and time, may be saved by the use of the above solution. J. C. HASSETT

Meadville, Pa.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address The latter are for our own convenience and will not be published

TESTS ON CAST IRON CYLINDERS.

J. A. J.—In testing cast iron cylinders used for dryer rolls on paper machines 18 inches diameter, 120 inches long with the heads secured by cap-screws, which is the most severe test, 100 pounds per square inch steam pressure or 100 pounds cold water pressure? 2. Is there any difference in the sizes of the molecules of steam and water?

A.—1. Theoretically the stresses imposed by 100 pounds steam pressure and 100 pounds water pressure are the same, but for the purpose of a test to determine the tightness of the joints, water pressure is to be preferred. Small leaks are easily discernible with water that would escape detection with steam. Moreover, small steam leaks soon "take up," in the parlance of steam fitters, whereas small water leaks close very slowly, the sealing depending on the rusting of the metal. Compressed air is more searching than either water or steam; it will escape through a very minute aperture, and the leaks have no tendency to seal themselves. Water pressure obtained with a pump is more severe on the structure of cast iron than steam pressure because of the water hammer due to the pump action. 2. The chemical combination H_2O exists in three forms, *i. e.*, ice, water, and steam, and it is supposed that the size of the molecule is unchanged in all three states.

MILLING SPIRALS—INVOLUTE SYSTEM OF GEARING.

J. G. I.—1. What is the method of figuring the angle to which to set a universal milling machine table for cutting a given spiral? 2. Is not the involute system for standard cut gears exclusively used?

A.—1. To calculate the angle of the spiral to be milled on a cylinder, the lead of the spiral and diameter must be known. Then the formula is:

$$\text{Tangent } a = \frac{D \times \pi}{\text{lead}}$$

in which a = angle of the tooth with the axis of the gear,

$\pi = 3.1416$,

D = diameter of piece.

For example: What is the angle of a spiral with its axis that makes one turn in 27.22 inches, the diameter being 3½ inches?

$$\text{Tangent } a = \frac{3\frac{1}{2} \times 3.1416}{27.22} = 0.40403,$$

the tangent of 22 degrees.

2. The involute tooth is the form most used in the United States for cut gearing, but it is by no means exclusive. Cast gearing is generally made with cycloidal teeth, and some users of cut bevel gears prefer the cycloidal to the involute system.

TO DRILL SMALL DEEP HOLES—SAND-BLAST FINISH ON TOOLS.

V. A. W.—1. How are oil holes drilled in the so-called oil twist drills used for deep hole drilling? The holes in the samples before me are only about 5/32 inch in diameter and about 8 inches deep. They follow the twist of the flute. 2. How is the beautiful gray color produced on drills and milling cutters that is characteristic of the product of some small tool manufacturers?

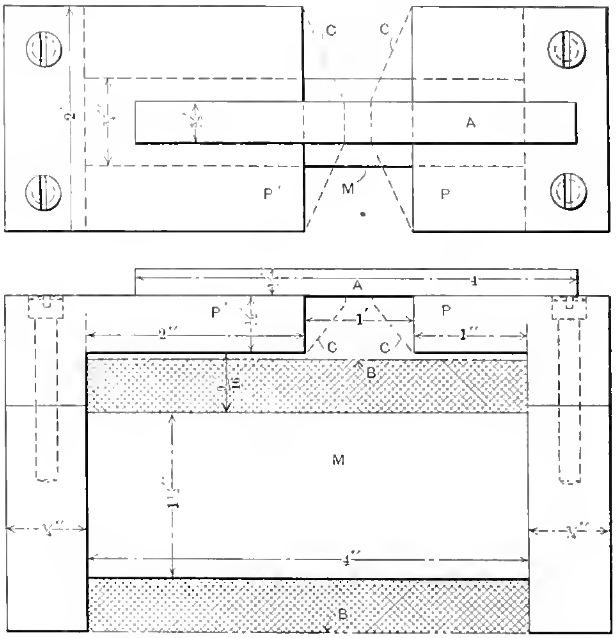
A.—1. The holes are drilled before the drill is twisted, the blanks being rough-fluted, the drill twisted, and then finished in the usual manner. The drilling of the oil holes is done progressively by small twist drills, arranged in order of length, each drill deepening the hole made by its predecessor only ½ or ¾ inch. The hole is begun with a short, stiff drill which starts the hole perfectly straight and true, and the following drills are guided by the section of the hole first drilled. This practice avoids the use of a long slender drill to drill the first part of the hole, and enables the drilling to be done much faster than would be possible otherwise. For a description of this practice in drilling small deep holes in pneumatic hammer handles, see MACHINERY, December, 1902, page 231, engineering edition. 2. The beautiful gray color noted on twist drills, milling cutters, etc., is doubtless produced by the sand-blast process used by some makers to remove the burned oil and oxide resulting from the hardening process. It is merely incidental to this method of cleaning, but because of the beautiful, frosted surface it has a merit of its own. We believe that the same result is also obtained by electrolysis, the tools being suspended in an electric bath. The passage of the electric current removes the oxide and leaves the surface in much the same condition as that produced by the sand-blast process.

CONSTRUCTION OF A MAGNETIC CHUCK.

C. M. W.—Please give me instructions for making a magnetic chuck to hold pieces of ⅜ × ¼ × 4-inch hardened steel for grinding, etc. I wish to use the chuck on an incandescent lighting circuit, and desire to know the size of wire and the quantity required for winding the magnet.

Answered by William Baxter, Jr., Jersey City, N. J

It would not be possible to give all the information you desire without writing an answer that would fill a book. We can say, however, that if the magnet *M* is made of cast-iron or wrought-iron and wound with wire up to the lines *B*, it will hold the steel piece *A* if a direct current is passed through the wire. The force with which *A* would be held against the poles *PP'* would depend upon the kind of metal, the number of ampere turns of magnetizing current flowing around *M*, the distance between the ends of *P* and *P'*, their shape, and the general conformation of the whole structure. The ampere turns are obtained by multiplying the number of turns of wire in the magnetizing coil, by the current strength in amperes. The force with which the poles *P P'* will hold the bar *A* is determined by the aid of the simple formula:



Machinery,N. Y.

$$F = \frac{AB^2}{72{,}000{,}000},$$

in which *F* is the tractive force in pounds, *A* is the area of contact between bar *A* and the poles *PP'* in square inches, and *B* is the magnetic density in lines of force per square inch passing through the surface of contact. To find the force with which *A* is held, all that is necessary is to know the magnetic density *B*. The way in which this is found we cannot give briefly, but you can find it in any good book on electrical engineering. If *M* is made of wrought iron, the pull will be about three times as great as with cast iron, other things remaining equal. If the ends of *PP'* are shaped as indicated by the dotted lines *C*, the pull will be further increased. You could wind the coil with No. 20 B. & S. gage magnet wire, and connect it in series with four or five 16-candle lamps; that is, connect so that the current passes through the lamps and then through the coil. If the wire does not get dangerously hot, and the magnet is not strong enough, connect more lamps in the group, putting the second lot of lamps in parallel with the others.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

A LINE OF ATTACHMENTS FOR THE LEBLOND MILLING MACHINES.

The R. K. LeBlond Machine Tool Co., 4609 Eastern Avenue, Cincinnati, Ohio, builds a line of milling machines which is well known to the readers of MACHINERY. To extend the usefulness of these milling machines over as wide a range of work as possible, the builders have designed a very complete and ingenious line of attachments. We show herewith half-tones and line drawings of these various attachments, together with numerous illustrations showing their application to general shop work.

Worm and Spur Gear Hobbing Attachment.

The device shown in Figs. 1, 2 and 3 is designed particularly for the hobbing of worm-gears, but, as will be explained later, can be used for spur gears as well.

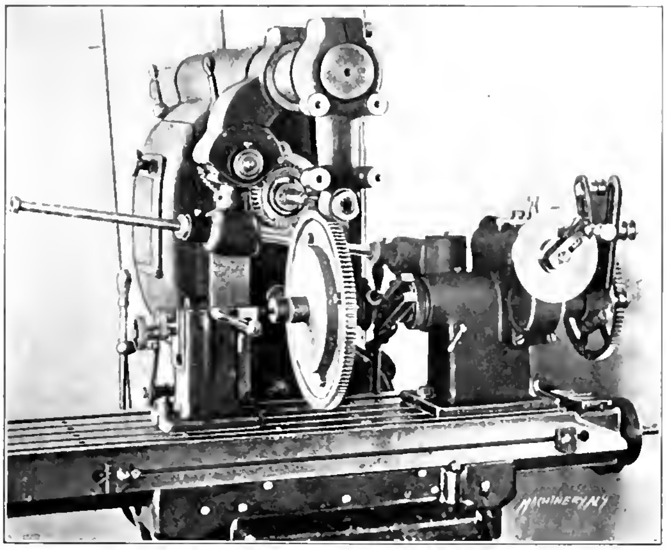


Fig. 1. Hobbing Attachment for the LeBlond Milling Machine Cutting a Larga Worm-wheel.

The head- and foot-stocks of this arrangement are those of the builder's standard plain dividing head, the attachment itself consisting of means for connecting (through the index worm or directly as required) the spindle of this dividing head by change gears with the spindle of the machine, in such a way as to give the required ratio of rotation between the hob and the wheel. This connection is made through a flexible transmission system consisting of bevel gear joints and a splined shaft, which permits absolute freedom of adjustment between the index head and the spindle. On the threaded nose of the latter is screwed a spur gear, meshing with a corresponding gear on a short spindle, supported by a bracket clamped to the over-hanging arm of the machine. This short spindle carries a bevel gear meshing with a mate keyed to a short vertical shaft from which the splined shaft is driven, through another pair of bevels. The connections from these through to the back side of the head can be readily followed by comparing Figs 1 and 2, where the machine is shown in two different adjustments, to each of which, as will be seen, the arrangement readily adapts itself.

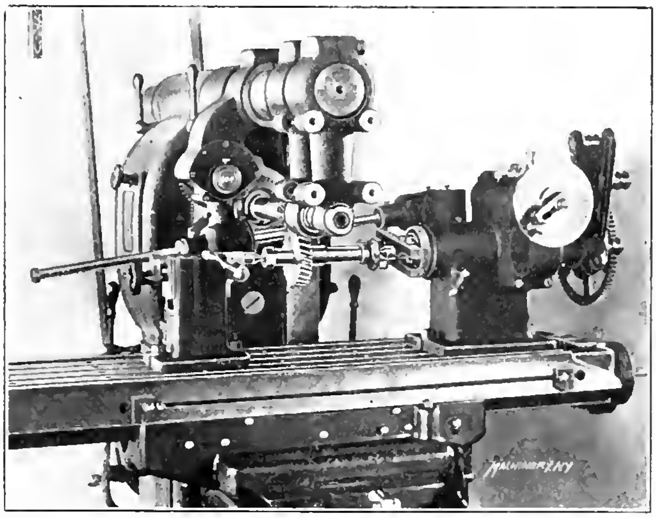


Fig. 2. Cutting a Small Worm-wheel with the Change Gearing Directly Connected to the Work Spindle.

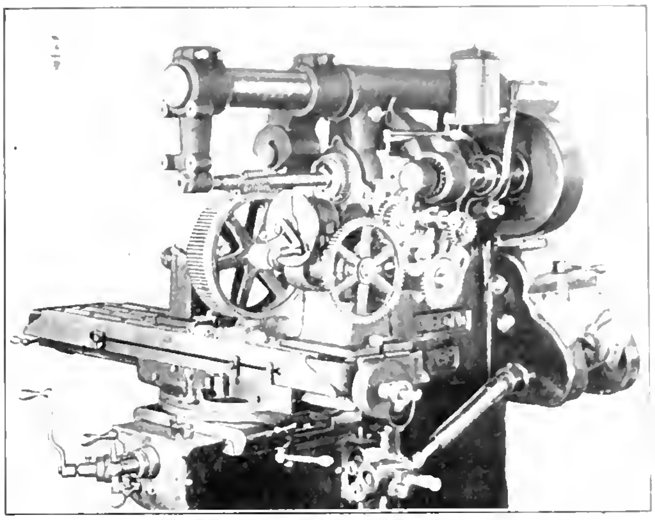


Fig. 3. Hobbing a Spur Gear with the Hobbing Attachment on a Universal Milling Machine.

The quadrant carrying the change gears for obtaining the desired ratio between the cutter and work spindles is best seen in Fig 3. The driving connections are so arranged that the driving shaft from the change gears can be connected either directly to the spindle for cutting wheels of few teeth, or through the indexing worm and worm-wheel for large numbers of teeth. In Fig. 1 the attachment is set up for hobbing a worm-wheel having many teeth, so the connection is made through the index worm of the dividing head. In Fig. 2, on the contrary, a worm-wheel of few teeth and for a multiple threaded worm is being hobbed, so the ratio of rotation is too high to be conveniently transmitted to the worm gearing. Under ,these conditions the change gearing is attached directly to the work spindle.

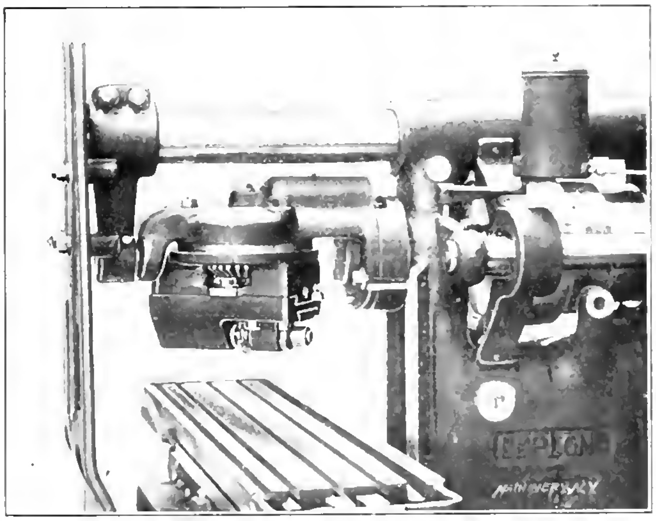


Fig. 4. Universal Spiral Gear Cutting Attachment.

The advantages of the positive method of hobbing worm-wheels are well known. The positive connection between the wheel and the hob makes unnecessary the preliminary gashing of the former, and so materially reduces the time and cost of doing the work. In some cases it may be done in from one-fourth to one-fifth of the time required for the method which combines gashing and hobbing on a freely running work spindle. A very fine feed is provided, and the work can

be fed into the hob automatically and tripped when the teeth have been cut to the proper depth.

The worm-wheel shown in Fig. 1 has 120 teeth, 0.390 inch circular pitch, and is a trifle over 15 inches in diameter. The coarse pitch worm-wheel in Fig. 2 has 26 teeth, 6 pitch, quadruple thread, and is 2 5/8 inches diameter. This gives a ratio of 6½ to 1, requiring the change gearing to be connected direct to the spindle, as explained. The gears are hobbed complete in 12 minutes apiece, with power feed.

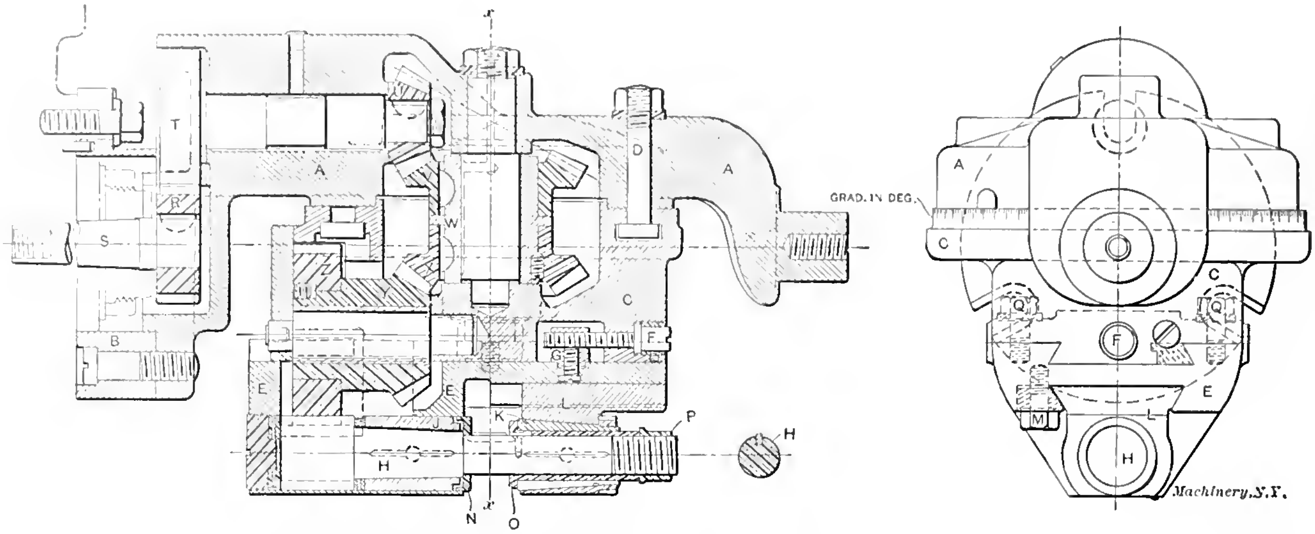


Fig 5. Details of Construction of the Spiral Gear Cutting Attachment.

Perhaps the most interesting use of this attachment is for the cutting of spur gears by the hobbing process. This process has been previously described in MACHINERY,* and the principle of its operation fully explained. It requires simply that a suitably shaped hob be rotated in the proper ratio with a spur gear blank, and fed through it at a suitable speed, the hob being set to cut teeth to the correct depth. The hob must also be set at the helix angle of its thread, as measured on the pitch line, if it is to give the proper shape to the teeth of the gear. It will be seen that this attachment, as described and shown in Figs. 1 and 2, furnishes the required movements and adjustments, except for the setting of the hob at the helix angle. To accomplish this, it is only necessary to use the device on a universal machine, as shown in Fig. 3, bringing the table around so that the work and the hob are in the proper angular relation to each other. Under these circumstances, with the hob set at the proper depth and the proper change gears mounted in place, the hob may be started at one edge and fed through, finishing the work complete at one passage. This method of cutting spur gears has the well-known advantages of cutting all numbers of teeth for a given pitch with a single hob, and of giving a large output, owing to the fact that the cutting action is continuous, and does not require the return of the cutter and the indexing of the blank, as is required by the usual method of performing this work on the milling machine or automatic gear-cutter.

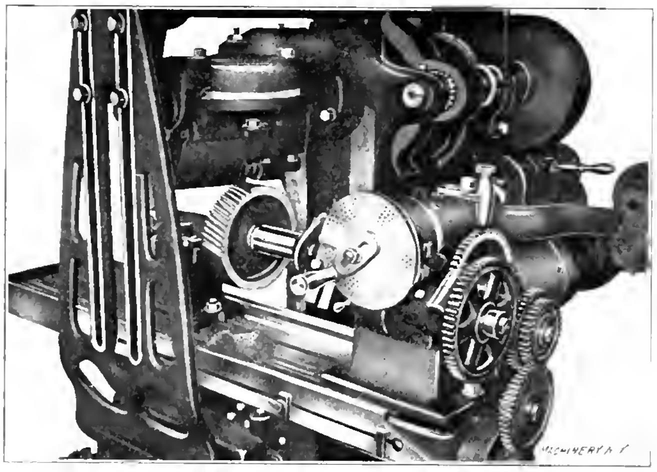


Fig 6. Cutting a Spiral Gear of Large Diameter and Large Lead.

A set of compound gears is furnished for reducing the feed in the ratio of about 20 to 1. The reason for requiring this very fine feed is that the advance of the cutter per revolution should be in proportion to the number of teeth of the gear. For instance, in cutting a spur gear with 60 teeth, if we wish to feed the work past the cutter at 0.060 inch per revolution of the work, it will be necessary to set the feed to equal 1/60 of this amount or 0.001 inch, per revolution of the cutter.

The spur gear being hobbed in Fig. 3 is 8 pitch 102 teeth. The capacity of the device is for work up to 16 inches in diameter, the spur gears and worm-gears alike.

Universal Spiral Gear Cutting Attachment.

There are two noticeable points of difference between the universal spiral gear cutting attachment shown in Fig. 4, and most other attachments which have been built for the same purpose. One of these differences is the fact that in this case the cutter is mounted so that it can be centered on the vertical axis about which the angular adjustment is effected. This being the case, the work may be centered with the cutter, which is then swiveled to any angle desired throughout the whole 360 degrees, without requiring recentering. The other feature of the construction, plainly evident in Fig. 4, is the manner in which the supporting head of the device has been off-set vertically, so as to raise the cutter nearer the center line of the spindle, and thus increase the maximum vertical distance obtainable between the top of the table and the bottom of the cutter. If it were not for this offset and for the change in the method of driving required by it, the capacity of the machine under the cutter for work mounted on the table or on centers, would be materially reduced.

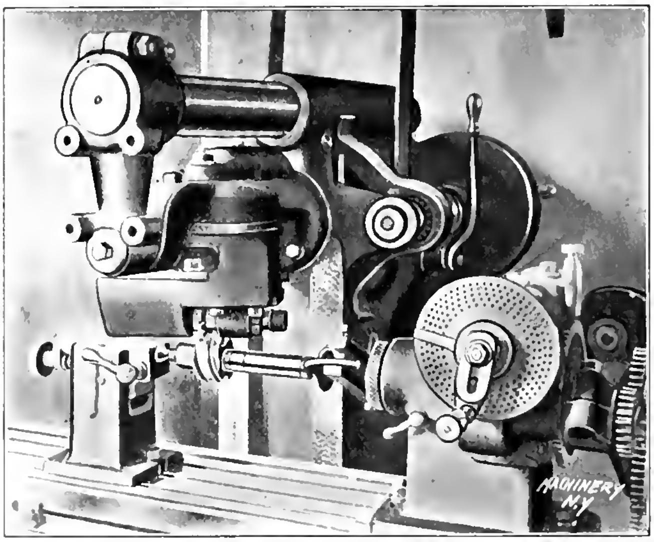


Fig. 7. Cutting a Spiral of Short Lead on the Plain Milling Machine, an Operation Impossible on the Universal Machine without Special Attachments.

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* See [illegible] Cutting Machinery, March, 1908, issue of MACHINERY.

The mechanism of this device is best understood by reference to Fig. 5. The body *A* of the device is clamped, through collar *B*, to the front of the column at the end, and is provided at the other, or outer end, with a bearing entering the hole in the outer support for the arbor (see Fig. 4). The attachment thus does not have to depend entirely on its own rigidity in supporting the cutter, but has the additional stiffness of the over-hanging arm to depend on. To *A* is clamped the swivel base *C*, by means of bolts *D* entering a circular T-slot in its outer face. This arrangement provides for the adjustment of *C* to any angle throughout a full circle about the vertical axis *xx*. It is centered on its seat in *A* by means of the internal shoulder shown. The exterior surface, as seen at the right, is graduated in degrees to indicate the setting obtained. Dovetailed to *C* on horizontal guides is the spindle head *E*. The adjustment along the slide is effected by shoulder screw *F*, seated in *C*, and nut *G*, clamped to *E*. This adjustment provides for the centering of the cutter on *xx*, the axis of angular adjustment.

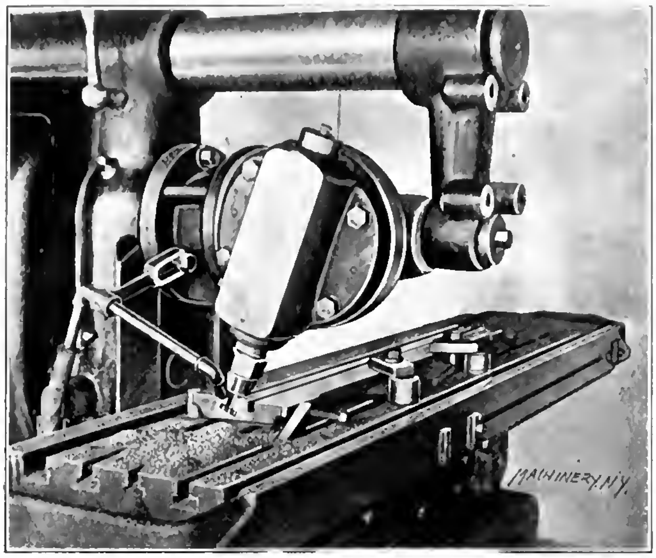


Fig. 8. The Universal Milling Attachment cutting an Inclined Slot.

The main bearing of the spindle *H* is tapered ⅝ inch to the foot, and runs in a bronze bearing *J*, fast in head *E*. An outboard bearing *K* is also provided. This is tapered and is drawn by the nut shown into a taper seat in the removable bearing support *L*. This bearing, which is thus adjustable for wear, is removed bodily with *L* when changing cutters. For this purpose *L* is mounted in a dove-tail slide on the under side of spindle head *E*, being clamped there by bolt *M*. The cutter is clamped between collar *N* and the flange on sleeve *O*, which latter is pressed against the cutter by nut *P* at the outer end of the spindle. For locking the horizontal adjustment of *E*, used for centering the cutter, bolts *Q* and *Q* are provided.

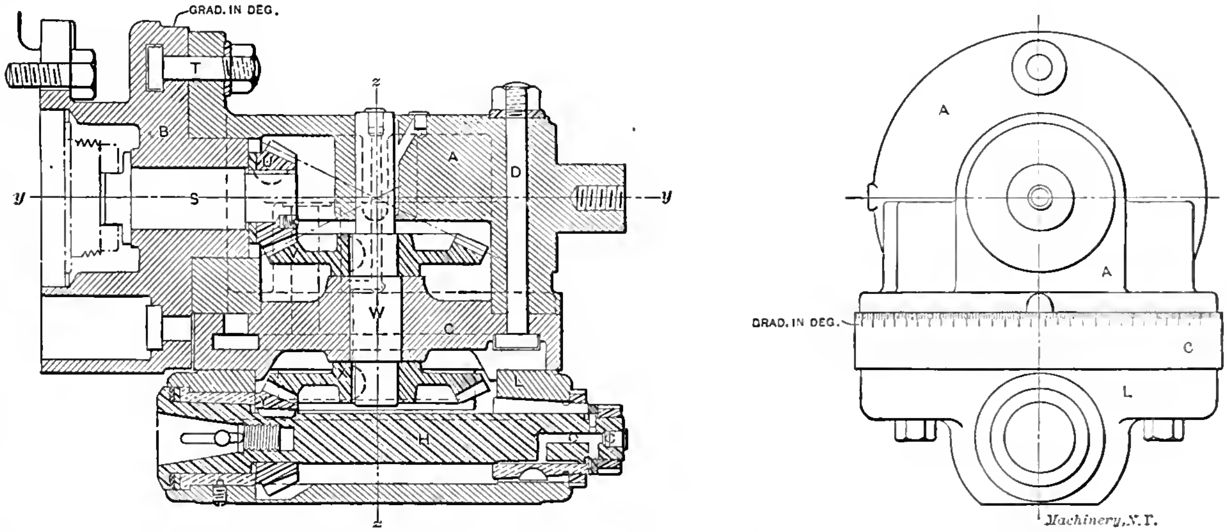


Fig. 9. Details of Construction of the Universal Milling Attachment.

The drive is taken from the main spindle of the machine through a pinion *R*, keyed to a taper shank *S*, driven into the spindle hole. This meshes with a gear *T*, which has a shaft integral with it journaled in casting *A*, and carrying keyed to it at its outer extremity bevel pinion *U*. This pinion meshes with bevel gear *V*, keyed to bronze sleeve *W*, to which is also keyed another bevel gear *X*. This sleeve revolves on the stud about whose axis the angular adjustment of *C* on *A* takes place. Bevel gear *X* mates with bevel gear *Y*, which is bronze bushed and revolves on a stationary stud. On the shank of *Y* is doweled gear *Z*, which engages pinion teeth cut at the left-hand end of spindle *H*. The teeth of *H* are made of sufficient length to provide for the longitudinal adjustment of the head *E* when centering the cutter. It will be seen from the end view that the bottom of the spindle head is flattened off as close as possible to the outside diameter of the driving pinion, so that the cutter may project beyond all parts of the attachment far enough to do such work as rack cutting, if required.

Two examples of the use of this attachment are shown in Figs. 6 and 7; in both of these cases a plain milling machine is used in combination with the same plain indexing head to which the hobbing device is shown attached in Figs. 1, 2 and 3. This combination of plain index head and spiral gear cutting attachment converts the plain milling machine into one of the universal type. In Fig. 6 a spiral gear of large diameter and small helix angle is being cut, so the head is set at but a slight angle from a position parallel with the spindle of the machine. As may be seen, the head is connected by change gears with the table feed screw, the same as for the universal arrangement. In Fig. 7 the attachment is shown performing work which the universal milling machine is incapable of doing except with special appliances. This work is the cutting of spiral gears of such large helix angle (or, in other words, of such short lead) that it would be impossible to swing the table through the required angle, thus necessitating the use of a right angle drive for the spindle, or the doing of the work with the vertical milling attachment. The possessor of the plain indexing device and this spiral gear attachment, therefore, is in some respects better equipped for

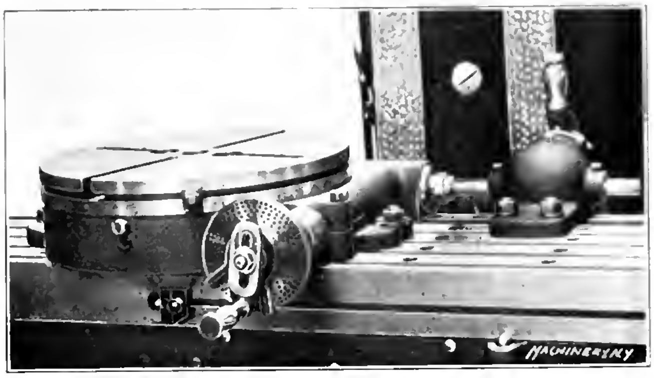


Fig. 10. Circular Milling Attachment with Automatic Feed and Throw-out.

spiral work than if he had a milling machine of the universal type. He is not, of course, able to do either indexing or spiral cutting on taper work, but otherwise he is provided for. This attachment may also be conveniently used for thread milling.

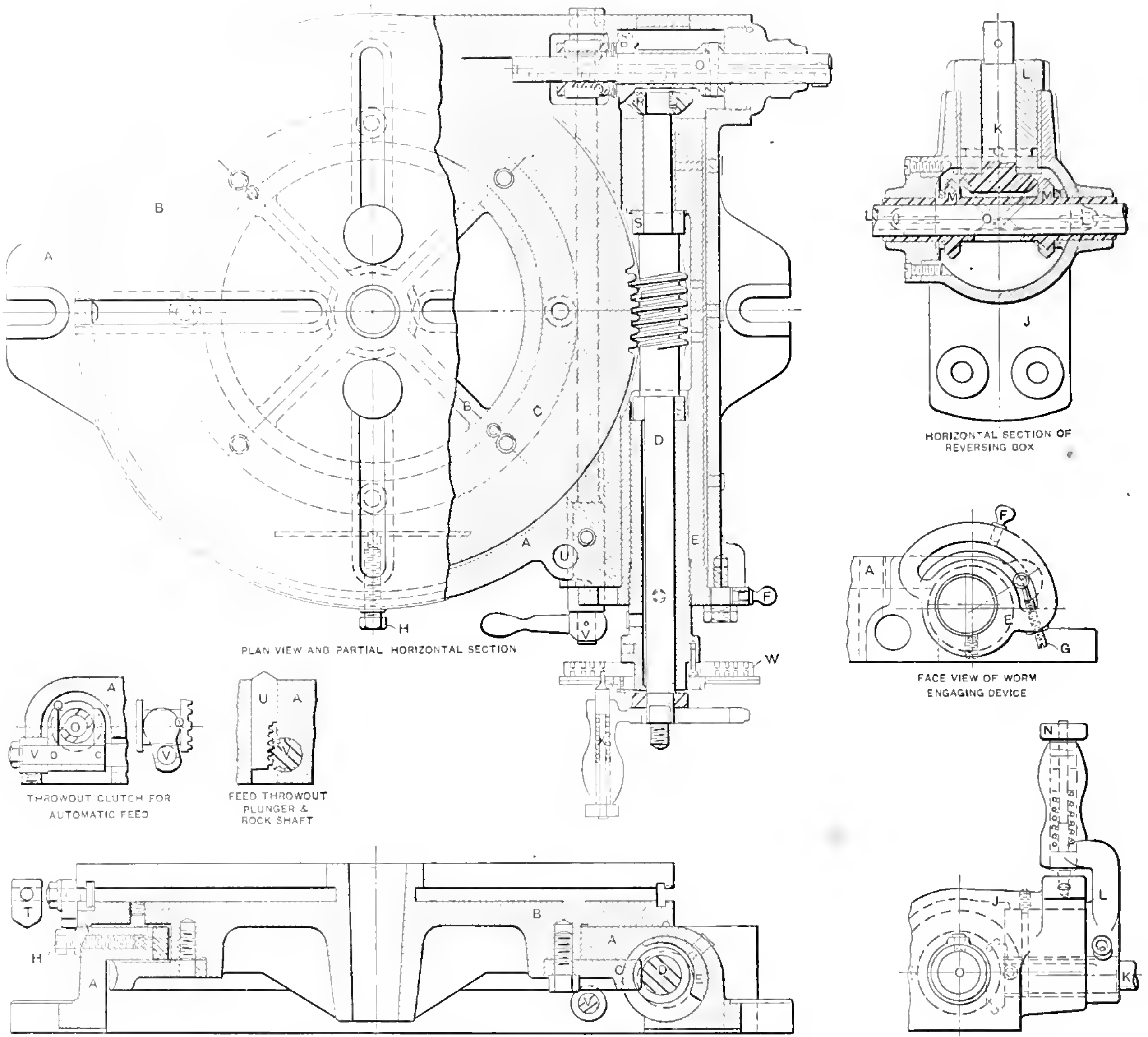
Universal Milling Attachment.

The universal milling attachment shown in operation in Fig. 8 and in detail in Fig. 9 is of something the same construction as the spiral gear cutting attachment, though it is built for a wider range of work, and so differs in the details of its construction. As may be seen in Fig. 8, the cutter is mounted in a taper hole at the end of the spindle, instead of centrally between two bearings, as in the previous attachment. No end movement is provided for the spindle, and there is no necessity for keeping the distance from the center line of the spindle to the face of the spindle bearings down to a minimum, as the work required of the device is mostly in the nature of end milling, or other operations in which this clearance is not vital. These considerations simplify the design of the device. An additional movement is provided, however: an adjustment at any angle throughout the whole circle, about the axis of the main spindle of the machine.

In Fig. 9, *A*, the main body of the device, is supported at the outer end by the over-hanging arm as in the previous case, while at the other end it is fastened to a flange *B*, which is in turn made fast to the face of the column. Bolts *T*, entering the circular T-slot in *B*, provide for clamping body *A* in any angular position about axis *yy* of the machine. Swivel plate *C* is clamped to *A* by bolts *D* entering the T-slot in the former, so that the spindle head L, which is fastened to *C*, may be adjusted at any desired angle about axis *zz*. Graduations in degrees are provided for both of the swivel movements with which the spindle is thus provided.

The device is driven by a short shaft *S*, having a tongue on its inner end entering the slot cut in the nose of the spindle. Bevel gear *U*, keyed to the outer end of *S*, engages bevel gear *V* keyed to shaft *W*, which latter is journaled in body *A* and swivel base *C* of the machine. The lower end of *W* has keyed to it bevel gear *X*, meshing with bevel gear *Y* on the spindle, which is thus revolved at the same rate of speed as the main spindle of the machine. It will be seen that the drive is simpler than in the case of Fig. 5, partly because the offset to give increased working range in the device is not required, and partly because the drive of the spindle is less restricted, so that a direct bevel gear drive may be used in place of the spur gearing of the previous attachment. The spindle *H*, shown in Fig. 9, is provided with a special taper for a collet with a threaded shank. It will also be furnished with a regular No. 7 Brown & Sharpe taper having a hole for a through bolt, to be used in drawing the taper shanks to their seats or ejecting them for removal.

In Fig. 8 the attachment is shown engaged in milling an angular T-slot, the work shown being the table of the cutter and reamer grinder built by the same firm. Other operations for which it is adapted are for such a variety of work as drilling, key-seating, and milling of spirals of too great an angle to be done with a cutter driven directly by the main spindle of the universal milling machine. Special conditions are readily met, the device often obviating the necessity for angular mills, since the spindle can be swiveled to any angle of the horizontal or vertical plane. It will be noted that the



PLAN VIEW AND PARTIAL HORIZONTAL SECTION

HORIZONTAL SECTION OF REVERSING BOX

FACE VIEW OF WORM ENGAGING DEVICE

THROWOUT CLUTCH FOR AUTOMATIC FEED

FEED THROWOUT PLUNGER & ROCK SHAFT

VERTICAL SECTION ON CENTER LINE

Machinery,N.Y.

PARTIAL ELEVATION OF REVERSING BOX

Fig. 11. Details of Construction of the Circular Milling Attachment and its Feed Connections.

front bearing is tapered 3/8 inch per foot, with a hardened and ground journal. The rear bearing is straight, and is adjusted by drawing in the split taper bushing.

Circular Milling Attachment.

Fig. 10 shows a circular milling attachment with automatic feed and throw-out, which is adapted to be used especially with a vertical attachment such as shown in Fig. 12, for the finishing of all kinds of cylindrical surfaces, on work which can be conveniently held on a circular table.

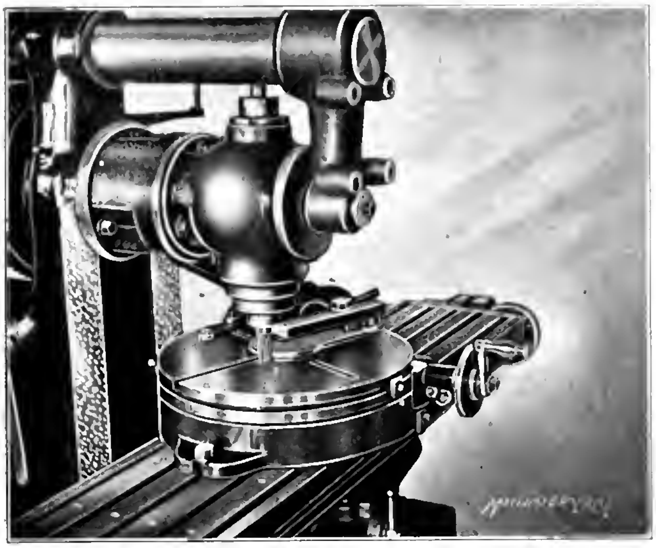


Fig. 12. Use of the Circular Milling Attachment in Finishing Straight and Circular Surfaces.

The details of this device are shown in Fig. 11. The circular base of the device, A, is clamped to the milling machine table. Table B rests on base A and is centered with it by a circular rib which closely fits a machined circular opening in the top of A. To a seat in this circular rib is clamped worm-wheel C, which, in combination with worm D, forms the means for revolving the table, and at the same time serves as a gib for drawing B down to its bearing on A. The center of B is provided with a tapered socket for convenience in holding arbors or studs for centering work, and other special uses. The extended hub provided for this taper hole is connected by ribs with the body of the table, so as to make the whole very rigid, and able to resist distortion due to the clamping of the work on its upper surface, without cramping the table on its guiding surface.

Worm D may be operated by a crank and index plate at the outer end, of the same kind as used on the builder's standard dividing head, thus permitting the dividing of work clamped to the table with the same facility. Graduations in degrees are also provided on the outside diameter of the table, so that angles may be conveniently laid out without the use of the index plate. For a quick movement of the table, the worm may be thrown out by an eccentric device, not shown in Fig. 10, but incorporated in the later design shown in the line engraving, Fig. 11. This consists of an eccentric sleeve E in which the worm and worm shaft are mounted. By rocking this by means of knob I, the worm may be thrown into or out of engagement at will. A stop screw G on the sector flange of the eccentric limits the inward movement to give the proper amount of play to the worm, and a clamp nut at the same point furnishes means for retaining it in either the in or out position. A set-screw H, at the front of the base, bears against a thin strip of the bearing of the table, which has been separated from the remainder of the base by the saw cut shown. This provides means for clamping the table in position while the cut is being taken, either for the rapid indexing with the worm thrown out, or for hand indexing through the worm and dividing plates.

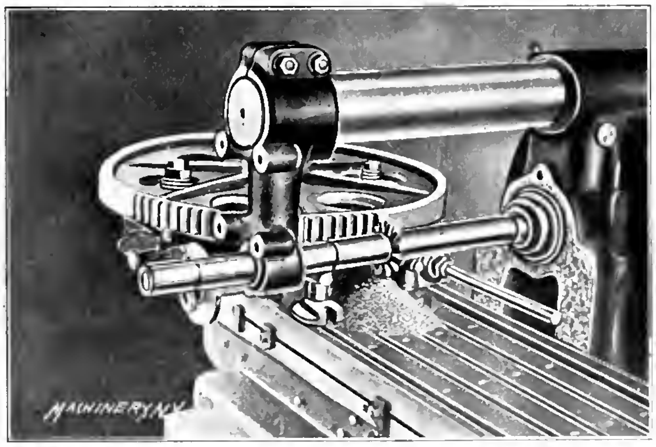


Fig. 13. Using the Circular Milling Attachment as an Indexing Device for Cutting a Large Gear.

The power feed for the device is obtained from the gear box without interfering with the regular transverse, cross, and vertical feeds, so that either of these may be used on the pieces without having to be disconnected for the circular feed. This makes it possible to finish very conveniently parts that have both plain and cylindrical surfaces to be milled. A telescopic feed rod is provided, leading from a shaft held in a bracket on the side of the column of the machine, and connected by chain and sprocket wheels with the shaft on the feed box. This telescopic shaft is connected with reversing gear box J, clamped on the milling machine table. The bevel gear and its shank K to which the telescopic shaft is pinned are seated in an eccentric bushing L, which may be rocked by means of lever N. Feed shaft O leading from the circular attachment, passes through reversing box J and is keyed to sleeve M, on which are formed a pair of bevel gears. The drawing shows lever N in its central or vertical position, in which bevel gear K is out of mesh with the gears on sleeve M. By throwing lever N to one side or the other, eccentric sleeve L is rocked and bevel gear K is thrown into engagement with one or the other of the two bevel gears M, thus giving motion in either direction to feed shaft O, as required.

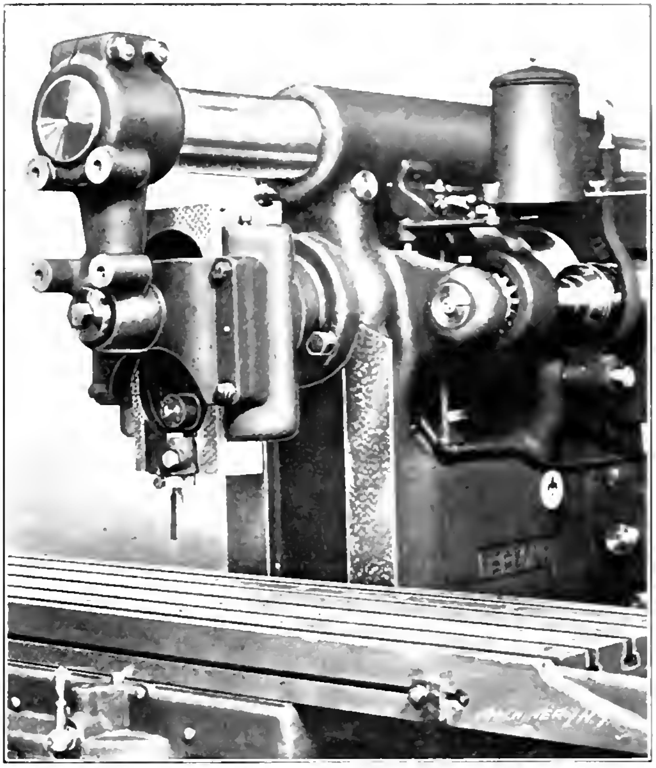


Fig. 14. Attachment for Slotting in the Milling Machine

Shaft O is connected with bevel gear P by means of clutch Q, which is operated by a long rock shaft V, connected with a handle at the front of the base. By means of this handle, the automatic feed is stopped and started. Bevel gear P meshes with a mating gear R on worm-shaft D, thus completing the connection required for the automatic feed. S and S are ball bearings to take the thrust of the worm, thus making the operation of the feed easy even under the heaviest cuts. For cases in which the indexing is not required, a hand-wheel is used on the upper end of shaft D in place of the index crank, thus making either the power or hand operation of the device equally easy. The periphery of the circular table

is provided with a T-slot in which is clamped adjustable tripping dog *T*, which may be set to depress plunger *U* at any desired point, thus rocking rod *V* and automatically throwing out the feed.

The design of the device is very compact so that the vertical capacity of the machine is not unduly reduced by its use. Figs 12 and 13 show two examples of its use. In the first case a piece of work which requires both straight and circular milling is clamped to the table, giving a good opportunity for the use of longitudinal and circular feeds in succession, as provided for by the independent connections previously mentioned. The vertical milling attachment, built by the same makers, is employed in this case. Most of the work for which the circular attachment is adapted is best done with the vertical attachment. In Fig. 13, however, is shown a case in which the cutter is driven directly by the main spindle, and the attachment is used primarily for indexing. This case is the cutting of a large gear—too large to be swung in any index centers, and so large that even if it could be swung, the cutting point would be so far above the bearing surface of the table that heavy cuts could not be taken. Arranged as shown, the pressure of the cut is vertically downward, and it may be supported, if required, by a rim rest clamped to the platen. The large diameter of worm-wheel provided is especially suited for indexing work of this character. The wheel is centered by a plug or arbor driven in the taper hole bored in the center of the table.

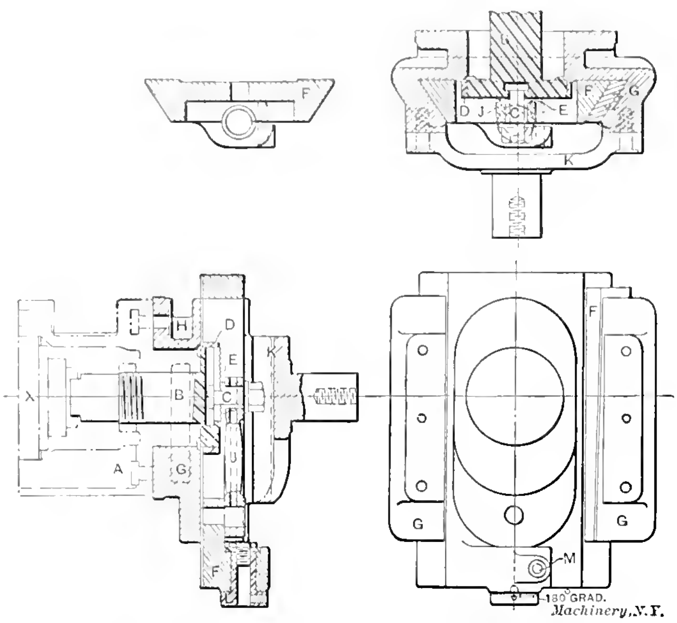


Fig. 15. Details of Construction of the Slotting Attachment.

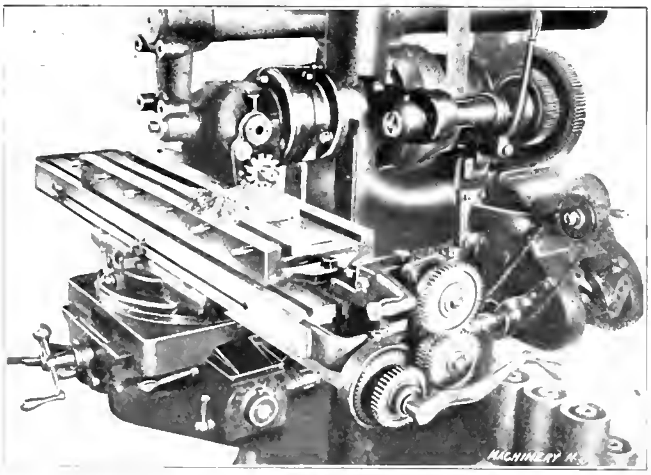


Fig 16 Change Gear Attachment for Spacing in Rack Cutting and Similar Operations.

Slotting Attachment.

The exterior of a slotting attachment for the milling machine is shown in Fig. 14, and its details are indicated in the line drawing Fig. 15. The special features of this attachment are that it can be swiveled through an angle of 360 degrees, that it is supported by the outboard bearing, and that the stroke is adjustable. It thus has a stiffness and a range of action which should make it a very useful device for such work as die making, light manufacturing, etc.

A flanged cap *A* is bolted to the face of the column. This cap has a bearing for crank-shaft *B*, whose inner end is provided with a tongue fitting the groove in the face of the nose of the spindle. The face of the crank disk is slotted for the head of bolt *C*, and has a ring *D* shrunk on it to prevent the bolt from escaping. Fitted over *C* is the bushing *E*, which serves as a crank-pin. The flange of this bushing where it rests on the face of the crank disk is serrated, to match corresponding serrations on the disk. By this means the crank may be adjusted for different lengths of stroke, with the assurance that the adjustment will not slip under any conditions of service. The tool slide *F* is gibbed in a swivel guide *G*, which may be adjusted to any angle about axis *x-x*, and clamped in the required position by bolts *H* entering the T-slot in base *A*. The tool slide is operated from the crank by connecting-rod *J*. The construction of the tool slide and the way in which it is gibbed to *G* will be best understood from the upper sectional view of the figure. A saddle *K* is bolted to the face of *G*, and is provided with a pivot which enters the hole of the overhanging arm, thus supporting the whole arrangement very firmly. The tool itself is held in bushing *L*, whose flange is graduated in degrees, so that the cutting edge may be revolved and presented to the work at any angle required. The bushing is clamped by bolt *M*, which locks it on the split hub principle. The gib between *G* and *F*, it will be noticed, is provided with a tongue fitting a groove in *G* to keep it in position. It is tapered and so is adjustable for wear.

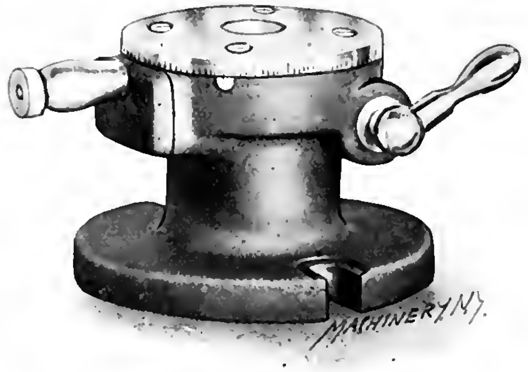


Fig. 17. Vertical Index Head for Slotting Screws, Finishing the Heads of Bolts, and for Similar Work.

Rack Spacing Attachment.

For rack cutting either the universal milling attachment or the spiral gear cutting attachment (both previously described), or the regular rack cutting attachment built by this firm, shown in Fig. 16, may be used. The work, if short, may be held in a regular milling machine vise, or if longer, in a special rack cutting vise such as shown. For indexing the table longitudinally, a new attachment is provided. This attachment, which involves the use of change gears, obviates the necessity for reading graduations on the collar for spacing the teeth. The device consists of a bracket bolted to the table and carrying a quadrant, on which the necessary change gears may be mounted to connect the feed screw and the locking disk. This locking disk is made in two sections and is reversible, one side containing two notches and the other one, for spacing whole or half revolutions. Fifteen change gears are furnished for spacing, giving all diametral pitches from 3 to 6 by half pitches, from 6 to 16 by whole pitches, and from 16 to 32 by even pitches. Circular pitches from 1/16 inch to 1/2 inch by 1/32 inch, and from 1/2 inch to 1 inch by 1/16 inch, are available.

In Fig. 16 will be seen the supplementary connection mentioned as being used for driving a telescopic shaft for the circular attachment, independent of the regular table, saddle and knee feeds. As stated, it consists of a pair of sprocket wheels and a chain, of which the driven member is supported by a special bracket, and drives the outer end of the telescopic shaft.

Vertical Index Head.

The half-tone, Fig. 17, and the line engraving, Fig. 18, illustrate a vertical index head which will be found convenient for such work as cutting clutches, milling the heads of screws, and taking other cuts of a similar nature. The spindle *A* is of steel, and has a tapered bearing in the base *B*, in which it is held by the nut *C*. The latter is split and provided with a lock screw to maintain the adjustment. The upper end of the spindle is provided with a large flange which covers the end bearing at the top of the base, and protects the index ring *D* from chips, oil, etc. This index ring is fastened to the flange of the spindle by screws and dowels, and is locked by bolt *E*. Handle *F* operates a clamp bushing, made on the plan commonly used for holding tools in place in the screw machine turret. In indexing the work, handle *F* is unlocked to release the spindle, lock bolt *E* is pulled out, and the spindle, by grasping the flange or the work, is revolved to the next indexing point, where the lock bolt is allowed to drop in place again. The spindle is again clamped by handle *F* and a new cut is taken. Twenty-four notches are provided in the index ring, so that 2, 3, 4, 6, 8, 12, and 24 divisions may be obtained. The spindle has a No. 11 Brown & Sharpe taper hole, in which may be driven the shanks of chucks, threaded arbors, studs, etc., for holding the work. The whole attachment is very rigid and capable of performing severe service.

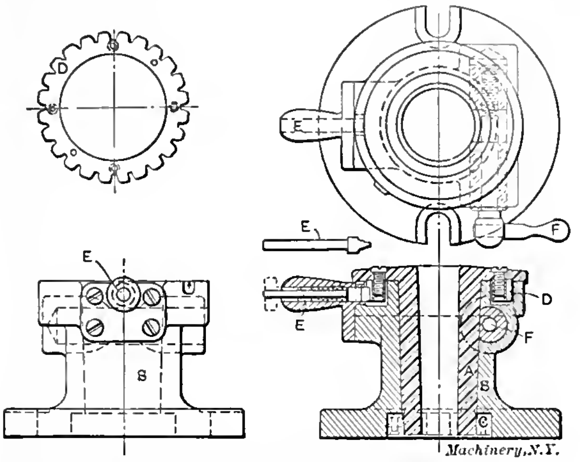


Fig. 18. Elevation, Section and Plan, showing Construction of the Vertical Indexing Head.

KEY-SEATING ATTACHMENT FOR SHAPERS AND PLANERS.

In Fig. 1 is shown a key-seating attachment built by the Cincinnati Shaper Co., Cincinnati, Ohio, attached to a shaper of the same make. The attachment consists of a knee with floating jaws for holding the work, and a cutter bar provided with means for feeding and relieving the cutting blade, and for attachment to the tool-post of the shaper. Special attention has been given to the matter of quick acting and secure means for holding the work, and convenient and strong mechanism for controlling the adjustment and relief of the blade. Owing to the rapidity of manipulation possible and to the fact that the cut is taken on the drawing stroke, the output of the device is very high.

Description of the Attachment.

The holding arrangement for the work, as is best seen in the line drawings, Figs. 2 and 3, consists of a knee *A*, provided with ways, in which jaws *B* and *B* are drawn together by the right- and left-hand screw *C*. A bushing, *D*, is provided, having a flange seated in a counterbored recess in the knee *A*, and having an outside diameter closely fitting the bore of the work in which it is desired to cut the keyway. In clamping the work in place, it is simply slipped onto *D* and screw *C* is tightened to bring the jaws *B* up against the work, which may be either rough or finished, without altering the conditions under which the work is held, since it will be seen that the gripping points are of the "floating" variety, adapting themselves to any surface or dimension presented. When so held, the work is located on the bushing *D*, by the bore, so that the key-seating is assuredly true with the hole.

The cutter bar *E* passes through an eccentric hole cut in bushing *D*. It is clamped to the head of the ram through a universal joint at *F*, the connection being made by a screw *G*.

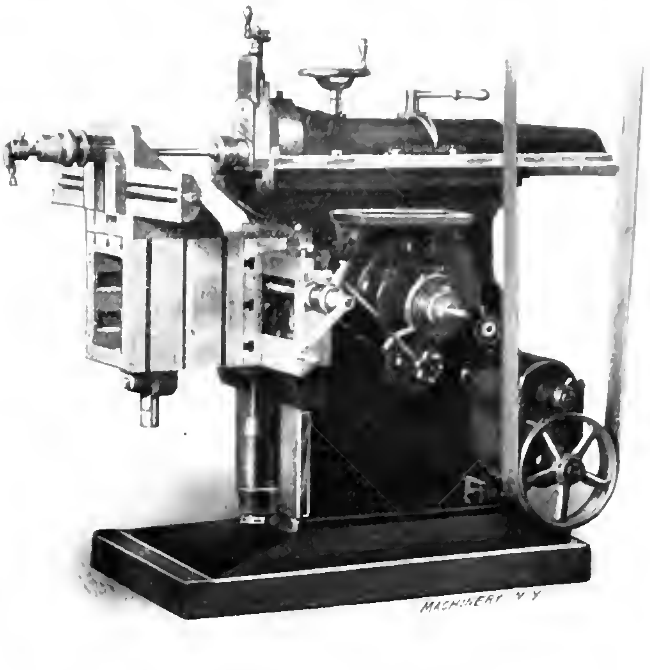


Fig. 1. Key-seating Attachment applied to Cincinnati Shaper

Provision is made in this universal joint to prevent the cutter bar from rotating. The cutter *H* is made from a simple block of tool steel, with a cutting edge formed to give clearance and top rake. It fits loosely in a slot cut through the bar as shown. A groove is cut across the rear edge, engaging the eccentric pin formed on the end of feed rod *J*. (The small details shown will assist in getting an understanding of these various parts.) By means of feed rod *J* the cutter is fed downward and relieved on the back stroke, since any rocking movement imparted to it effects a vertical movement of *H*. A slot, of course, is cut in the bottom of bushing *D*, as shown in the detailed section, to permit the cutter to project through into the work. A corresponding slot is formed in the cutter bar itself to give clearance room for chips.

Feed rod *J* extends to the front end of the cutter bar, where it is keyed to lever *K*, by means of which the operator controls the cross movement of the cutter. A screw *L*, entering a recess in *J*, prevents it from being shifted longitudinally. An eccentric *M* is keyed to an extended hub on bar *E*, and projects over a hub of corresponding diameter on lever *K*. Screw *N* has a projecting pin which enters a groove cut in the periphery of the hub *K*, thus tying it to eccentric *M*, while still permitting it to revolve. *M* and *K* may thus be pulled off of *E* and *J* respectively, to which they are keyed, and

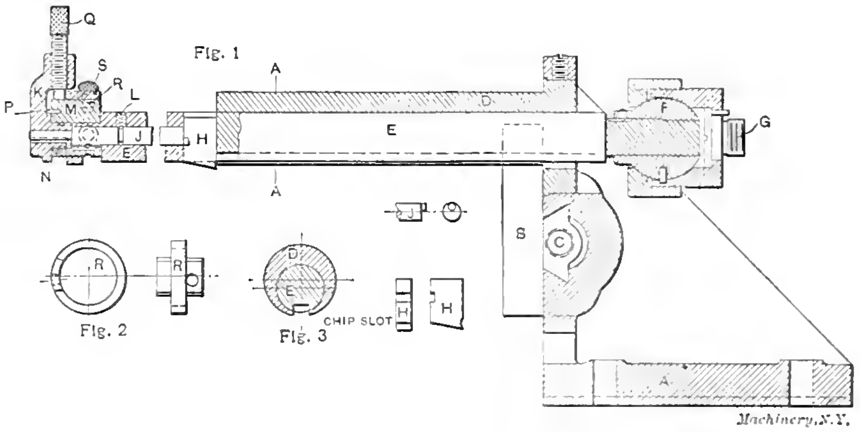


Fig. 2. Section through Cutter-bar of Key-seating Attachment.

replaced if desired, being handled as a single unit. *M* is fastened to *E* by a set screw *O*, when the device is in operation.

The movement of *K* may extend through an arc of 180 degrees. In the upright vertical position shown, cutter *H* is extruded to the limit of its movement. If *K*, in Fig. 3, were swung vertically downward toward the right, *H* would be withdrawn to the limit of its upper movement. The swinging of *K* in a downward direction is limited by the striking of a projection on its hub against stop pin *P*, driven in eccentric *M*. The upward movement is limited either by the striking of the point of adjusting screw *Q* against the periphery of eccentric *M*, or against the projection on adjustable stop collar *R*, which may be clamped in any desired position on *M* by thumb-screw *S*.

Method of Operating.

Having thus described the mechanism, we are able to follow the method of operating the device. First, lever *K* is turned around 180 degrees from the position shown, to its lower vertical position, thus entirely withdrawing cutter *H* within the bar. Thumb-screw *O* is then loosened, and eccentric *M* is withdrawn, taking arm *K* and the attached parts with it. The work is then slipped over bar *E* and onto bushing *D*, which fits its bore. Floating jaws *B* are then clamped on the work, holding it securely. Eccentric *M* and lever *K* are next replaced in position and clamped there by screw *O*, lever *K* remaining in its downward position. Adjusting screw *Q* is now set so that it nearly touches the eccentric in this position, and the shaper is started up, it being understood that the stroke is set properly for the work in hand.

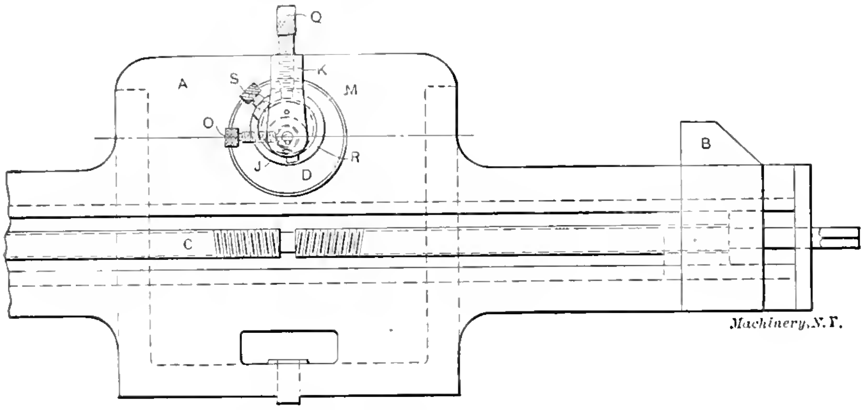


Fig. 3. Face View of Attachment showing Vise Jaws for Holding Work.

As the ram commences its cutting stroke, which is the inward stroke in this case, the operator throws the lever *K* around in the direction opposite to the hands of a watch, until the point of screw *Q* stops against the eccentric surface of *M*. This, as explained, throws blade *H* downward, probably far enough to take its first chip. When the blade has passed through the work, the operator, with his hand constantly on *K*, again swings it back against stop pin *P*, meanwhile unscrewing *Q* a trifle more. At the beginning of the next cutting stroke he again swings it around in a counter-clockwise direction until the point of *Q* again stops against the eccentric surface of *M*, this time further around, causing *H* to project out a little further and take a second chip. This operation of feeding in deeper on the cutting stroke and relieving on the return stroke, is continued until the key-way has been cut in the work to the proper depth. This depth is located by stop collar *R*, which is adjusted on *M* to limit the movement of *K* to the position that gives the proper depth of key-way. *R* is clamped in its position by thumb-screw *S*. The key-seating being then completed, arm *K* is returned to its lower position so that the cutter blade is withdrawn; then *K* and *M* are removed (thumb-screw *O* is loosened) and the finished work is slipped off of bushing *D* and a new piece placed in position, after which *K* and *M* are again replaced and the operation proceeds as before.

As evidence of the capacity of the device to handle repetition work in large quantities, it may be mentioned that 400 pieces [illegible] in the machine in Fig. 1, were key-seated [illegible] minutes apiece. The key-way was ¼ inch wide, ⅛ inch deep and 7 inches long. The material was high grade steel casting.

Practice in Finishing Gear Blanks in the Shops of the Builders.

One feature of the shop practice of the Cincinnati Shaper Co., is dependent on the use of this attachment. Owing to the fact that the key-way is cut true with the bore, no matter what the condition of the outside surface by which it is gripped, this operation may be performed immediately after the chucking. As is common practice in making gears of the first quality, gear blanks in this shop are finished on a true lathe arbor. The key-way being cut before turning, an opportunity is afforded for putting a key in the arbor for driving the gears. A gear thus mounted on the arbor is shown in Fig. 4, together with the arrangement of the tools in the special slide rest which is used for facing the blanks. Since it is not necessary to depend on the forced pressing of the arbor into the work for driving the latter, it is possible to press a snugly fitting arbor of the kind shown, into the key-seated bore of the blank to the same point every time in such position that the edges of the finished faces will overhang slight clearance spaces on the arbor. When so arranged, the double roughing tool may be fed down until it rough faces the two sides of the gear down almost to the arbor. Returning the cross-slide, the two facing tools at the rear may be brought up, finishing the sides completely, clear down to the bore, and running out into the slight clearance spaces mentioned.

The fact of the blank being keyed prevents the longitudinal shifting of it on the arbor which might take place if the latter were pressed into the work no more firmly than would be the case here, with holes varying slightly in diameter. In order to slip easily on an arbor lengthwise, the work must rotate on it as well, and this rotation is prevented by the key. The finish turning of the blanks is done on true gang arbors, on which the work is stacked to the full capacity of the arbor. Owing to the fact that two sides of the gears are faced in the same operation, they are true with each other and with the bore, so the gang arbor is in no danger of being sprung when the work is tightened up on it. This makes a very rapid and very accurate method of finishing small gear blanks that are made in large quantities.

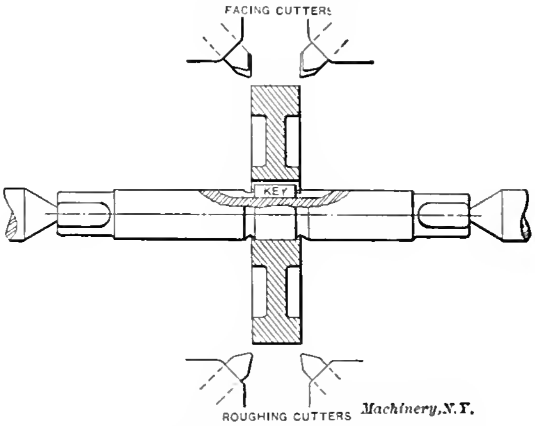


Fig. 4. Facing Gear Blanks, mounted in the Lathe on a Keyed Arbor.

Range of Sizes.

The bars *E* are made in seven sizes, to cut all key-seats up to 1-inch in width, in holes from 9/16 inch upwards, in diameter. Bushings *D* are furnished in any desired size to fit the bore of the work to be key-seated. Bushings for cutting tapered key-ways will be furnished if desired. The device is evidently applicable to the planer, as well as to the shaper.

GEARED FEED DEVICE FOR THE CINCINNATI LATHE.

A positive-geared feed device, giving six changes, has recently been applied to the Cincinnati 16-inch engine lathe, by its builders, The Cincinnati Lathe & Tool Co., Cincinnati, Ohio. This feed box, as may be seen from an inspection of the half-tone engraving in Fig. 1 (where it is shown attached to the lathe) and of the line engraving, Fig. 2, is of original

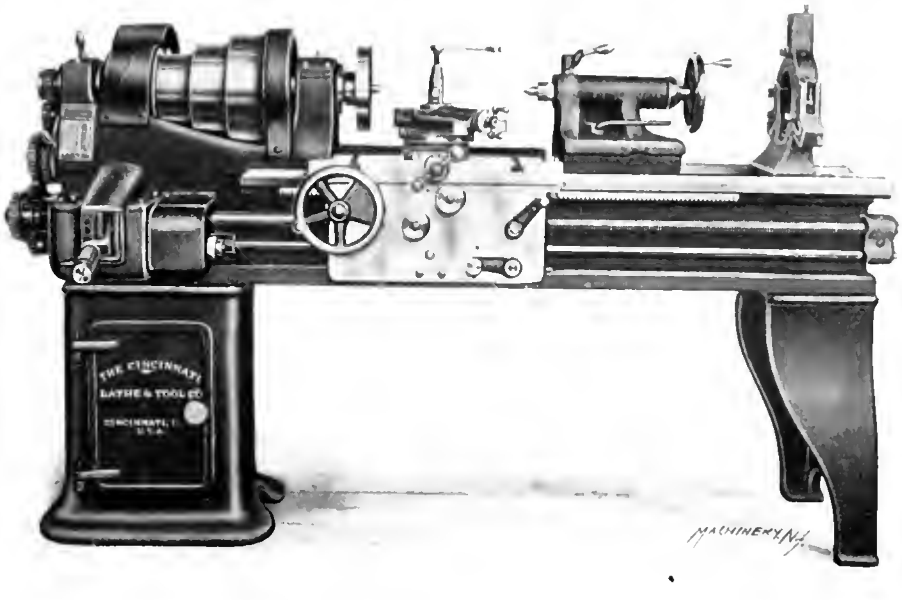


Fig. 1. Cincinnati Lathe provided with Improved Quick Feed Change Device.

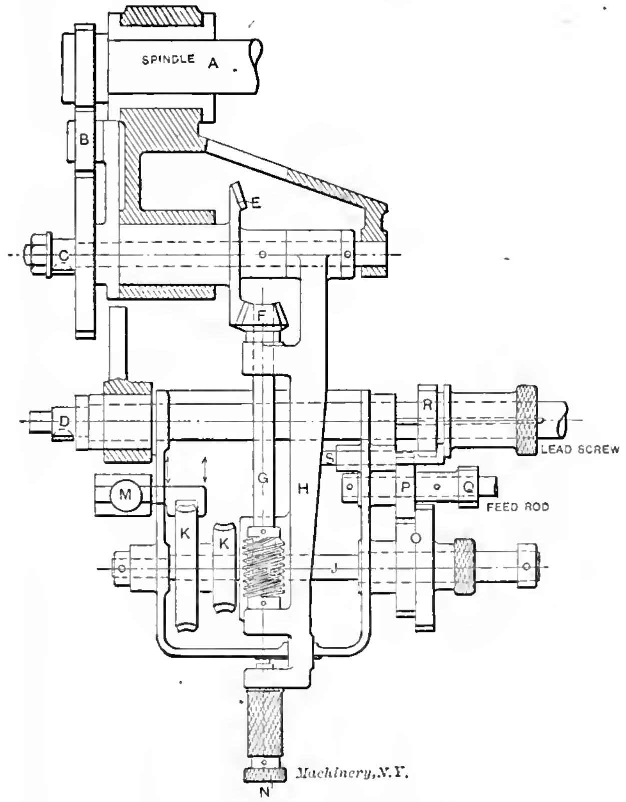


Fig. 2. Arrangement of Feed and Screw Cutting Connections for the Cincinnati Lathe.

and interesting construction, and seems to have been so designed as to accomplish its work with very few parts and simple mechanism.

Referring to the line engraving for the details, *A* is the lathe spindle which, through the usual reversing tumblers *B*, drives the stud gear shaft *C*. From this, connection for threading may be made with the lead-screw *D* by the usual change gears. Mounted on the change gear stud on the inside of the head-stock, is bevel gear *E*, meshing with a pinion *F* driving a worm-shaft *G* which is supported by bearings in swinging arm *H* pivoted about shaft *C*. To shaft *J* in the feed box is splined a triple worm-wheel *K*. Any one of the three wheels composing this may be shifted into position under worm *L* by means of a slide *M* on the outside of the box. The inner extension of this slide embraces the largest of the wheels and so controls the axial position of all three. Arm *H* extends out through the feed box at the front of the lathe, where it is provided with a lock bolt *N*, by means of which it may be fixed at any one of four different vertical positions. To change the rate of feed, *N* is pulled out and arm *H* raised until the worm *L* is out of reach of the worm-wheels *K*. Then fork *M* is shifted to bring that one of the three worm-wheels corresponding with the desired feed into position beneath the worm. Arm *H* is then dropped to the corresponding vertical location for that wheel and locked in place by bolt *N*. The three changes thus obtained are doubled by means of the double sliding gears *O* which may be shifted to engage with either *P* or *Q* on the feed rod, thus giving six changes in all, varying from 16 to 100 turns per inch. This is sufficient for general manufacturing work.

In addition to these speeds which are instantly obtainable, 22 additional changes ranging from 5 to 64 per inch, may be obtained, to suit special cases, by using the regular change gearing between *C* and *D*, and shifting sliding gear *R* on the lead-screw into engagement with gear *P* on the feed rod, which is thus driven from the spindle. To make it possible to drive the feed rod in this way, without interfering with the regular drive through the worm gearing, a lock bolt *S* is provided, having a finger engaging a groove in slip gear *R* and projecting into the feed box in the path of the swinging movement of arm *H*. Bolt *S* and arm *H* are so placed that the former prevents gear *R* from being thrown into mesh with *P* until *H* is raised to its extreme upper position, where engagement with even the largest of the worm-wheels *K* is impossible.

This lathe has been previously built in two forms, either with the Emmes patent quick change gear device, or with plain belt feed. The lathe with the feeding device we have just illustrated is intended to take the place of the belt feed machine, and will be furnished at the same price. The range of feeds provided appears to be suitable for ordinary work without requiring the use of the change gears at all for feeding. It will be noted that the feed is independent of the screw-cutting motion, so that the lead-screw is not operated except when required for actual threading. The machine shown in the illustration has a 3-step cone and double back gears. If required by the purchaser, a 5-step cone and single back gears will be furnished instead.

EBERHARDT BROS. UNIVERSAL AUTOMATIC GEAR-CUTTING MACHINE.

The Eberhardt Bros. Machine Co., 66 Union St., Newark, N. J., has recently built the remarkable gear-cutting machine illustrated herewith. In Fig. 1, a blank is shown, cut with the various styles of teeth which the machine is capable of producing. As may thus be seen, it is practically universal in its adaptability, it being designed for the cutting of spur, bevel, skew, and face gears, besides being useful for gashing worm-wheels. It is intended to fill the requirements of a machine for stocking out bevel gears preparatory to finishing on a planing machine, and, likewise, of jobbing and repair shops for finishing bevel gears by the formed cutter method. This is done without limiting the capacity of the machine for spur gear work, in the way met with in the ordinary automatic spur and bevel gear cutter, provided with a swivel adjustment for the cutter slide. In other words, this machine will finish spur or bevel gears with equal accuracy, and with an equal output.

Structural Features of the Machine.

A heavy base casting is provided, having at one end guides on which the work spindle head is adjustable longitudinally, and on the other, a seat of circular form, on which the cutter head stanchion may be adjusted to the proper angle for any gear from a spur to a face gear. The work head, it will be

seen, is adjustable in two directions. The adjustment of the saddle on the bed is for accommodating different diameters of blanks, and for setting the cutter to the required depth. That of the spindle head on the saddle is at right angles to the first, and is used to accommodate bevel gears and pinions having varying lengths of hub, so as to bring the point of the pitch cone to the proper position. This also is used to set the cutter to depth in cutting face gears. The screws for both of these movements are provided with adjustable dials, graduated to read to thousandths of an inch. The screw which makes the adjustment for the diameter of the blank may be operated from either end, as most convenient.

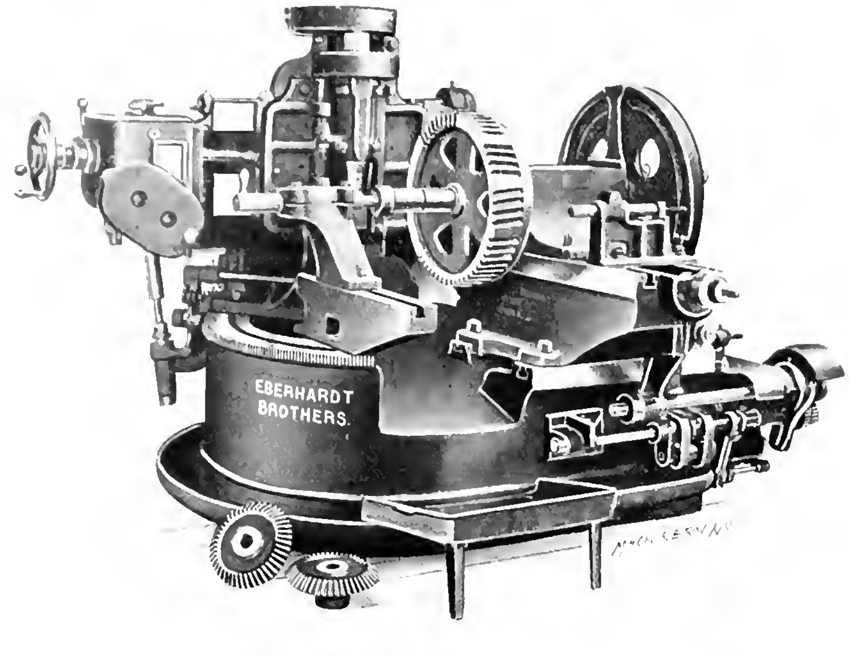


Fig. 1. An Automatic Machine for Cutting Spur and Bevel Gears; also adapted for Worm, Skew, and Face Gears.

The method by which the cutter slide is supported and the cutter driven, may be understood by reference to the line drawing, Fig. 3, in connection with the two half-tones. The cutter stanchion *A*, as has been explained, is adjustable about its circular seat on the top of the base to the required angle. The axis of adjustment is shown at *x-x*. The cutter slide itself, *B*, is mounted on a guide *C*, which swivels through a limited angle on a bearing on the face of stanchion *A*, about axis *y-y*. The slide *C* is set by this adjustment to the required angle for making the approximation necessary when cutting bevel gears by the formed cutter process, and is clamped by bolts *D*. For spur gears, of course, the slide is set in a horizontal position, shown in Fig. 3. For cutting skew gears (much used in steel mill work in place of the more expensive and less easily removed worm-wheel) slide *C* is set to agree with the helix angle of the worm the skew gear is to mesh with. In gashing worm-wheels the same thing is done. For this latter case, of course, the automatic feed is not used, the work slide being fed on the saddle to the proper depth by hand for each cut. It will thus be seen that the cutter slide and work are as strongly supported when the work is set for cutting bevel gears, or even for face gears, as when cutting spur gears.

The Driving Mechanism.

The machine is driven through constant speed pulley *E*, which is connected by bevel gearing with a shaft *F*, whose center line is on axis *x-x*, about which *A* is adjusted. Shaft *F* is connected in turn by bevel gearing with shaft *G*, journaled in cutter head *A*. *G* is connected by spur gearing with shaft *H*, with center line on axis *y-y*, about which *C* is adjusted. This, in turn is connected by spur gearing with shaft *J*, connected at one end with the feed box *K* for the power feed and quick return, and at the other by spur gearing to splined shaft *L*, which drives bevel pinion *M*, supported in a bracket attached to cutter slide *B*. *M* meshes with bevel gear *N*, which is keyed to a vertical shaft which is connected with shaft *O* by change gears as shown, for obtaining the required rate of spindle speed for the case in hand. A pinion on *O* drives the spindle gear *P*. The same provision for adjusting the spindle *Q* lengthwise is made in this machine as with the usual automatic gear-cutting machine. It will be seen from the foregoing that the spindle drive is effected from a pulley of fixed position, without interfering with the two angular adjustments of the cutter slide, or the axial adjustment of the cutter spindle. For making the angular adjustments of the cutter stanchion, a worm is provided, engaging a circular rack secured to the bed. The worm carries a dial graduated to read to minutes of a degree, one degree being a whole turn of the crank.

Feeding and Indexing.

The feed of the cutter carriage is varied by change gears, the quick return remaining constant. The cutter speeds and feeds are entirely independent of each other. The thrust bearings for the feed-screw are placed at each end, so that the screw is not under compression either during the feed or the return of the carriage. This "draw-cut" principle is said to reduce vibration and chattering to a marked degree. The cutter carriage is of exceptional length, and travels on long and narrow guiding surfaces of the same construction as on the spur gear machines built by the same firm. The cutter spindle is in the center of the length of the carriage, thus preventing the possibility of lifting the latter, or "gouging" on the part of the cutter, when beginning the cut.

The indexing mechanism is positive, and is operated by means of a rod from the feed box trip mechanism, as is usual on spur gear cutting machines. As this rod operates through the centers of angular adjustment of the machine, no attention is needed whatever when the stanchion or swivel slides are moved for different angles, or when the head is moved in either direction. The use of chains is eliminated; there are only the two usual dogs to be set to suit the various lengths of face of the gear blanks. The indexing worm runs in a bath of oil and meshes with an index wheel of large diameter, made in halves to insure accuracy.

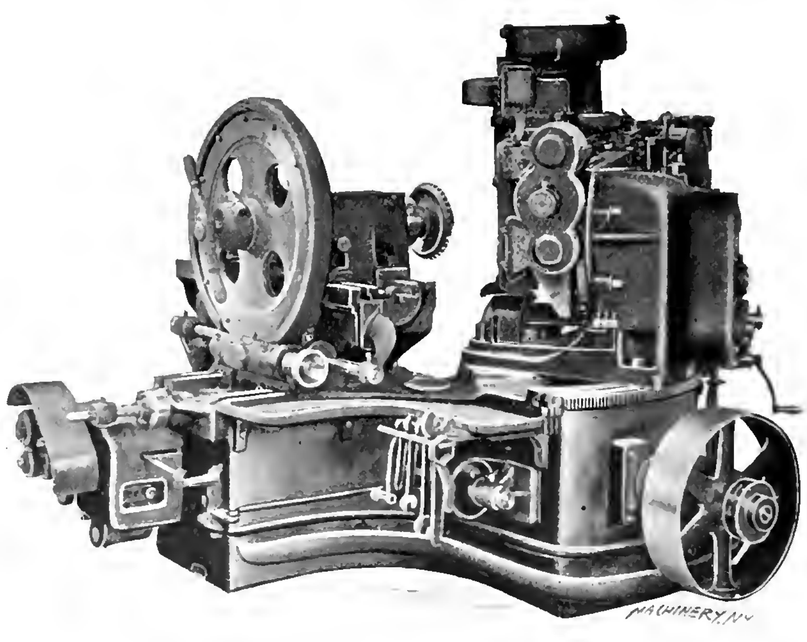
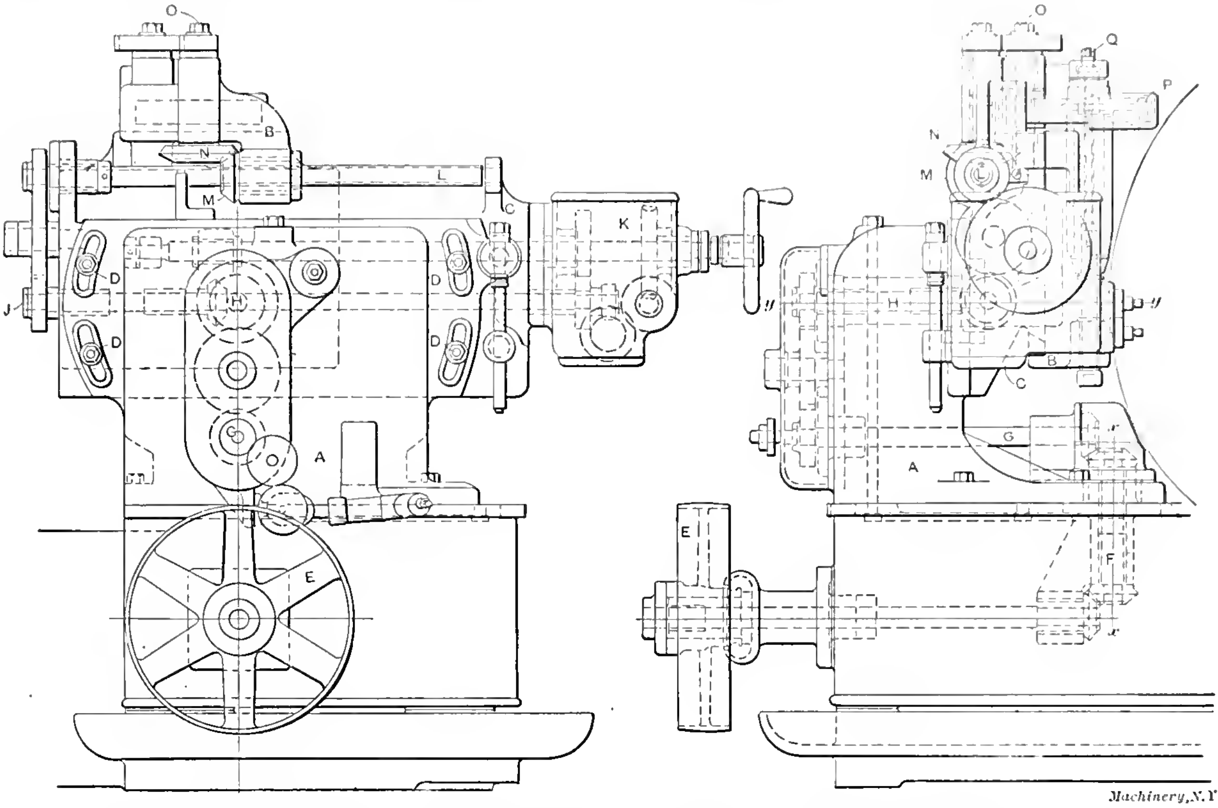


Fig. 2. Rear View of the Universal Automatic Gear-cutting Machine.

Incidental Features of the Design.

An outside support is furnished for the work arbor, as shown in Fig. 1. This support accommodates wheels up to the full diameter of the machine, and is easily removed. Rim rests are provided to support large gears against the thrust of the cutter. A face-plate is also provided, with chucks and drivers for positively holding and driving wheels of large diameter. The cutter and work spindles have tapered holes, and each is provided with a draw bolt for positively drawing in and forcing out arbors. The work spindle is a machine steel forging, while the cutter spindle and arbor are of tool steel. All driving shafts are of high carbon machinery steel and finished by grinding as, of course, are also the spindles.



Machinery,N.Y.

Fig. 3. Front and Side Elevation of Cutter End of Machine, showing Cutter Slide Adjustments and Method of Driving.

Fig. 1 shows very plainly the convenient height of the machine, and the accessibility of all the parts, such as the hand indexing and feed levers at the left of the machine, near the feed hand-wheel. These are used when setting the machine and are always within easy reach, being about 4 feet from the floor. A number of minor conveniences will be noticed. The change gears are enclosed by hinged covers, and guards are provided for encasing all the gearing. The oiling facilities provided have been carefully studied out. The bearings of all shafts and spindles operating in a vertical position have spiral oil grooves, cut in the opposite direction to the rotation of the shaft, so as to retard the downward flow of the lubricant. Felt wipers are arranged on all the planed bearing surfaces to keep the dirt and chips out, and retain the oil. An oil pump with suitable piping and reservoir is provided for supplying a lubricant, as when cutting steel.

Capacity.

The machine has a capacity up to 48 inches in diameter, and 10 inches face, and will cut 3 diametral pitch in steel and 2½ diametral pitch in cast iron. By taking stocking cuts, heavier pitches can, of course, be cut. One of the first lot of these machines built is cutting 2 diametral pitch in steel as its regular work. It will be noticed that, owing to the construction of this machine, the full capacity, so far as diameter is concerned, is available whatever the angle at which the cutting takes place. This is owing to the fact that the swivel is effected by the cutter slide instead of by the work spindle, so that the latter always bears a definite relation with the clearance cut in the base for swinging work of large diameter.

PRESSED STEEL TROUGHING AND RETURN ROLLS FOR CONVEYOR BELTS.

The question of troughing conveyor belts has always led to controversy, and about the only point that seems to have been definitely settled, is that with deep troughing-rolls the belt must be made so that it will bend to the required shape; and to obtain this shape with the ordinary multiple pulley idler, the belt is sometimes made up with fewer plies of fabric at the flexing part. The rubber protective cover of the belt has little or no tensile strength, and the result of weakening the fabric, especially in cases of the wide belts designed for large carrying capacities, is to bring about a weakening at the very point where the load is heaviest and the bending of the belt most severe.

An improved type, of pressed steel, is shown in the illustration. The carrying-roll, firmly secured to the through shaft which revolves in self-oiling, dust-tight bearings, consists of three parts rigidly fastened together—one straight middle section, and two bell-shaped end-sections, the inner edges of which are flanged so that the center section overlaps each snugly, making a close joint and a well balanced roll. The ends are closed, which prevents entrance of material to interfere with the rotation of the roll or throw it out of balance. A point is also made of the clear height above the supporting

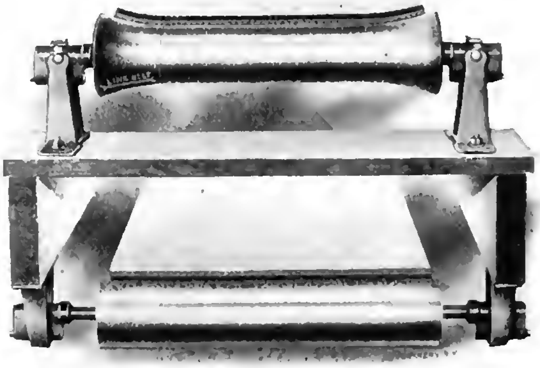


Fig. 1. A Pressed Steel Troughing Roll which gives a Maximum of Life and Carrying Capacity to the Conveyor Belt.

plank, as this effectually removes the roll from possible contact with spilled material. The carrying run is thus over a one-piece roll on which the loaded belt bears evenly for its entire width. The result is that all troughing strain is eliminated and the belt wear is confined to ordinary carrying service; nor does observation show that the difference in diameters of the roll injures the under side of the belt. This is no doubt due to the fact that the roll revolves at the speed of the loaded part of the belt and that rubbing is confined to its edges. The wear here is slight, and it has been found that the life of the belt is determined by the wear on the carrying part rather than on the under side.

The return rolls are of the one-piece, straight-face type, set-screwed to a through shaft which revolves in bearings identical with those on the carrying-run. Both rolls are compact, light and strong, and in service, under severe conditions, show remarkable durability. The lightness and simplicity of construction have so reduced the initial cost that closer spacing is possible, and this, where high speeds and great capacities are desired, prevents sagging of the belt and assures smooth, easy operation, lessened horse-power consumption, and a minimum of belt wear. As the rolls are fixed to the shafts which, as noted, revolve in oil, the lubricating points for each are reduced to two, and these are so accessible that the bearings are always in good condition.

The following considerations should govern the adoption and use of the belt conveyor principle. First, it should be used only for materials to which it is adapted, there being no such thing as a universal conveyor. Second, the more nearly a belt conveyor approaches the flat position, the longer the belt will last, so troughing should be shallow enough to allow the belt to assume its shape naturally and without strain. Third, the belt, however it is made, should be uniformly strong throughout its width, its construction being governed entirely by the material to be handled and the conditions under which the conveyor must be run. The roll just described, when used as it should be, conforms to the above conditions. It is built by the Link-Belt Co., Philadelphia, Pa.

THE DILL DRIVE.

The T. C. Dill Machine Co., Philadelphia, Pa., is building the variable speed drive shown in the accompanying illustrations. As may be seen at the first glance, it embodies an exceedingly ingenious principle of action and is constructed along novel lines, though it somewhat follows the principle of the well-known Sellers drive in the matter of varying the speed by forcing straight disks in between tapered disks, pressed together by springs, the drive being by the frictional contact between the edge of each straight disk and the sides of its mates on the other shaft. By varying the center distances of the two sets of disks, the diameter of the drive on the tapered disks is varied, thus altering the speed. The novelty of the construction consists in multiplying these disks to as great an extent as required to transmit the desired power, and in making them of thin steel stampings, allowing the whole arrangement to be of very compact construction. Refinements have also been introduced in the methods of applying the pressure, and in varying the center distances of the disks.

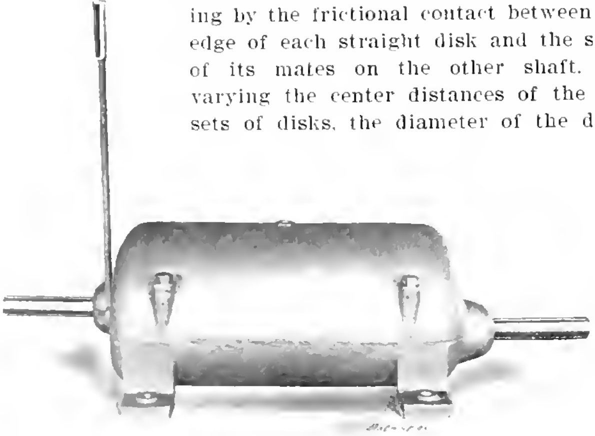


Fig. 1. Dill Variable Speed Drive as supplied for General Use

The Commercial Form of the Device.

A variable speed device of this type is shown in its enclosed form in Fig. 1, and with the cover removed in Figs. 2 and 3. The shaft which extends from the casing at the opposite end from the handle, is the one which receives the power. On a squared portion of this shaft are loosely mounted flat ground disks, punched from steel plate, with the holes to fit the shaft. The driven shaft, which delivers the variable speed from the device, has a similar squared portion on which are loosely mounted similar flat ground disks with squared holes. Between these constant speed and variable speed shafts is mounted a third, whose bearings are supported by arms keyed to a rock shaft, parallel to the other two. On this intermediate shaft are mounted tapered disks which enter the spaces between those on the other two shafts. They are held to this intermediate shaft in the same way as the others, by squared seats. By means of the heavy coiled spring shown, which presses together the flanges which confine them, all the disks in the device are pressed into contact with each other. The rock shaft on which the arms are mounted which support the intermediate shaft, is provided with a handle by means of which the latter may be swung toward either the constant speed or the variable speed shaft. In the first case, the edges of the constant speed disks come in contact with a smaller diameter of the intermediate taper disks, while those of the driven shaft, on the contrary, engage a larger diameter of the disks they engage with. This results in the increase of the speed of the driven shaft. Of course, this shifting of the center distance between the shafts alters the spacing of all the disks, as the straight ones enter or recede from the tapered openings between the tapered disks. Owing to the rapid rate of rotation of the shafts, this side adjustment takes place practically instantaneously, all of the disks being free to move endwise on the squared shafts, as explained, except for the pressure of the coiled spring on the intermediate shaft, which gives the pressure required for the driving.

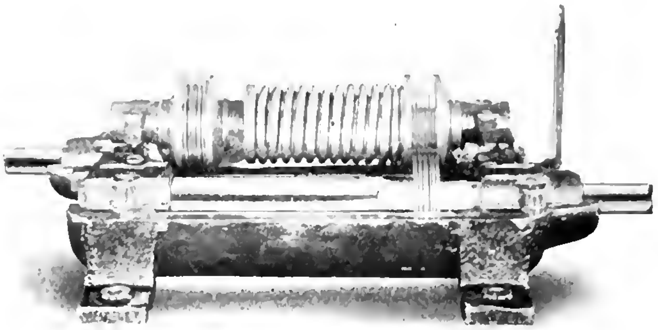


Fig. 2. View of the Dill Drive with Cover removed from Casing, showing the Alternate Sets of Flat and Taper Disks which Transmit the Power.

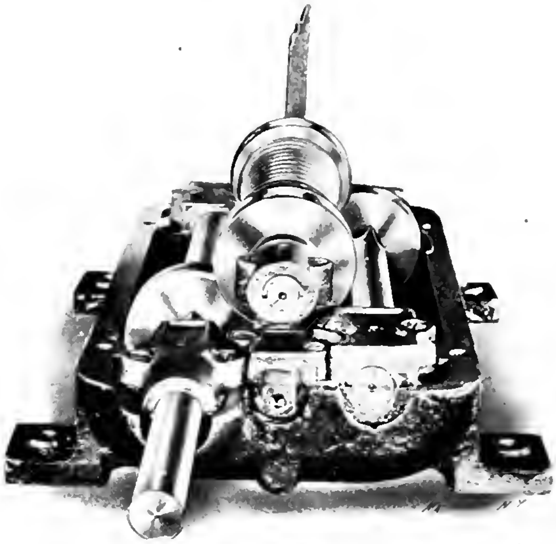


Fig. 3. End View of the Drive, showing the Method of Supporting and Shifting the Intermediate Shaft to change the Speed.

The contact between the flat and tapered disks is but a spot, and as they have a rolling action on each other, the frictional resistance is reduced to a minimum. Great power, while still retaining exceptional endurance, is obtained by first determining the proper pressure from the standpoint of endurance for one disk, and then adding a sufficient number to transmit the power required. The spring is adjusted to suit the load at a given speed, and as the speed is increased the pressure is reduced, and *vice versa*. Owing to the peculiar construction of this spring, constant horse-power output is attained by making the pressure vary with the speed.

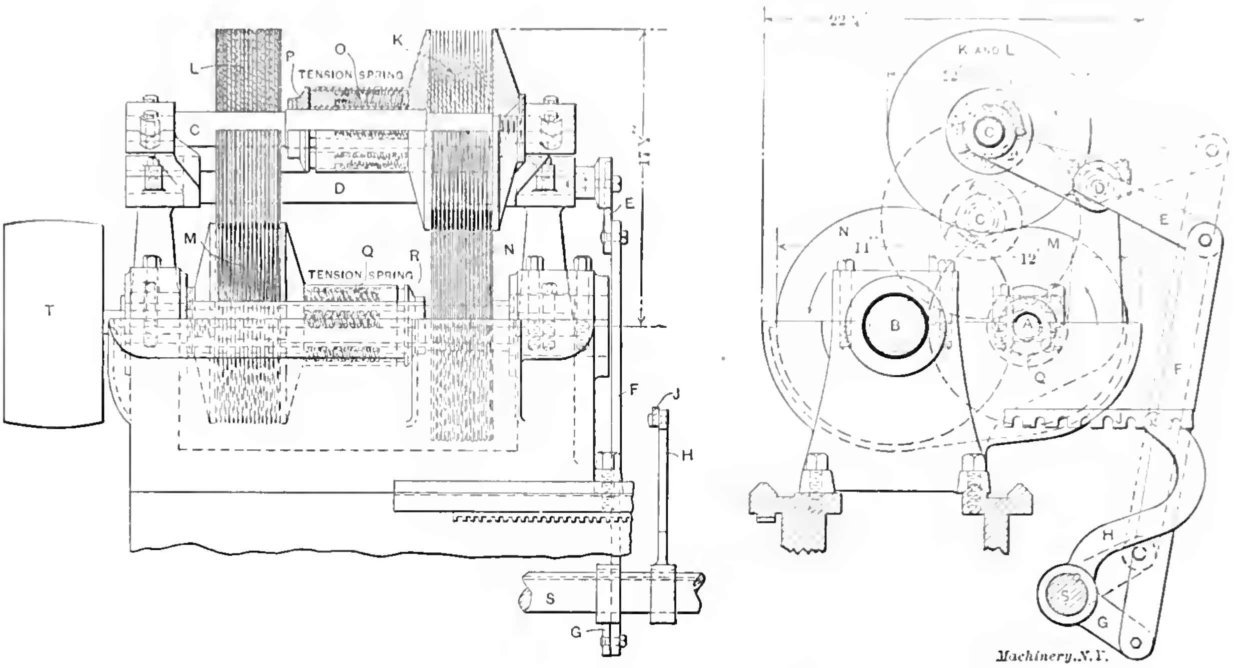


Fig. 4. Suggested Arrangement of Dill Drive as Incorporated in the Head-stock of a 20-inch Lathe.

The apparatus shown in Figs. 1, 2 and 3 shows the drive in the form in which it is being put on the market as a speed box for general use. These speed boxes are made in several sizes, from ½ horse-power up, and with a speed ratio of 5 to 1, though more or less can be had if desired. The drive shown, which is suitable for 5 horse-power, is 23 inches long and 15 inches wide over all, including the extensions for the feet and bearings. The frame proper is only 19 inches long, 11 inches wide, and 9 inches high. The disks are 4 inches in diameter and 3/64 inch thick. The constant speed shaft runs at 400 revolutions per minute. Compactness will thus be seen to be a prime characteristic of this device, as compared with others previously built for the same purpose.

Direct Application to Lathe Head-stock.

Instead of giving the constant-speed shaft a velocity midway between the highest and lowest of the driven shaft, the diameters of the disks may be so arranged that the change of speed is all in the direction of a reduction, so that the highest speed of the driven shaft does not exceed the initial speed. This arrangement is recommended as being a suitable design for incorporating in the head-stock of a lathe or boring mill. Such a modification of the device is shown in the sketch of Fig 4 which suggests a suitable arrangement of the Dill drive as applied to a lathe head-stock.

In this sketch it will be noted that the flat disks *N* (which are fitted directly to a squared seat on the spindle *B*) are 14 inches in diameter, meshing with 12-inch tapered disks *K* on the intermediate shaft *C*. On the other end of the intermediate shaft is another series of flat disks *L* 12 inches in diameter, which intermesh with tapered disks *M* of the same size on the constant-speed shaft *A*. Sufficient power for this application to the lathe may be obtained with a comparatively small number of disks. With the arrangement shown a speed ratio of 30 to 1 is obtainable.

It will be noted that in this case, instead of swinging intermediate shaft *C* from *A* toward *B*, it is mounted on arms *E*, pivoted in such a way that it approaches or recedes from *A* and *B* simultaneously. This construction is still more compact than that shown in the variable speed counter-shafts in Figs. 1 to 3. The change in the movement of the intermediate shaft as compared with the first design, necessitates a rearrangement of the disks. As will be noted, the tapered disks are mounted on the driving shaft and the driving end of the intermediate shaft, while the flat disks are mounted on the driven end of the intermediate shaft and on the spindle. This also necessitates two sets of compression springs, *O* and *Q*, for giving the pressure required for transmitting the power desired. The spreading apart of the disks and the consequent increased pressure of the springs as the speed decreases, gives the increased torque required for transmitting constant power at variable speed—a provision which is necessary in the case of lathes.

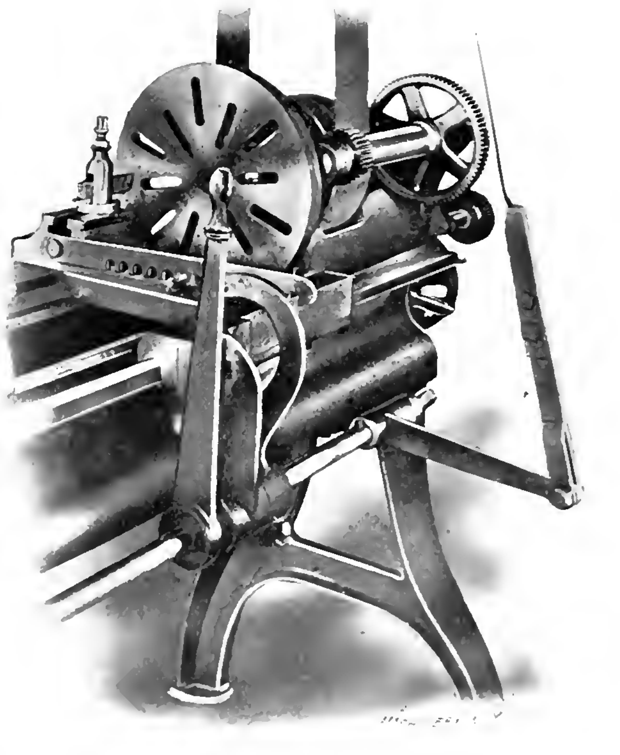


Fig. 5. Arrangement by means of which the Speed of the Drive, mounted on the Counter-shaft, is controlled by the Position of the Tool-post, for Facing, etc.

Automatic Speed Control for Lathes.

The sketch shows an arm *H*, having a pin adapted to engage any one of a number of notches in a link *J* attached to the cross-slide. This arm is connected by link *F* to rock shaft *D*

in such a way as to vary the speed with the position of the cross slide, thus automatically adapting it to the diameter of the cut. This would be very convenient for facing cuts, or for work in which the diameter is constantly varying. The lathe shown in Fig. 5 is provided with a somewhat similar arrangement, intended, however, to be used with a variable speed box such as shown in Fig. 1, bolted to the ceiling. In this case the bell-crank at the rear is connected by a long link with the rock shaft of the speed box on the ceiling. A lever is also provided, as will be shown, by which the speed is changed manually when desired, the lever being so arranged as to slide with the carriage and be always in convenient position for the operator. The lathe in this case is adapted to the variable speed box drive by slipping a special wide-faced pulley over the two largest steps of the cone, thus giving a more powerful drive than the original construction, as well as a more flexible one.

THE NORTON 20 x 192-INCH GRINDING MACHINE.

The machine shown in the two accompanying engravings, is the latest addition to the line of grinding machines built by the Norton Grinding Co. of Worcester, Mass. The machines shown are notable for their great capacity, particularly in regard to length. They are especially intended for grinding long and heavy shafts such as found in stationary engine and marine work, as well as for finishing shorter work, such as spindles, etc. The machine shown is not by any means the longest of this size the builders are prepared to make, though it is the limit practicable with the bed cast in one piece. In the case shown, the base is 30 feet long; for greater lengths it is made in three pieces. That for the largest machine of the series (which is capable of grinding work 22 feet between centers) has a base 42 feet long.

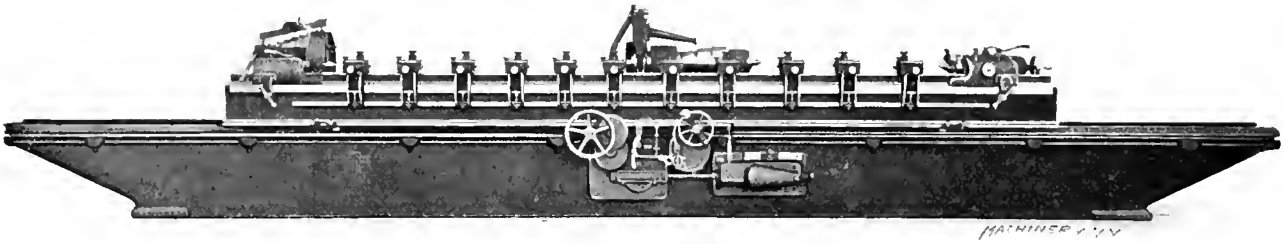


Fig. 1. A Norton Grinder of Unusual Capacity, designed for the Finishing of Heavy Engine and Marine Shafts.

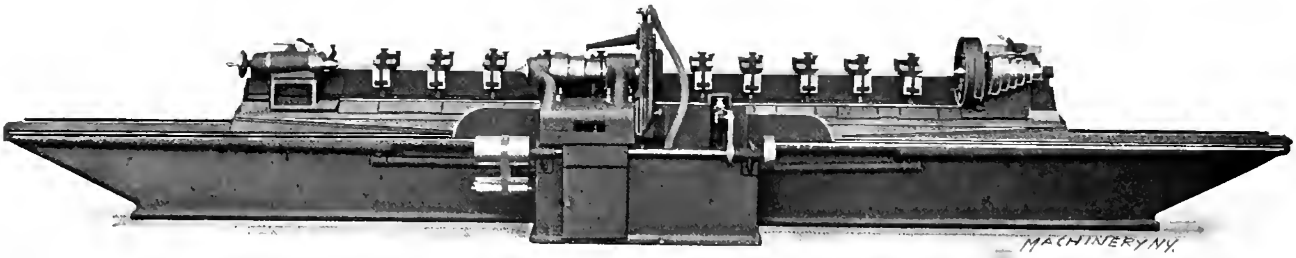


Fig. 2. Rear View of Heavy Norton Grinder. The Bed is made in Lengths of from 8 to 22 feet.

The base casting is unusually heavy, even when its size is considered. The ways are provided with a series of oiling rolls, closely spaced, thus furnishing the lubrication necessary to insure long life and continuous accuracy in guiding ways. An equipment of permanent adjustable wedges is provided for correcting the alignment after the machine has been placed on the foundation. These corrections are made at any time when errors appear, due to the settling of the foundation. The wedges are machined and rest on iron plates, which should be imbedded in the cement foundation and made to line up with a straight-edge and level. This system of adjusting blocks has been previously described in MACHINERY. (See issue of March, 1907.)

This machine has the same general features as the other Norton grinders. In the case shown, it is driven from an over-head counter-shaft, though it can be furnished for self-contained electric drive. It has no provision for grinding tapers, but it made simple and rigid, so that it may do accurate and heavy work, without the complication due to extra adjustments on the table itself. There is, however, an adjustment for the foot-stock to correct the alignment of the centers in case of any wear in the center points. The grinding wheel of this machine is furnished in various widths (from 2 to 4 inches) to suit various kinds of work; it is 24 inches in diameter. The machine will use 20 horse-power to good advantage. From 5 to 20 horse-power should be reckoned on in installing the machine, the amount depending on the character of the work to be produced, and the ambition of the operator.

The smaller sizes, that is, from 96 to 120 inches length between centers, are designed for the grinding of rolls and similar work.

ELECTRICAL FAULT FINDER FOR DETECTING GROUNDS, SHORT CIRCUITS, ETC.

A new and useful instrument has recently been brought out by the Electrical Controller & Mfg. Co., of Cleveland, Ohio. The makers call it a "Fault-Finder." It is intended to be used in detecting and locating grounds, short circuits, open circuits, leaks and other faults in armature and field coils, control circuits, switchboard wiring, or any other electrical connection. It will not only indicate trouble, but will locate it as well. In the case of a motor armature, for instance, a faulty coil can be accurately located and the nature of the trouble defined. If the coil is damaged, the layer in which the fault lies can be determined. In a bunch of control wires in a multiple unit train control or other magnetic switch control, the faulty wire or pair of wires can be promptly located and the nature of the fault quickly found. The instrument consists of a small box, provided with a strap for carrying over the shoulder when testing motors in inaccessible places, such as under cars or on electric over-head traveling cranes. From this small box, leads are connected to telephone receivers (either one or two, depending on the noisi-

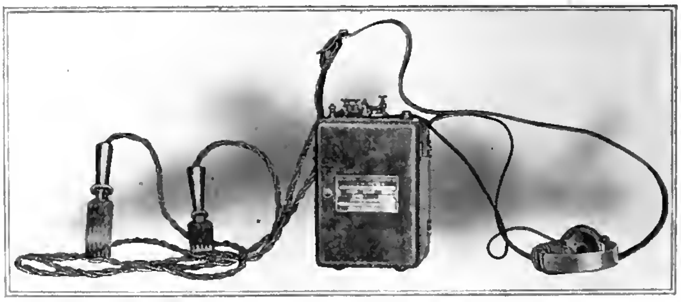


Fig. 1. Device for Detecting Faults in Electrical Connections.

ness of the surroundings) fitted with a head piece so as to leave both hands free for testing. The rheostat may be adjusted to give a sound of any magnitude from a very loud one, more than a normal ear can stand, down as faint as may be desired. Leads extend from the box also to the two test terminals.

This device is inexpensive, small and portable, and requires no outside current to operate it. But one man is needed to operate it under any conditions, so there is no excuse for the tester's desiring a helper. The manufacturers have prepared a neat booklet describing the instrument and giving instructions for its use; this will be sent on request to interested persons.

BLISS TRIPLE-ACTION DRAWING PRESS.

We show herewith a drawing press, placed on the market by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., in which three sliding motions and a knock-out arrangement are so combined that work formerly done in two operations may now be done in one. This does away entirely with rehandling and annealing first operation shells, inasmuch as the second operation immediately follows the first, making the second draw while the metal is still warm.

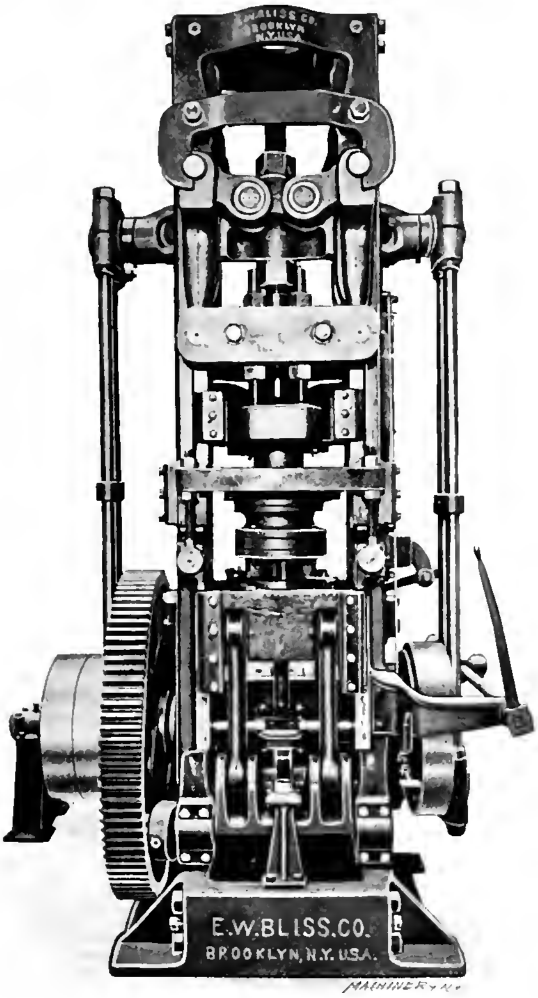


Fig. 1. Triple-action Prese by means of which Two Drawing Operations are performed at Each Stroke of the Machine.

In this press, the dies and the blank placed on them are carried by the lower table, which is raised by the toggle movement shown at the base of the machine to meet the stationary blank holder, supported by the sides of the press frame. Projecting through this stationary blank holder are two plungers, one within the other, of which the outer or first operation plunger is operated by a lever movement which gives it a dwell, independent of and succeeding that given to the lower table, while the inner or second operation plunger is operated by the cranks and connecting-rods shown at the sides of the machine.

In performing a drawing operation, the movements are as follows: The blank is laid on the die carried by the lower table. This is raised by the toggle movement, holding the blank between the die and the stationary blank holder, dwelling there while the first operation punch (the outside plunger) comes into action and makes the first draw. This plunger is then given a dwell by the lever mechanism which operates it, so that it acts as a blank holder for the shell in the second operation. This second operation is performed by the smaller inside plunger, which redraws the shell through a second opening in the die. The parts now all separate, and the knock-out comes into action, ejecting the blank so that it may be easily removed.

This press is of very compact construction, and occupies no more room than any double action machine of the corresponding size for second operation work. The floor space occupied over all is 9 feet 3 inches from front to back, and 10 feet 11 inches from right to left. The height from the top of the frame to the floor is 15 feet 9 inches. The machine is geared in the ratio of 21½ to 1. The fly-wheel is 54 inches in diameter and 8 inches face, weighing 2,300 pounds, while the weight of the whole machine is 60,000 pounds. This machine is another evidence of the tendency in sheet metal working to combine operations, and reduce the number of handlings and annealing required for doing a given piece of work.

THE VIXEN MILLING FILE.

In the March, 1907, issue of MACHINERY, was published a brief description of a file of European origin, in which the teeth were of circular shape, and were cut out of solid metal, instead of being raised by chiseling as with the usual process of file cutting. This file is now introduced to the American market as a commercial product under the name of the "Vixen" patent milling file. It is sold by the National File & Tool Co., 205-206 The Bourse, Philadelphia, Pa.

As may be seen in the half-tone, the teeth have a circular form and are cut unusually deep. This form makes them self-clearing—a great advantage, especially on soft metals. The file cuts equally well on soft or tool steel, cast or wrought iron, bronze and other hard metals, and, in addition, will cut brass, lead, aluminum and other soft metals without clogging. It is also useful as a wood or farrier's rasp, as well as for slate, marble, etc. Although its capacity is higher than even a tool of the rasp or bastard order, it does its work with such smoothness and precision that in spite of its great capacity for removing metal, it is adapted to the finest work as well. This is largely owing to the manner in which the teeth are cut, they being left with true, even cutting edges, which leave a smooth surface, producing curling chips more like that resulting from a true cutting action, than that of the ordinary file. The shape of the teeth is such that the file works as well on a greased surface as on a dry one.

Fig. 1. A Smooth Free-cutting File in which the Teeth are cut out of Solid Metal.

The first cost of the Vixen file is somewhat greater than that of the older variety, but it is asserted that on account of the enormuos amount of work it will do and its long life, it is very much the cheapest file on the market. Besides this, it may be resharpened four times, each operation costing about half that of the re-cutting of the ordinary file, and after each resharpening the file is again quite as good as new. In addition to the special shape of the teeth, the capacity of the file is increased by the special process of hardening which is followed, as well as by the high quality of the steel from which it is made. This steel is a special preparation, obtained after exhaustive experiments. The file is made with 9 teeth to the inch for regular work and

12 teeth to the inch for fine work. The latter ranks with the "smooth" file in the matter of finish, though it greatly exceeds it in the ability to remove metal.

WALCOTT 16-INCH ENGINE LATHE.

The new engine lathe built by the Walcott & Wood Machine Tool Co., of Jackson, Mich., is intended to be a plain manufacturing tool, in which the points specially looked out for are stiffness and cutting power. The accompanying halftone illustration, and the line drawing showing a section through the head, and feed mechanism, will enable the reader to judge as to how nearly these requirements have been filled.

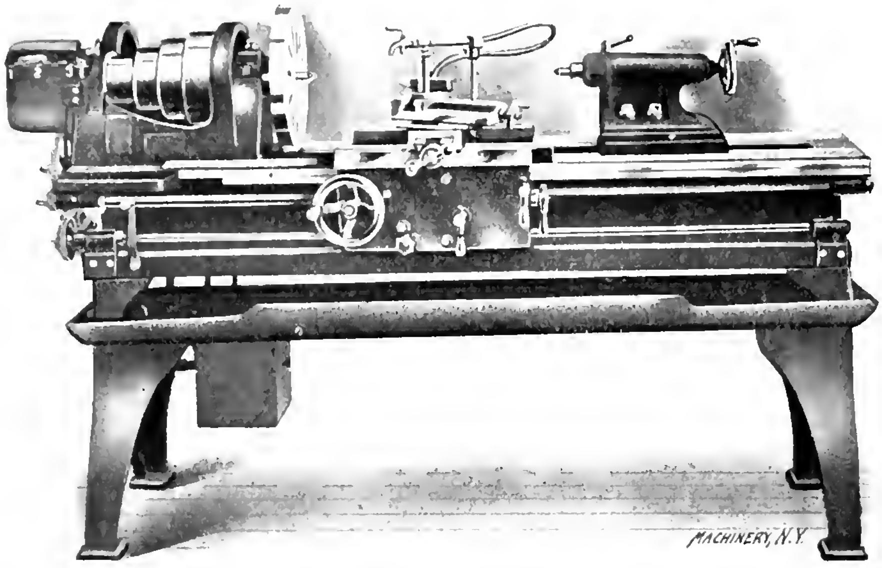


Fig. 1. The Walcott 16-inch Engine Lathe.

As is required for modern conditions, the bed is deep and cross-ribbed at short intervals throughout its entire length. The head-stock is of heavy section, and is rigidly bolted to the bed. A 4-step cone is used, the largest step being 9⅜ inches in diameter and 2 9/16 inch face. The spindle is of high carbon steel, ground, and with a 1 1/16-inch hole through its center. The bearings are of the best phosphor bronze, provided with ample oiling facilities and adjustable for wear. The thrust is entirely taken up at the rear bearing.

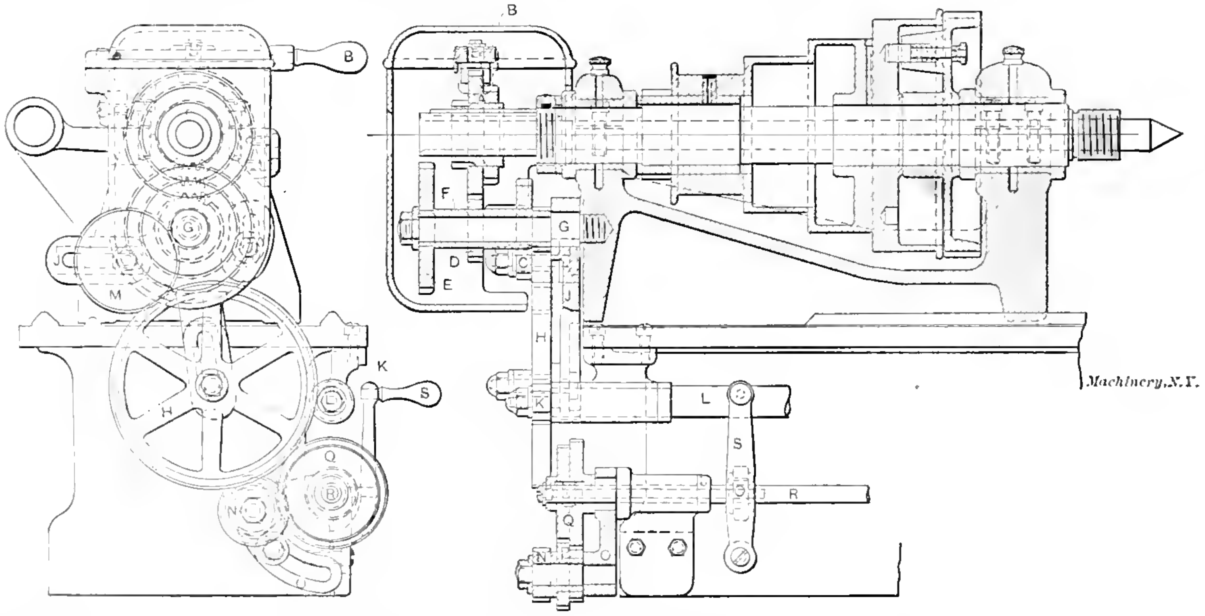


Fig. 2. End View and Section through Head-stock, showing Feed Connections.

Perhaps the principal feature of interest, so far as mechanism is concerned, is the arrangement of the feeds. As may be seen in Fig. 2, the rear end of the spindle is extended to support the triple sliding gear *A*, which, by means of lever *B*, may be shifted to either one of three positions to mesh with gears *C*, *D* and *E*, respectively. These last gears are keyed to sleeve *F*, which runs loosely on stud *G*. For screw cutting, the intermediate gear *H* on quadrant *J* is engaged with pinion teeth cut on the inner end of sleeve *F*, and with the proper change gear *K* on lead-screw *L*. For left-hand threads, intermediate gear *M* is interposed between *F* and *H*. There is nothing to correspond to the tumbler gears of the usual lathe, as the changes for direction of feeds are effected in the apron. For any given change gear at *K*, three threads are available, depending on which of the three positions handle *B* occupies. The thread cutting index provided indicates the position of *B* as well as the change gears used.

While this quick-change apparatus extends the range of screw cutting, it was not primarily designed for this being intended rather for giving a quick control of the feed. When feeding, gear *N* on lower quadrant *O* is thrown into mesh with intermediate gear *H*. To the inner hub of *N* are keyed two gears *P*, meshing with corresponding gears *Q*, which run loosely on the splined feed rod *R*. In recesses in the hubs of gears *Q* are formed clutch teeth, which may be engaged by a clutch blade between them, and manipulated through a sliding collar and an internal rod by hand lever *S*. Two changes of feed are thus obtained, which, combined with the three controlled by lever *B*, gives six in all. This is sufficient for the ordinary range of manufacturing, and makes the machine well adapted to the general run of work, quick change of feeds being much more important in this respect than quick changes for screw cutting.

The carriage is strongly constructed, and has a bearing 22 inches long on the ways. It is securely gibbed to the bed. The longitudinal and cross feeds are driven as explained by the feed rod, independently of the screw. The apron, which is securely bolted to the carriage, is provided with gearing of ample face and pitch to withstand coarse feeds. There is no friction engagement, the drive being positive. Both the longitudinal and cross feeds are reversed in the apron, and the mechanism is so interlocked that the two cannot be thrown in together. The handles and hand-wheels for controlling these, together with those for the clamping arrangement and the throwing in of the half nut for thread cutting, are all on the front of the apron, within easy reach of the

operator. The gearing of the apron is so arranged that one turn of the hand-wheel moves the carriage approximately one inch. This is very convenient in thread cutting, as the lathe can be stopped and the carriage moved back by hand a suitable number of whole turns of the hand-wheel. This being done, the lead-screw nut can be thrown in with the assurance that the threads will match up in the right place.

Special attention is given to the workmanship of these machines, and they are sent out guaranteed to show correctness of alignment within 0.002 inch, in both cross and longitudinal feeds. The beds are made from 6 to 10 feet long, as desired. The 6-foot bed will take 3 feet 3 inches between the centers. The regular equipment includes large and small face-plates, steady and follow rests, compound rest, full set of change gears for cutting threads from 3 to 36 per inch, counter-shaft and wrenches. At extra cost, the lathe will be furnished with an oil pan and pump (as shown in the engraving), or with a taper or relieving attachment.

KIRK STOVE-PIPE ELBOW MACHINE.

The three half-tones shown herewith illustrate an ingenious machine invented by Mr. N. C. Kirk, of Chattanooga, Tenn. The purpose of the machine is the forming of elbows in stove-piping by the crimping process. Unlike other machines for the same work, there are no reciprocating movements whatever in the mechanism, the whole process being a rotary one. This makes possible an exceedingly rapid production, with an almost absolute absence of noise and vibration in the action, which is smooth and continuous.

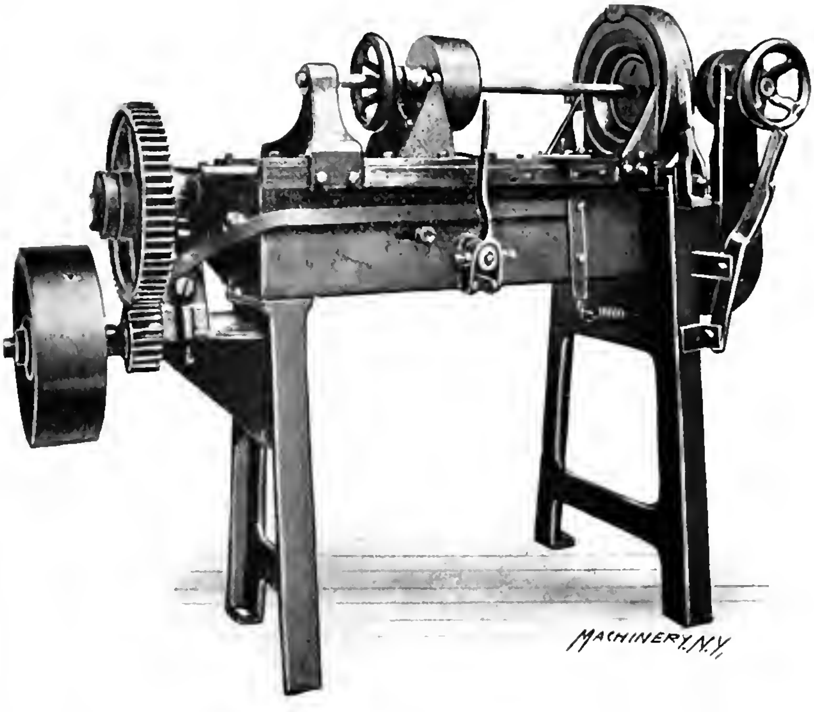


Fig. 1. A Machine for Forming Ribbed Stove pipe Elbows by the Rolling Process.

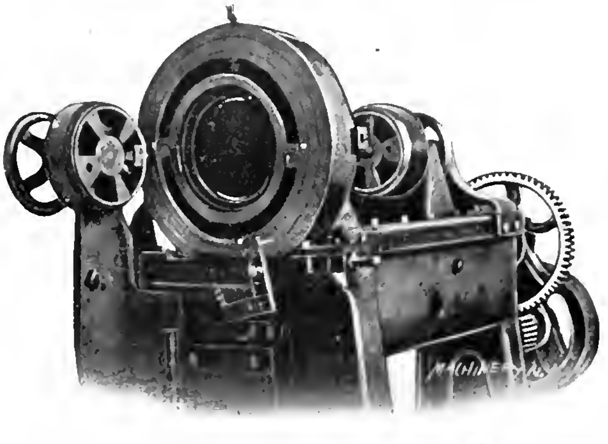


Fig. 2. The Machine Open, ready to receive the Work.

Fig. 1 shows a general view of the machine, Fig. 2 shows the machine with the work in place ready to commence the operation, and Fig. 3 shows the work completed. The power is applied to the pulley shown at the rear of the machine, which, through suitable shafting and gearing, drives a spur gear mounted in the head. This spur gear has an eccentric seat, in which is mounted, on roller bearings, the ring which forms the grooves, the position of this ring being eccentric to the outside of the gear wheel by the depth of crimping required. At each revolution of the gear a crimp is formed. The fact that the crimping ring is mounted on roller bearings, allows it to roll in contact with the work instead of rubbing over it, preventing the shearing action that would otherwise take place.

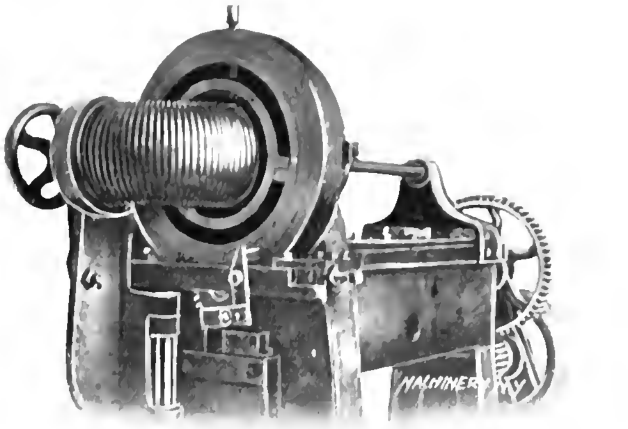


Fig 3. Appearance of Work at the Completion of the Operation note the Swinging Chuck which forms the Elbow to the Desired Radius

The work itself, as shown in Figs. 2 and 3, is held at each end by conveniently operated chucks, so that it does not revolve. The inner chuck is mounted on the sliding bar, while the outer one moves on a swinging support whose radius is equal to that it is desired to give the completed elbow. During the feeding of the pipe, the rear chuck slides on the bar, and the outer chuck swings about its pivot. The feeding is accomplished by the action of the crimping ring, whose axis is set in a position out of parallel with the axis of rotation of the gear which drives it. This angular setting, combined with the rotation, causes the rolling to take place in a helical line around the pipe, advancing the latter a uniform amount for each revolution.

To form an elbow, the operator swings the hinged support with its outer chuck and hand-wheel around in position to receive the end of the blank pipe, which has been slipped through the housing and into the chuck. The two ends are then made fast in inner and outer chucks (the latter being swung in for the purpose) by a slight turn of the hand-wheels. The machine is now started up, and the continuous helical crimp is formed, the pipe being fed out along the desired curve as the operation proceeds. When the correct curvature has been formed, the machine stops automatically with the crimping ring in position to receive another blank, in which position the finished elbow may be easily removed.

DRESES 48-INCH RADIAL DRILL.

The 48-inch radial drill built by the Dreses Machine Tool Co., of Cincinnati, Ohio, has been redesigned throughout, but with particular reference to the driving mechanism. The back gears and clutches for stopping and reversing are now mounted on the spindle head instead of on the arm at the back of the column. This makes it possible to arrange the controlling handles in considerably more convenient locations for machines of different sizes than was previously possible,

and at the same time permits the use of high-speed shafts with low torque to a point in the drive very close to the drill itself. Other features of the machine are the double column with the stationary stump carried very nearly to the top of the outer sleeve, and the gear box which, in combination with the back gears, gives 14 rates of speed, and may be changed with ease while the machine is running. This is due to the fact that the variable speed shaft, if not connected with a higher speed, runs constantly at a speed determined by the lowest ratio of the change gears. The pilot wheel for the quick return movement has four handles, any one of which may be used as a lever for operating the clutch connecting the worm-wheel with the pinion shaft. The machine gives a general appearance of ruggedness and extreme simplicity, especially when the number of movements and adjustments provided, is considered.

LANCASTER OVAL TAPER DRILL SOCKETS, AND LATHE ATTACHMENT FOR PRODUCING THEM.

The Lancaster Machine & Knife Works of Lancaster, N. Y., is selling a new style of twist drill socket which, it would appear, overcomes most of the difficulties met with in driving taper shank twist drills. The great difficulty in doing this, as is well known, is in preventing the tang of the drill from twisting off under the heavy service to which these drills are subjected under modern conditions and with modern tool steels. In the case of the Lancaster socket, the taper shank of the twist drill is oval in section throughout its length, and approximately a corresponding taper oval hole in the socket. When so made, there is no way for the drill to slip, the only possible accident being the breaking of the drill itself, due to an over strain.

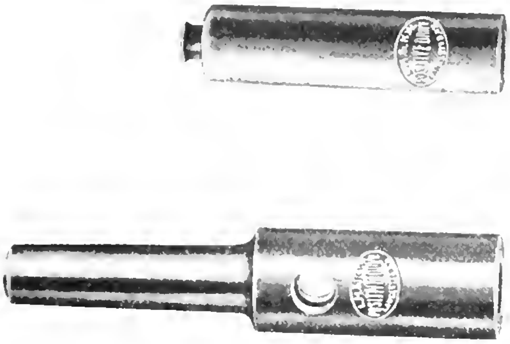


Fig. 1. Lancaster Oval Taper Drill Sockets, which obviate the Use of the Tang

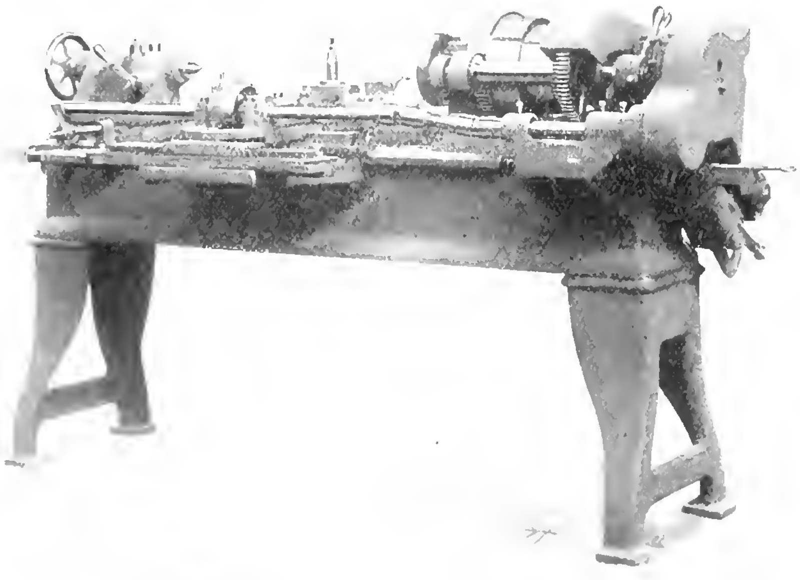


Fig. 2. Lodge & Shipley Lathe fitted with the Lancaster Attachment for Turning and Boring Ovals and other Irregular Shapes.

In the upper part of Fig. 1 is shown a reducing socket with an external and internal taper, both oval in section. A knock-out pin is provided, as shown, for forcing out the drill from the socket without injuring it by raising a burr or otherwise. The lower socket is provided with a shank and is of the usual form, the drill being removed by a drift inserted in the cross hole.

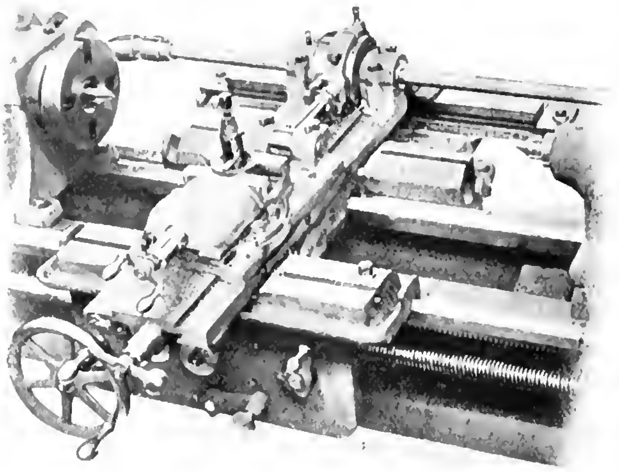


Fig. 3. Rear View of Lathe fitted with Irregular Turning and Boring Attachment.

A lathe built by the Lodge & Shipley Machine Tool Co. and equipped with a Lancaster attachment for turning ovals and other odd shapes, is shown in Figs. 2 and 3. The taper sockets are produced on lathes so arranged. The device consists essentially of a shaft carried in bearings at the rear of the bed, connected on one side by change gearing to the spindle, and on the other by a telescopic shaft to an eccentric on the cross-slide, the eccentric being arranged to reciprocate the tool-post in unison with the rotating of the spindle, thus producing the form desired. The change gearing between the lathe spindle and the attachment may be arranged in the ratio of 1 to 1 for eccentrics, 2 to 1 for ovals, 3 to 1 for 3-lobed cams and 4 to 1 for square sections. Increased ratios may be used for polygons of greater numbers of sides. The eccentric is double, the inner and outer members being rotatable on each other so as to vary the throw at will from zero to ½ inch. A graduated disk is provided showing the throw obtained. For special work special eccentrics may be provided for any desired travel of the slide. Solid eccentrics (not adjustable) may be substituted for the arrangement described above for producing duplicate work in quantities.

The tool-post is mounted on a supplementary slide, dovetailed to the carriage, and under the control of the taper attachment. This supplementary slide has cast to it brackets for the bearings of the sleeve on which the eccentric is mounted. The eccentric rod reciprocates the tool-slide, on which the tool-post may be adjusted to the diameter of work required. The main cross-slide screw operates the supplementary slide.

The lathe shown is equipped with a taper attachment. For round taper turning, the driving shaft of the attachment on the back side of the lathe is disconnected from the spindle, while for plain straight turning the block is disconnected. When this is done the lathe may be run as an ordinary engine lathe. When boring or turning to shape, and using the forming device with or without the taper attachment, the work is done with the same precision and with as little extra care is in turning or boring round surfaces, the whole mechanism being positive and taking care of itself without attention. All the wearing surfaces of this attachment are provided with ample oiling facilities. A depth gage is fitted to the compound rest screw, so that all diameters can be easily and positively duplicated in boring or turning. A gage is furnished for locating the point of the tool for all cutting conditions.

Besides the sockets shown in Fig. 1, other examples of the use of the attachment are shown in Fig. 4. These examples include a series of oval taper shank sockets, inserted one within the other, and a 3-lobed coupling joint, which may be used in the same way as the universal joint common in rolling mill practice. The builders claim that the device is applicable to the making of drives of all kinds, doing away with keys, set-screws, splined shafts and other holding devices. By using the squared design with the ends of the shafts tapered, a square positive coupling drive is procured, free from projecting set-screws and other objectionable features, and one that can be separated quickly and put together again without the necessity of re-facing. The hubs of gears may be bored to a square outline to fit correspondingly square turned shafts. Milling cutters, shell reamers and other tools at present held in place by keys, may also be fastened to their arbors in a similar way. This will avoid much loss from cracking in hardening, due to the weakness in this respect of the sharp corners of the key-way, as at present used.

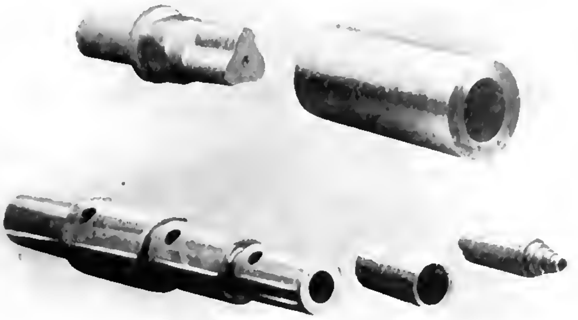


Fig. 4. Samples of Turning and Boring produced by the Attachment.

KEUFFEL & ESSER TAPES WITH KECO FINISH.

The Keuffel & Esser Co., 127 Fulton St., New York, has recently applied a new finish to its line of steel tapes. The illustration shows their Liliput steel tape photographed to show the excellent contrast given by this new finish, known as the "Keco." It will be seen that the figures may be plainly read, the numerals and graduations standing out brilliantly and clearly upon a jet black background. Another advantage of the finish is the fact that it is not injured by exposure to moisture, as rusting is impossible. Its brilliancy is also not marred by handling with moist hands, as is the case with many other methods of finishing.

Fig. 1. The "Liliput" 25-foot Steel Tape; note the Legibility of the Graduations.

The tape shown gives a length of 25 feet in an exceedingly small space. It is known as the "Liliput." It is provided with the maker's compensating centers, which may be adjusted for wear after long use, so as to give just the friction required for the proper winding and unwinding of the tape. This results in materially longer life for the latter.

POWER FEED FOR HOEFER 16-INCH DRILL.

The Hoefer Mfg. Co., Freeport, Ill., has recently designed a power feed for its line of 16-inch drills. This power feed is shown attached to one of these drills in the accompanying engraving. As will be seen the arrangement adopted is rather original and very simple.

The proper ratio for reducing the movement given by the driving shaft to that required for the feed, is obtained by two sets of worm gearing in series. The worm mounted on the driving shaft engages the worm-wheel keyed to the upper end of the vertical shaft, which is supported in a bearing fastened to the upper tie-bar of the frame. The lower end of this shaft carries a 3-step cone, which is belted to a corresponding cone, supported on an arm pivoted to the frame. This second cone is keyed to the shank of a worm, which engages the worm-wheel on the rack and pinion shaft. The engaging or disengaging of the worm is effected by swinging the arm on which it is mounted in towards the worm-wheel or away from it. In the engaged position it is held by a catch operated by a lever, which may be automatically released by an adjustable stop on the spindle sleeve; the depth drilled with the power feed is thus automatically gaged. The tension of the belt on the cone pulleys pulls the worm out of engagement as soon as the trip is released. The rates of feed given with this arrangement for the 16-inch drill are 0.005, 0.008, and 0.012 inch per revolution of the spindles. This has proved to be a suitable range for this size of machine. The convenience of the lever feed has not been sacrificed in attaching this power connection, as the right hand is free to use the lever as before.

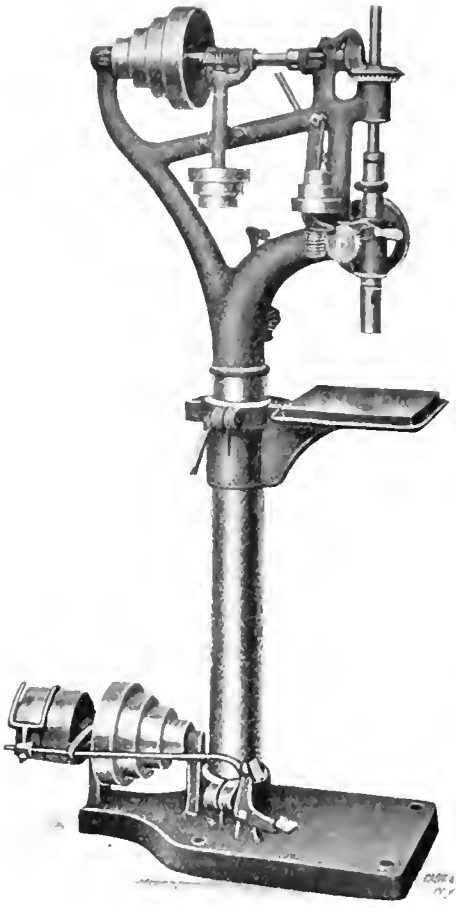


Fig. 1. Hoefer 16-inch Drill arranged with Power Feed.

NOYES VERTICAL T-SQUARE.

The Emmert Mfg. Co., of Waynesboro, Pa., has undertaken the manufacture of the Noyes vertical T-square, which is shown in the two accompanying illustrations. This instrument, which is very well described by its name, comprises a T-square, guided at the top of the board, and provided with a protractor adjustable to any position along its blade. The protractor is arranged with right-angle graduated arms, so as to avoid the necessity for loose scales, thus making the device especially convenient for vertical use.

A round steel track is fastened to the top of the drawing-board. The head of the T-square forms a truck, provided with a set of four rollers which run on and are guided by this track. One pair of the rollers is beveled, and runs on ball bearings, so arranged that the weight of the head holds it down on the track with no lost motion, making possible a

very free and sensitive movement. The head also carries a spring balanced drum to which is attached a cord supporting the vertical sliding protractor, holding the latter to the blade and counterbalancing it. As the protractor is also guided by rollers, it thus has a very sensitive vertical movement. It will be seen that this combination of protractor and T-square makes provision for motion in accurate horizontal and vertical lines.

Pivoted to the sliding protractor is a forked arm, to which interchangeable scales are attached at right angles to each other. This arm is provided with a worm, which engages notches cut on the rim of the protractor, and which can be quickly pressed out of engagement therewith. These notches are spaced 3 degrees apart, thus making possible instantaneous setting of the protractor to any multiple of 3. This includes all the most commonly used angles as 0, 15, 30, 45, 60, 75, and 90 degrees. This 3-degree angle is convenient also in that it is a common draft to give to patterns, and is suitable for the conventional angle used for showing screw threads. For the finer adjustment, the neck of the worm has a graduation of 12 divisions, each of which represents $\frac{1}{4}$ of a degree. Thus, readings are easily made to as fine a scale as $\frac{1}{4}$ of a degree, which is as close as is ever needed in drawings. Interchangeable scales are provided which may give any desired graduations.

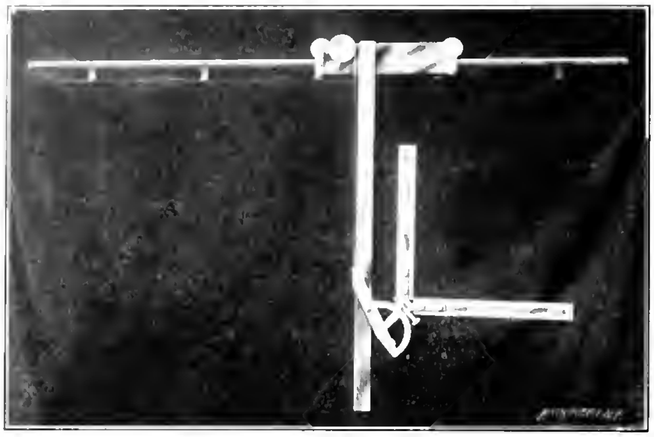


Fig. 1. A T-square which is guided from the Top of the Board and is provided with an Attached Protractor having Adjustable Scales.

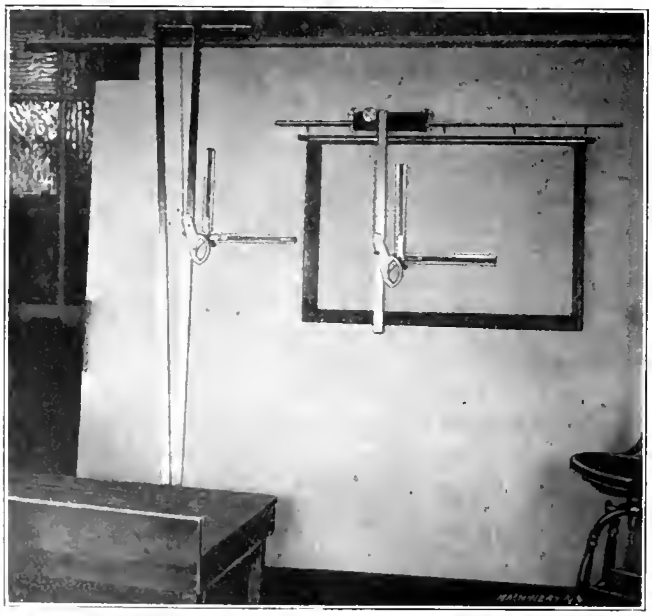


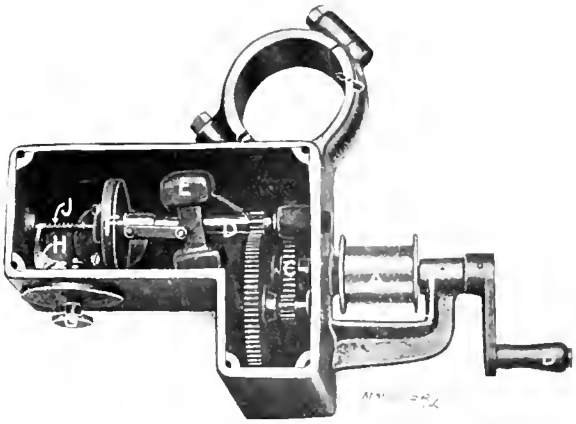
Fig. 2. Two Sizes of the T-square, showing the Application to Small Drawing Boarda, and to Vertical Boards of Great Size.

Fig. 1 shows the instrument itself, which may be seen applied to the smaller board in Fig. 2. In the latter illustration is also seen a modification of the T-square for use with boards of large size, that in question accommodating a drawing 6 x 10 feet. The use of such boards is a great convenience, as it is possible to make full-sized drawings of a large machine with the same ease, accuracy and speed as on a 24 x 36-inch board. Full sized assembled drawings, with each part standing in its natural and normal life-sized position, furnish almost the same advantages as a model. With such a layout the location of the operating mechanism and the handles can be tried, and their convenience and accessibility can be determined. A more accurate scale layout is always possible also when a full-size scale is used.

The use of the instrument is by no means confined to the vertical position, it being equally suitable for use on smaller boards in the ordinary horizontal or inclined position. One of its greatest conveniences, however, is the fact that it may be so readily used on the vertical board as to do away with the inconvenience of holding triangles, scales, etc., on the awkward vertical surface, all these instruments being combined in this one. The advantages of the vertical board are thus made available. Owing to the vertical position of the T-square, it may be made much shorter than when it is guided from the left-hand side of the board, thus resulting in greater accuracy. The device does not take up much room outside of the board, it being necessary to extend the track beyond its ends but a few inches.

GOVERNOR FOR BUCKEYE BLUE-PRINTING MACHINE.

The Buckeye electric blue-printing machine manufactured by the Buckeye Engine Co., Salem, Ohio, is of the type in which the tracing to be copied and the blue-print paper are wrapped around a stationary vertical glass cylinder and held there by a convenient rolling curtain while an arc lamp is lowered through the center of the cylinder at the proper rate to give the length of exposure required to make the desired print. In the older machines, with which most of our readers are familiar, the rate of descent of the lamp and the consequent length of exposure of the sensitized paper was regulated by an adjustable pendulum controlling an escapement, the whole being operated by the weight of the lamp. This device has been superseded by the mechanism shown in the accompanying engraving, which employs a governor to give the speed of descent required.



Blue-printing Machine Governor for Controlling the Movement of the Lamp.

The cord which supports the lamp is wound around drum *A*, which, with the attached crank, serves as the means for raising the lamp at the conclusion of the exposure, in preparation for a new one. Inside of the casing shown, and mounted on the same shaft which carries drum *A* and crank *B*, is a gear *C*. This, through the intermediate gearing, rotates governor spindle *D* at a considerable velocity, the ratio of the geared connection being high. The governor *E* consists of a double weight, connected with arms, and pivoted at center of the spindle. Normally the spring at the right of *E* draws the governor to the outward position, pressing disk *F* (by means of the links shown) down against a bearing in a stationary bracket at the left, which also serves as the outer bearing for the shaft. Disk *F* being splined to the shaft, the friction between it and the stationary surface, under the influence of the spring, is sufficient to prevent the rotation of *D*. The lamp is thus held in a stationary position. On the front of the case is a knob *G*, provided with a pointer indicating graduations on the circular dial shown. *G* is connected to a small worm which meshes with seg-

mental worm-wheel teeth cut in the lower arm of lever *H*. The upper arm of this lever encircles a push-rod *J*, and bears on the lower end of the coiled spring shown mounted on it. *J* passes through the stationary friction bracket into a hole in spindle *D*, where it bears against the cross-pin by which the links are fastened to *F*, and by which *F* is keyed to *D*.

It will be seen that the spring on *J* tends to force *F* away from its stationary seat against the influence of the spring attached to *E*, and that this pressure may be varied by the manipulation of knob *G*. When the pointer on *G* is set at zero, the spring on *J* is released, and that attached to *E* has its full effect in preventing rotation of the parts. As the pointer is turned around to increase the pressure of spring *J*, *F* is raised further from its seat, allowing the spindle to revolve until it has attained such a speed that the governor again forces the disk down to its bearing.

The rate of movement of the lamp will thus be maintained at a point corresponding with that position of the governor balls which just barely allows the friction surfaces to rub on each other, with the spring pressure provided. This spring pressure may be varied by knob *G*, which consequently furnishes a means of adjusting the speed. The dial permits the determination of the proper rate of printing for any given paper and given conditions. This rate may be duplicated with certainty at any time without having to go to the trouble of making trial printings.

This device gives a greater variety of speeds than the older method, being capable of the most minute adjustment. It is noiseless and eliminates all jerk and jar from the lamp, thus greatly increasing the life and efficiency of its mechanism. The whole apparatus is enclosed, free from dust and dirt, in an iron box, which is clamped to the frame of the blue-printing machine at any height to suit the convenience of the operator.

AN ADDITION TO THE SLOCOMB LINE OF MICROMETERS.

The accompanying illustration shows six new micrometers which have been added to the line made by the J. T. Slocomb Co., Providence, R. I. They measure all sizes from 13 to 19 inches, inclusive. The heads are provided with the well-known adjusting arrangement provided with all of this line of micrometers.

Set of Slocomb Micrometers, measuring from 13 to 19 Inches.

The six instruments are furnished with the stand shown, which will be found very convenient for use in the tool-room, a board being provided with hooks for checks, to indicate the numbers of the workmen who borrow them. The base of the board forms a compartment for a set of end measures from 13 to 18 inches, increasing by 1-inch steps. They are 7/16 inch in diameter, and are fitted with rubber grips to avoid changes in length due to the heat absorbed from the hands in making measurements.

AMERICAN GAS FURNACE CO., 24 John St., New York. Gas furnace for hardening with barium chloride. This furnace is especially adapted to the use of this form of hardening bath. The crucible is set into the furnace and sealed, in such a way as to prevent the gas flame from attacking the liquid in the crucible, and thus generating noxious fumes.

JOHN H. DORMAN, 1 Bethune St., New York City. Tapping attachment for use in sensitive drill presses. It will drive taps up to and including 3/8 inch in diameter. A stop is provided which, when the desired depth of tapping has been reached, reverses the spindle and backs the tap out. A friction device has been incorporated in the attachment.

CLEVELAND AUTOMATIC MACHINE CO., Cleveland, Ohio. Motor drive for screw machines. This company provides its screw machines, if required, with motor drives entirely self-contained. The motor is placed at the end of the machine, four posts extending upward from the corners of the frame for the support of the counter-shaft to the machine, which is thus independent of any hangers on the ceiling.

WESTERN RAIL SUPPLY CO., Chicago, Ill. Pneumatic vise of simple and rigid construction. On account of its quick and reliable control it can be used not only as a vise, but as a metal former, punch or forcing press, shear, riveting machine, or bull-dozer. The air-cylinder is cast solid with one jaw and the base of the vise. The piston rod is a solid casting carrying the other jaw of the vise.

THE CINCINNATI SHAPER CO., Cincinnati, Ohio. Heavy 24-inch crank planer. This machine is driven by a positive crank motion of Whitworth type so as to secure a quick return. The cross rail is provided with a head which swivels on each side of the vertical, the angle being read from graduations in degrees. The machine will plane 20 inches high, 20 inches wide and has a 24-inch stroke. It is built with a solid base resting on the floor, and weighs 5,500 pounds.

JOSEPH T. RYERSON & SON, Chicago, Ill. A portable automatic key-seating machine, especially designed for cutting key-ways in locomotive axles, either before or after the engine has been assembled. This machine is operated by an air drill or electric motor, as most convenient. An end mill is used, carried by a slide which reciprocates continuously over the length of the key-way, while the mill is slowly fed in until the desired depth has been reached.

THE WESTINGHOUSE TRACTION BRAKE CO., Pittsburg, Pa. A line of belt-driven air compressors for industrial service. These compressors are made in four sizes, having 15, 26, 44½ and 54½ cubic feet of free air per minute capacity, respectively, at standard speeds. The horse-power for these sizes at 100 pounds pressure is 3, 5, 9 and 11, respectively. They are provided with water jackets, but may be operated without if required. This compressor is of the duplex, horizontal, single-acting type, and is easily portable.

BARDONS & OLIVER, Cleveland, Ohio. Motor driven brass working lathe, in which the motor is mounted directly on the spindle. The controller provided is of the reversible drum type, and has an automatic brake, so that the lathe is brought to rest as soon as the power is shut off, though the controller may be set to allow the spindle to be easily turned by hand when desired. The spindle is reversed by the controller for threading in less time than is possible with a belt. Twenty changes of speed are provided, ranging from 300 to 1,400 revolutions per minute in either direction.

GRAPHLIO A NEW GRAPHITE PRODUCT.

A new form of graphite has been placed on the market by Walter D. Carpenter Co., 39 Cortlandt St., New York. This product is of crystalline structure, but ground to a degree of fineness hitherto unattained except with the amorphous form of the same material. The superior toughness and adhesiveness of the flake or crystalline condition make it very difficult to grind, and it is claimed that until recently it has been impossible to reduce it to the impalpable powdered form which would be most effective for practical application. In grinding the graphite to this condition the operation introduces into the material a considerable quantity of fine grit—waste from the stones used for producing the material. Only a part of this grit could be removed, the process usually adopted being that of "blowing," on the same principle that chaff is separated from grain by winnowing. By a process developed by the manufactnrer of Graphlio, the grit produced by grinding this tough flaked graphite to an impalpable powder is so fully gotten rid of that it is impossible to detect its presence in the finished product, thus making a very superior article for the lubrication of the finest and most closely fitted bearings.

Still another characteristic of Graphlio is the fact that it has been so treated that it will remain suspended in light oil practically indefinitely, and thus may be used in any system of oil piping or lubricators already installed, without requiring any special appliance to be furnished for using it. This permits also the continuous application by sight devices, instead of requiring a troublesome periodical application by force pump or otherwise. It is of the highest commercial purity, containing about 95 per cent carbon and 5 per cent silicate, having thus in a high degree the characteristic advantage of the crystalline over the amorphous form—the latter having usually a large proportion of foreign substances combined with it (such as clay) which it is difficult, if not impossible, to remove. Particular attention is called to its freedom from grit. This may be tested by rubbing a small quantity of it on a hard surface, like a glass plate, with a paper knife or any other convenient implement. The substance is so inexpensive that it adds very little to the cost of a gallon of oil, while it is said that its use will decrease the amount of oil used from 40 to 50 per cent, thus resulting in a marked saving in the cost of lubrication.

* * *

As an interesting example of the working of the true mathematical mind, the case of Prof. Akerlund, of the Boras Technical College. Sweden, who lately died, may be mentioned. In many particulars this man resembled Lord Kelvin, and he was well known in mathematical circles in Scandinavia. His former instructor in mathematics stated that, while at high school, after the first principles and the object of trigonometry and analytical geometry had been verbally explained to him, he worked out and became proficient in the fundamental theories of these two subjects without the aid of any textbooks whatever. While at the university he studied philosophy, but as a true mathematician he would accept nothing which he did not understand, and as he found that the learned text-book in logic used there was beyond his own comprehension, he would not admit that it was founded on real logic, and finally made the professor of the subject himself admit that he, too, did not comprehend the particular subject as tanght. This is the supreme test of the true mathematician. He accepts nothing as fact unless he can comprehend or prove it. In this connection it may be interesting to note that Akerlund, while still at school, constructed an electric motor simultaneously with Gramme. Gramme, however, brought his invention first before the public eye and consequently the credit of being the inventor of the electric motor has been accredited to him.

* * *

Commencing October 1, the postage rate on letters mailed in the United States addressed to places in Great Britain and Ireland, will be 2 cents per ounce or fraction thereof. Letters mailed without postage will be forwarded to their destination, but double the deficient postage calculated at the 2 cent per ounce rate will be collected from the recipient upon delivery.

AN AMERICAN MECHANIC IN EUROPE—6.

A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

STOCKHOLM, SWEDEN, August 12th, 1908.

The commercial situation in Sweden at the present time appears to be somewhat discouraging. The wave of industrial depression which began last fall in the United States, reached Sweden later than the larger European countries, and consequently the improvement in conditions will doubtless commence somewhat later as well. The machinery dealers who handle largely foreign machines—American, English or German—feel the depression most keenly. The Swedes are patriotic by nature, and, therefore, prefer to buy the products of home industry, other conditions, such as price, quality, etc., being about equal; as a consequence, the importers of foreign products received the first and hardest shock in the financial and industrial depression. The greater number of the works visited here are still working full time, though some of them are building for stock.

The industrial depression in Sweden has, however, also a local cause. The labor unions have during the last few years become very powerful and have time and again, with more or less success, tried to better the conditions of the working people. This summer a dispute arose between the men and employers in some shops, and a strike was declared. The questions involved were rather complex and it appeared at one time as if all the Swedish industries would be drawn into the conflict, and the Employers' Association threatened a general lockout affecting the whole organized force of labor of the country. At the very last moment, however, this extreme step was prevented, and temporary peace, at least, restored. The feeling of unsafety which this state of affairs naturally brought about, had a very demoralizing influence on industry in general, and firms neither dared to take or place an order. The restored peace, however, it appears, has also restored confidence, and already signs are visible of a considerable revival in the industries.

The sales of American machine tools in Sweden are stated to be on the decrease as compared with the sale of other machine tools. Germany, being near to this territory and being in possession of a better knowledge of local conditions, is a very able competitor with America; and the Germans also have the advantage of shorter shipping distances, and can, consequently, deliver their machines more promptly, and, at the same time, the freight charges are smaller. English machinery is also sold to quite a large extent in Sweden, and the competition on the part of the home manufacturers is making itself more and more keenly felt. A few Swedish machine builders are beginning to specialize on standard machine tools to a considerable degree.

Noteworthy Swedish Works.

The largest of the works located in Göteborg is Lindholmen's Mekaniska Verkstad. These works are largely devoted to the shipbuilding trade, and are equipped with some very large docks for the purpose. Many of the vessels for the Swedish navy are built here, and one was under construction at the time of the writer's visit to the plant. The shops are also equipped for building engines and boilers, and for sheet metal work in general. The boiler department is well up to date and equipped with the most modern machinery, but the machine shop is less modern. The most notable work in the hands of the company at this time, perhaps, is the construction of one of the large railway ferryboats ordered by the Swedish government for the traffic between Sweden and Germany. This boat, which is to ply between Trelleborg, Sweden, and Sassnitz, Germany, a distance of some 65 miles, has a capacity of from 15 to 18 railway cars in addition to spacious accommodations for the passengers. The length of the ferryboat is 348 feet, the width being 48 feet.

One of the best-known of the Swedish mechanical works is that of Nydqvist & Holm, Trollhättan. This firm has gained a high reputation in locomotive building, most especially for the high quality of workmanship and careful design of its product. A large number, perhaps, in fact, the largest number of all the locomotives used by both the state

railways and the private roads in Sweden, are made by this concern. For some years past, the firm has also made a specialty of air compressors and pumping machinery, and is, at the present time, starting out in still another line of machine building—that of building gas engines. Sweden has no coal deposits worth mentioning, but is instead in possession of large quantities of peat. The company is now carrying on extensive experiments with a view to using peat in gas producers for the motive power of gas engines. It is stated that there have been some difficulties in connection with these experiments in regard to the gas purifying apparatus, but it is said that the company has been able to eliminate all the difficulties which have arisen; the results of the experiments, however, are still kept secret. A large new machine shop has recently been erected by the firm, which is to be used in addition to the old shops, the latter being too small for the growing business. The new shop is splendidly lighted, and equipped with up-to-date heavy-duty machine tools and large electric traveling cranes. The electric welding process is employed in these works and gives very satisfactory results. It is used largely for mending and welding castings, and it is stated that the welded joint is as strong as the unbroken piece. On account of the large amount of current consumed by the process, it is only run during the night, when there is but little load on the generators.

A remarkable piece of work now in course of construction in these works, is one of the two large water turbines, each of 12,500 H. P., for the government power generating station at Trollhättan. The utilization of the Trollhättan falls by a large government power station, which will ultimately also furnish power for part of the electrified state railways, has previously been, from time to time, referred to in MACHINERY. When complete, the present station will have 8 turbines, each of 12,500 H. P., or a total of 100,000 H. P. Only four units are, however, to be installed at the present time, and the others will be installed as the demand for power increases. The required canal, the tunnels and the buildings, are at the present time built large enough to take care of the ultimate capacity. The energy is transformed by exceptionally large generators into three-phase, 25 period, alternating current of 50,000 volts tension. The current is to be utilized partly by factories within easy reach of the power station, and partly by neighboring cities and towns for lighting purposes. In the future, of course, when the electrification of the state railroads has been carried through, the greater part of the power will be consumed by these. The power plant is planned to be ready January 1, 1910.

A concern which for some time past has been devoting itself exclusively to the building of machine tools, is Lidköpings Mekaniska Verkstad, Lidköping. While this firm largely specializes on lathes, it does not devote itself exclusively to this one line in the American sense of the word specialization, but builds also a large number of other types of machine tools, such as drills, planers, boring mills, etc. This firm's machines, although not of so highly developed design as American machine tools, are strong and powerful, and, apparently, of good workmanship.

The Motala Mekaniska Verkstad, Motala, is one of the largest works in the country, employing about 1,000 men. These works are equipped principally for the making of marine engines, boilers and locomotives, and for bridge building, and have recently commenced to develop a line of oil engines. The concern is old and well established, and commands a skilled and well-trained staff of officers and men, and to the skill of the workmen, rather than to the employment of high-grade tools, must be credited the high class of work produced. Besides the regular machine shops, there is also a small rolling mill plant largely for the individual needs of the shop, and a well-equipped forging shop for heavy forgings. The company also makes the larger portion of its own locomotive accessories.

Without question, the best and highest developed of the Swedish machine tool firms is the Köpings Mekaniska Verkstad, Köping. This is a medium-sized concern which during the course of the last few years has specialized on lathes of large and small types. The largest types of machines are usually built to order, but medium sizes are often built lots of from six to twelve and smaller ones in lots of twenty at a time. Following the practice of most other European works, the company, however, makes also a few other machine tools, such as planers milling machines, drills, etc. but the building of these machines is more or less spasmodic depending upon the variations of demand in the lathe business. A very high class of machine tools is employed in these shops, and the works are conducted according to the most modern methods. Recently some of the latest styles of American grinding machines were bought and introduced into the shops, and the company is commencing to use the latest American methods in grinding; electric chucks are used to a large extent in connection with the grinding machines. An increase in trade is expected by the company in the near future, and an enlargement of the works is therefore contemplated.

A firm which is known outside of Sweden as a machine tool building firm of repute, is Nya Aktiebolaget Atlas, Stockholm. This firm has developed a number of original designs of machine tools, such as drills, milling machines, boring mills, gear-cutting machinery, etc. During the last few years, however, its manufacture of machine tools has gradually diminished, partly because of the keen German competition. The firm is still engaged in this work, but only to a small extent, its efforts being directed toward the locomotive and railway car building industry. The firm is also building steam engines, air compressors, pneumatic tools, railroad bridges, etc. On account of the high price of land in Stockholm and the consequent high living expenses and high wages, the company is contemplating moving the works to a town a few miles out from the city. The first portion of the shops will probably be moved in about a year, and the remainder later, according to the conditions of the trade.

* * *

FIRE RISK IN LOWER NEW YORK CITY.

Owing to the concentration of enormous buildings, the lower end of Manhattan Island is regarded by insurance experts as a very dangerous fire risk. Mr. William McCarroll, president of the New York Board of Trade and Transportation, has published a letter from Mr. P. F. Schofield, in which the danger is vividly pointed out. Mr. Schofield states that the area of Manhattan Island between 14th St. and the Battery is about equal to the area of Chicago, swept by the fire of 1871 in which the property loss was $170,000,000. The assessed valuation of the improvements on this section of New York is over $400,000,000, and the merchandise housed in these buildings brings the valuation up to more than $1,000,000,000. One warehouse alone in this district is said to have stored at one time merchandise valued at more than $50,000,000. It is no wonder then that the wholesale dry goods district of Manhattan is the "nightmare of the insurance world." A conflagration in this section of New York, on the scale of the Chicago fire, would wipe out property values unparalleled, and the effect of such a disaster would not be limited to the metropolis or to New York State. It would be felt in every city of the union, and in the Old World as well. The geographical situation of Manhattan Island, between two rivers, and the narrow cross streets, make the condition very favorable to the spread of a fire, especially when it is considered that winds attaining velocities of forty to fifty miles an hour in combination with a temperature below the freezing point, are not unknown. Take such a situation, with insufficient water pressure, and the possibility of a fire that would be unparalleled in property destruction in the world's history is not so remote as it might be. Should such a fire gain headway, the towering piles of architecture that dominate Broadway, and which are considered impregnable to fire would, in no small measure, add to the conflagration. The streets would be converted into artificial tunnels and canyons, acting like funnels or blow pipes to fan the flames when they had once gotten beyond the control of the fire department, and the flames would leap from building to building far above the puny streams that the fire engines and water towers could throw.

OBITUARY.

Harris Tabor.

Harris Tabor, of the Tabor Mfg. Co., died July 29, 1908, at his home in Philadelphia, his death being the result of an automobile accident which occurred on July 4 of last year. He was on his way to visit friends when the heavy machine in which he was riding was overturned by the shifting of the soil of the narrow hillside road they were following. He was caught beneath the overturned machine and seriously injured, and was confined to his bed until the first of September, shortly after which he resumed his duties at the Tabor Mfg. Co. His improvement was slow, and in March he contracted a severe cold which early in May forced him to again take to his bed. This, together with his weakened condition, brought about his death.

He was born in Clarence, Erie County, New York, on January 26, 1843. At the age of 21 he enlisted as a private in the Civil War for a term of two years. He was honorably discharged and mustered out of service at Elmira, N. Y. He began his mechanical training as an apprentice in the shop of his brother, Leroy Tabor, Sr., at Tiago, Pa., where he remained two years previous to his enlistment. After leaving the army he went to work as a machinist with S. Payne at Troy, N. Y. From there he went to B. W. Payne & Sons, Corning, N. Y., and when this company moved to Elmira, he was made superintendent. In the early 80's he moved to Hartford, Conn., to assume the position of superintendent of the Hartford Steam Engine Works. After a year here he went to Pittsburg as superintendent of the Westinghouse Machine Co., where he remained for three years. During all this time his work had been specialized in the line of steam engineering. The well-known Tabor governor and Tabor steam indicator were invented and placed on the market during this period The former was sold to, and is now being manufactured by, the Ashcroft Mfg. Co.

While with the Westinghouse Machine Co. he became interested in foundry work, and conceived the idea of a power operated molding machine. For furthering the development of this idea, he associated himself with Manning, Maxwell & Moore, and later resigned his position in Pittsburg and took up quarters in New York, where he could give the development of the molding machine his full attention. In 1888 he placed on the market the first successful power molding machine, operated by steam, through an over-head cylinder In the fall the manufacture of the machine was transferred to the Pond Tool Works, Plainfield, N. J., and continued there until the early 90's when the Tabor Mfg. Co was organized, and the manufacture of the machine transferred to Elizabeth, N. J., where the vibrator system of molding and the first compressed air machine were brought out. In 1900 the greater portion of the interest of the company was sold to Mr. Wilfred Lewis, and in September of that year the plant was transferred to Philadelphia. Up to this time he had been president of the company. From 1900 to 1906 he was occupied in looking after his various interests, and acting in the capacity of consulting engineer of the Tabor Mfg. Co. In June, 1906, he moved to Philadelphia, where he again took active part in the affairs of the company up to the time of his illness. Mr. Tabor is survived by a wife.

* * *

PERSONAL.

W. E. Farrel has been elected president of the Stoever Foundry & Mfg. Co., Myerstown, Pa., succeeding Ralph McCarty, who has resigned.

Walter J. Friedlander has been made general manager of the Hisey-Wolf Machine Co., Cincinnati, Ohio, manufacturer of electric drills, grinders, etc.

Walter S. Lang, of the Glasgow branch of Charles Churchill & Co., Ltd., sails for Great Britain September 8. He has spent considerable time in this country studying American methods in a number of the prominent machine tool manufacturing shops.

Forrest E. Cardullo, an occasional contributor to MACHINERY, who was instructor of practical mechanics at Syracuse University, has resigned his position and has been made professor of mechanical engineering at the New Hampshire State College, Durham, N. H.

Edward R. Euston has been elected vice-president and general sales manager of the Stoever Foundry & Mfg. Co., Myerstown, Pa. He will have offices at 140 Cedar Street, New York City. Mr. Euston has been manager of the company's New York office for the past six years.

R. B. Anthony, graduate of University of Wisconsin; E. L. Moreland, graduate of Johns Hopkins University, and F. W. Willey, graduate of Purdue University, have received the degree of master of science from the Massachusetts Institute of Technology for post graduate work done in the electrical engineering department.

S. Coulange, for the past twelve years designer for the Fabrique Nationale d'Armes de Guerre, of Herstal, Belgium, and representative of Fenwick, Freres & Co., has opened an office in Rue Louvrex, Liege, Belgium, as a consulting, inventing and constructing mechanical engineer of machine tools and special machinery. American and foreign manufacturers are requested to send Mr. Coulange their catalogues.

B. B. Quillen, secretary and treasurer of the Cincinnati Planer Co., Cincinnati, Ohio, and Alfred Marshall, president of the Marshall & Huschart Machinery Co., with their wives and a party of friends, left Cincinnati on August 13th in automobiles for a tour through the East, and will travel through Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, visiting New York city, Philadelphia, Atlantic City, etc. The party expects to be on the road four weeks.

Arthur D. Dean has been appointed chief of the division of trade schools of New York State, the appointment taking effect September 1. This appointment is made in accordance with an act passed by the New York legislature this year authorizing the establishment of industrial and trade schools in cities and union free school districts. Mr. Dean will do much traveling throughout the State to meet boards of education and gatherings of citizens interested in promoting local trade schools and industrial education.

* * *

NATIONAL MACHINE TOOL BUILDERS' CONVENTION.

The National Machine Tool Builders' Association will hold its regular annual convention at the Hotel Imperial, corner of Broadway and 32d Street, New York, Tuesday and Wednesday, October 20th and 21st. Further information may be obtained from the secretary, Mr. P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio.

* * *

Never forget that you must begin at the bottom and not at the top if you desire results. Scattering seeds over an unprepared surface is a waste of time. You must plow first. Then the results will be in direct proportion to the persistence with which the work is followed up.—*Geo. G. Yeomans before the Railway Storekeepers' Association.*

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ADVANCED DEGREES IN ELECTRICAL ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

The demand for young men with a more extended and a deeper training in electrical engineering theory than can be obtained in an undergraduate engineering course has led the Massachusetts Institute of Technology, Boston, Mass., to emphasize its graduate courses. These graduate courses lead either to the degree of master of science for young men who propose to spend one year of advanced study of electrical engineering, or to the degree of doctor of philosophy or doctor of engineering for young men who are able and propose to spend longer periods in their advanced study and research. The degrees of master of science and doctor of engineering are particularly applicable to students following electrical engineering studies, and lectures, seminars, and other advanced instruction for students who are candidates for the doctor's degree will be well under way in the electrical engineering department during the next school year. In addition to students who will follow the course leading to the degree of master of science, candidates who will follow the works leading to the degree of doctor of engineering have already arranged to begin this work at the Institute next fall. The advanced work leading to the doctor's degree may follow in its major part either the lines outlined by Professor Jackson's lectures on the organization and administration of public service companies, or by Professor Clifford's advanced course on alternating currents, as the individual student may choose, and it is expected to be accompanied by such other work as may be chosen by the individual student (subject to faculty approval) from other departments of science and engineering. It is believed by the faculty of the Massachusetts Institute of Technology, that engineering students of particular ability can well afford to spend from one to three years of special advanced study under competent instructors along the lines of engineering theory and practice, and that such students will profit largely from the results of such study. Indeed, this seems to be proved by the experience of numbers of engineering students who have gone through courses of advanced study in engineering or scientific schools either in this country or abroad. The schools of foreign countries were doubtless formerly in advance of the American schools, for the purpose of advanced study in engineering and applied science, but it is believed that this condition no longer prevails. The advanced courses in electrical engineering at the Institute are planned particularly with a view to meeting the needs of such students as have hitherto found it necessary to go to foreign countries for advanced engineering instruction.

* * *

LUDWIG LOEWE & CO.'S SCHOOL FOR APPRENTICES.

The machine tool building firm of Ludwig Loewe & Co., Berlin, Germany, has installed in its shop a very complete apprenticeship school. There are seven different courses for apprentices, according to the work for which the young man wants particularly to fit himself. The time of apprenticeship for all-around machinists is four years, divided up between nine different departments in the shop. For tool-makers, molders, pattern-makers, lathe hands, planer and milling machine hands, and blacksmiths, the apprenticeship time is three years. The apprentices are given a rather thorough all-around experience, the lathe hands, for instance, spending three months in the tool grinding department and three months in the hardening department; the pattern-maker apprentices spending six months in the foundry, etc. Besides the practical training, the boy attends an apprentice's school within the shop in which he spends eight hours a week the first year (in the case of a four year's apprenticeship eight hours for the first two years), seven hours for the second year (or third) and six hours for the third (or fourth) year. The curriculum is made up not only of purely mathematical subjects, such as geometry, algebra, drawing, strength of materials, etc., but a general course is also included, giving the rudiments of business law, civics and political economy. Besides this two hours a week are devoted during the last two years to the study of German. It appears that the idea of this apprenticeship school is not only to train good workmen, but also to produce men who have a broadened view of their work and their duties, and who will, if successful in their mechanical work, be able to take any kind of a responsible position around the shop that may fall to them. There is no doubt that an apprentice training planned broadly will give more satisfactory results in the long run than one planned along too narrow and specialized lines.

* * *

ASHES FOR PILLARS IN COAL MINES.

In some of the anthracite coal mines of northeastern Pennsylvania, ashes are being used as pillars to prevent cave-ins. Flushed in the spaces formerly occupied by coal, the ashes form a solid mass when the water drains off, capable of holding up the earth and rock above. Thus they enable the miners to "rob pillars"—to take out coal which they had been forced to leave as supports. A mine just outside of Scranton, Pa., is near a big boiler plant which consumes three hundred tons of coal daily. Naturally, a large supply of ashes is created in the fire boxes beneath the boilers. It is estimated that about fifty tons of ashes a day are sent down into the mine. Water pumped from a nearby mine is used for the flushing. Running through a wooden trough, it reaches a tunnel that passes beneath the ashpits. This tunnel slopes at a grade of three-eighths inch to the foot. At intervals the ashes are shaken into it from above. The flow of the water carries the ashes to a borehole leading down through the ground to the mine. At the bottom are pipes leading to the worked-out places which are to be filled. Through the pipes goes the torrent of ashes and water, and the ashes are piled into the abandoned "breast" or gangway, while the water seeps and drains away. Gradually the pile of ashes grows, until it reaches from floor to roof. Then it becomes hard and firm. Nearby have been left pillars containing hundreds of tons of coal. When the new ash-pillars are large enough to be safe supports, the coal can be taken out. The piping is worn out very rapidly by the sulphur which is always present in mine water and therefore has to be replaced frequently.

* * *

INTERNATIONAL CONGRESS OF INVENTORS.

In view of the discussion that has been carried on in the columns of MACHINERY and elsewhere regarding the status of inventors and their relation to the U. S. Patent Office, it is interesting to know that an organization known as the International Congress of Inventors was established in 1906 and incorporated in 1907 for correcting present abuses and furthering the interests of inventors. Its object is to secure legislation which shall insure to the inventor the services of the patent office which his application fees should provide and protection for his inventions which a government guarantee should give. It was largely through the efforts of this association that Congress this year provided for an increased force of examiners and for an advance in the salaries of the patent office employees. An important matter now under consideration by the association is the establishment of a standard for a United States patent. The patent system purports to be a system for insuring a reward to inventors for their efforts and for stimulating the production of inventions of value to the public, but patentees and holders of patents have found that a United States patent has no definite standing until it has been passed on by the courts. Further information regarding the objects of the association can be obtained from Mr. Ralph T. Olcott, secretary, International Congress of Inventors, Rochester, N. Y.

* * *

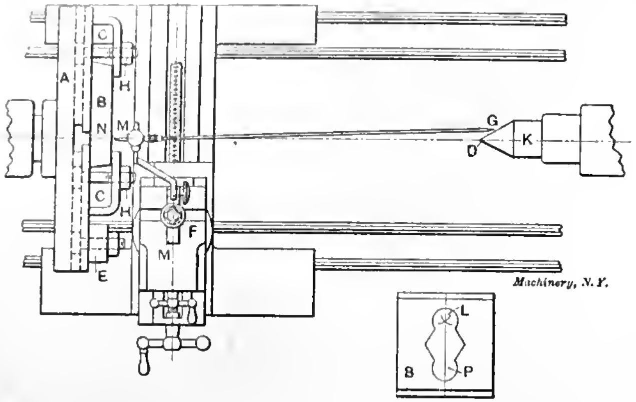
Experiments carried out at the testing plant of the United States Geological Survey, regarding the fuel value of Florida peat, indicate that in a gas producer plant this peat produces gas having a thermal value of 175.2 B.T.U., compared with 149.6 B.T.U. for West Virginia coals and from 141.6 to 153.2 B.T.U. for Pennsylvania coals. The amount of peat consumed per brake horse-power was 2.08 pounds as compared with 1 pound of West Virginia coal, and 1.12 pounds to 1.47 pounds of Pennsylvania coals.

Supplement to MACHINERY, October, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Machining the Hole for the Punch and Finishing a Blanking Die."

SHOP OPERATION SHEET NO. 76.

C. F. Emerson. MACHINERY, October, 1908.



To True Up on the Face-plate of a Lathe a Prick-punch Mark that has been Spotted on the Face of a Die Blank.

NOTE.—The die blank is assumed to have been planed, laid out, and the centers of the holes to be bored or drilled prick-punched, previous to this operation. The die blank, as laid out, is shown in the lower right-hand corner of the sketch. The prick-punch center *L* is to be trued up with the center of the lathe spindle.

1. Strap die blank *B* on the face-plate *A*, by the aid of the straps *C* and the bolts and nuts *H*. Bring the tail-stock forward, close to the face-plate, and move the tail center *K* forward, so that the point almost touches the die blank *B*.

2. Remove the belt from the head-cone, and let it hang loose.

3. Turn the lathe spindle by hand, and true up the prick-punch mark by lightly tapping die blank *B* until the mark is apparently true with the point *D* of the tail center.

4. Strap weight *E* to the face-plate, to counter-balance the weight of the die blank *B*, which is eccentrically clamped on the face-plate.

5. Revolve face-plate by hand to see if it has been counter-balanced correctly. If not, replace *E* with a heavier or lighter weight, as required.

6. Place the indicator *M* in the tool-post *F* and bring the centering point *N* of the indicator forward so as to enter the prick-punch mark on *B*.

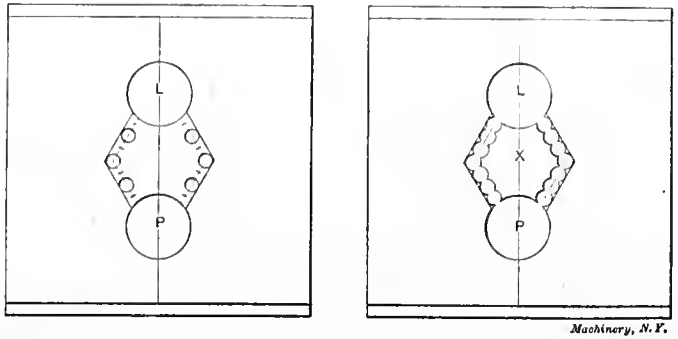
7. Revolve the face-plate *A* and see if the rear end point *G* of the indicator moves. If it does, the prick-punch mark does not run fully true.

8. Turn the face-plate by hand, letting *G*, which will move in a circle, come as close to tail-center *K* as possible. Then tap die blank *B* lightly at a point in a straight line with the center of the lathe spindle, until point *G* remains perfectly motionless when the spindle is revolved.

NOTE.—After having trued up the prick-punch mark, spot and drill hole *L*, and then bore it with an inside turning tool to a taper of 1½ degree on each side, for clearance. Repeat the operation of truing up, drilling, and boring for the hole *P*.

SHOP OPERATION SHEET NO. 77.

C. F. Emerson. MACHINERY, October, 1908.



To Drill Out the Core in a Die, Eliminating the Necessity of Broaching Out the Web of Stock between the Hole.

NOTE.—Previous to this operation the die blank has been planed and holes *L* and *P*, drilled and bored. The core should be drilled out so that the drilled holes incline about 1½ degree with the perpendicular to the face of the die, for clearance.

1. Place a drill in a drill chuck, and tighten the chuck jaws.

2. Lay the die on the drill press table, and proceed to spot every alternate prick-punch mark with the drill.

3. When spotting the holes, care should be taken to see that the drill does not run into the scribed outside lines. Where the drill shows a tendency to do so, draw the spotted hole over towards the inside with a small chisel.

4. Place a thin piece of sheet steel under the corner of the die directly opposite the holes to be drilled. The sheet steel piece is put in so that the holes will be drilled at a slight angle with the bottom of the die, to make unnecessary the operation of reaming the holes from the back with a taper reamer, in order to save time in filing out the die, which is filed to an angle of 1½ degree for clearance.

5. Proceed to drill a hole at every other prick-punch mark all around the inside of the scribed line, as shown to the left in the engraving.

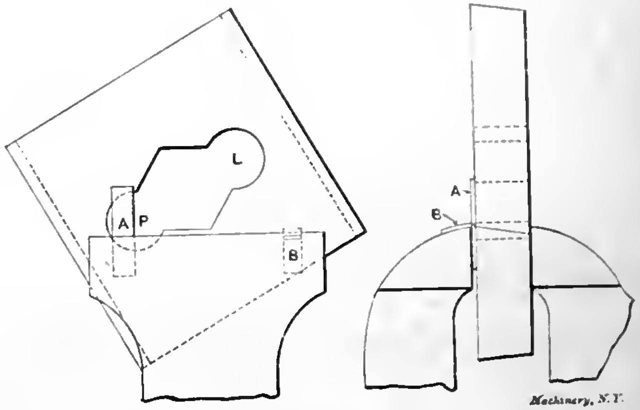
6. After having drilled every other hole, proceed to drill the holes indicated by the prick punch marks between the holes already drilled. When all these holes are drilled, as shown to the right in the engraving, core *X* falls out.

7. With a sharp chisel chip out the remaining projecting points, almost down to the scribed line. In chipping, begin at the face of the die and chip through. If the start is made at the bottom of the die, the stock is apt to break off below the scribed line on the face of the die when the chisel comes through.

NOTE.—When the shape of the opening in the die does not permit the chipping all the way through from the face of the die, chip through as far as the open space will permit, and then begin chipping from the bottom of the die, to meet where the chisel left off when entering from the top.

SHOP OPERATION SHEET NO. 78.

C. F. Emerson. MACHINERY, October, 1908.



To File Out a Blanking Die to Fit a Sample Blank or Templet.

NOTE.—It is assumed that, previous to this operation, the die has been planed, the shape of the opening laid out, the holes *L* and *P* drilled and bored, and the core in the center of the opening removed by drilling around the scribed outline of the core as shown in Shop Operation Sheet No. 77.

1. Place the die in a vise with the face of the die towards the back of the vise.

2. Place pieces *A* and *B* in the vise as shown. Piece *A* prevents the edges of hole *P* in the die from coming in contact with the edge of the file when the die is filed out. Piece *B* simply serves the purpose of permitting the die to be held parallel in the vise.

3. A coarse file is first used for rough filing the opening, filing down to the inside of the lines scribed. File to a clearance of about 1½ degree.

4. Insert the sample blank or templet from the bottom of the die, pressing it lightly forward as far as it will go into the opening in the die.

5. Remove the die from the vise, and hold it up to the light, and mark with a lead pencil those parts of the die where the sample blank bears against the sides of the opening in the die.

6. Remove the sample blank, place the die in the vise, and file out the lead pencil marks. Insert the blank once more, and repeat the operation described in steps 4 and 5 until the blank will pass through the opening. When the die is nearly filed out to the required size, use a fine file for finishing.

NOTE.—In filing out the die opening, care should be taken to see that the clearance is filed straight, and not rounded, as in the latter case, the die will not cut the stock properly and the blanks will not readily drop through the opening. The clearance angle may be made correct and uniform by the use of a die-maker's square, which differs from other squares in that the blade is set at an angle of 90 degrees plus the clearance angle, with the stock.

Tables for the Articles in this number entitled "Band and Block Brake

FORMULAS FOR BLOCK BRAKES.

F = force in pounds at end of brake handle,

P = tangential force in pounds at rim of brake wheel,

μ = coefficient of friction between the brake block and brake wheel.

(1) Block brake (Fig. 1)

For rotation in either direction:

$$F = P\frac{b}{a+b}\times\frac{1}{\mu} = \frac{Pb}{a+b}\left(\frac{1}{\mu}\right)$$

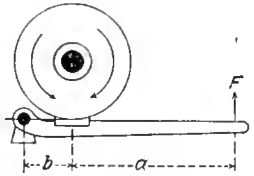


Fig. 1.

(2) Block brake (Fig. 2)

For clockwise rotation:

$$F = \frac{\frac{Pb}{\mu}-Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu}-\frac{c}{b}\right)$$

For counter clockwise rotation:

$$F = \frac{\frac{Pb}{\mu}+Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu}+\frac{c}{b}\right)$$

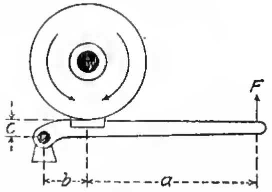


Fig. 2.

(3) Block brake (Fig. 3)

For clockwise rotation:

$$F = \frac{\frac{Pb}{\mu}+Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu}+\frac{c}{b}\right)$$

For counter clockwise rotation:

$$F = \frac{\frac{Pb}{\mu}-Pc}{a+b} = \frac{Pb}{a+b}\left(\frac{1}{\mu}-\frac{c}{b}\right)$$

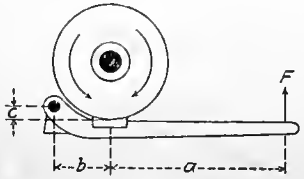


Fig. 3.

The brake wheel and friction block of the block brake are often grooved as shown by Fig. 4. In this case substitute for μ in the above equations the value $\frac{\mu}{\sin\alpha+\mu\cos\alpha}$ where α is one half the angle included by the faces of the grooves.

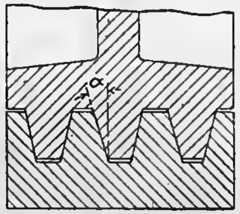


Fig. 4.

Contributed by A. L. Campbell.

FORMULAS FOR SIMPLE AND DIFFERENTIAL BAND BRAKES.

F = force in pounds at end of brake handle,

P = tangential force in pounds at rim of brake wheel,

e = base of natural logarithms = 2.71828,

μ = coefficient of friction between the brake band and the brake wheel,

θ = angle of contact of the brake band with the brake wheel, expressed in radians (one radian = $\frac{180^\circ}{\pi}$ = 57.296 degrees),

$$T_1 = P\frac{1}{e^{\mu\theta}-1}, \qquad T_2 = P\frac{e^{\mu\theta}}{e^{\mu\theta}-1}.$$

(1) Simple band brake (Fig. 1)

For clockwise rotation:

$$F = \frac{bT_2}{a} = \frac{Pb}{a}\left(\frac{e^{\mu\theta}}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{bT_1}{a} = \frac{Pb}{a}\left(\frac{1}{e^{\mu\theta}-1}\right)$$

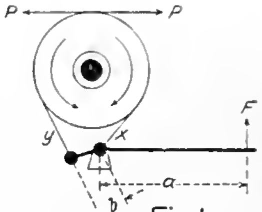


Fig. 1.

(2) Simple band brake (Fig. 2)

For clockwise rotation:

$$F = \frac{bT_1}{a} = \frac{Pb}{a}\left(\frac{1}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{bT_2}{a} = \frac{Pb}{a}\left(\frac{e^{\mu\theta}}{e^{\mu\theta}-1}\right)$$

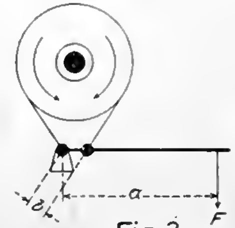


Fig. 2.

(3) Differential band brake (Fig. 3)

For clockwise rotation:

$$F = \frac{b_2T_2-b_1T_1}{a} = \frac{P}{a}\left(\frac{b_2e^{\mu\theta}-b_1}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{b_2T_1-b_1T_2}{a} = \frac{P}{a}\left(\frac{b_2-b_1e^{\mu\theta}}{e^{\mu\theta}-1}\right)$$

In this case, if b_2 is equal to, or less than, $b_1e^{\mu\theta}$, the force F will be 0 or negative and the band brake works automatically.

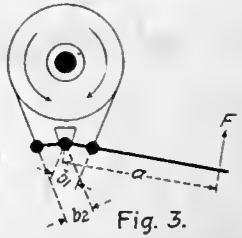


Fig. 3.

(4) Differential band brake (Fig. 4)

For clockwise rotation:

$$F = \frac{b_2T_2+b_1T_1}{a} = \frac{P}{a}\left(\frac{b_2e^{\mu\theta}+b_1}{e^{\mu\theta}-1}\right)$$

For counter clockwise rotation:

$$F = \frac{b_1T_2+b_2T_1}{a} = \frac{P}{a}\left(\frac{b_1e^{\mu\theta}+b_2}{e^{\mu\theta}-1}\right)$$

If $b_2 = b_1$, both of the above formulas reduce to $F = \frac{Pb_1}{a}\left(\frac{e^{\mu\theta}+1}{e^{\mu\theta}-1}\right)$. In this case the same force F is required for rotation in either direction.

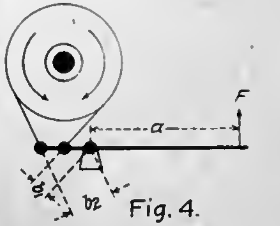


Fig. 4.

Contributed by A. L. Campbell.

I.—TABLE FOR BLOCK OR MULTIPLE INDEXING.

Teeth to be cut	Number Indexed at once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disc	Teeth to be cut	Number Indexed at once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disc
25	4	100	50	72	30	4	62	5	100	30	90	62	2
26	3	100	50	90	52	4	63	5	100	30	80	56	2
27	2	100	50	60	54	4	64	5	100	30	90	64	2
28	3	100	50	90	56	4	65	4	100	50	96	52	2
29	3	100	50	90	58	4	66	5	100	44	80	40	2
30	1	100	50	60	60	2	67	5	100	30	90	67	2
31	3	100	50	90	62	4	68	5	100	30	90	68	2
32	3	100	50	90	64	4	69	5	100	46	80	40	2
33	4	100	50	80	44	4	70	3	100	50	90	70	2
34	3	100	50	90	68	4	72	5	100	30	90	72	2
35	4	100	50	96	56	4	74	5	100	30	90	74	2
36	5	100	48	80	40	4	75	7	100	30	84	50	2
37	5	100	30	90	74	4	76	5	100	30	90	76	2
38	5	100	30	90	76	4	77	4	100	70	96	44	2
39	5	100	30	90	78	4	78	5	100	30	90	78	2
40	3	100	50	90	80	4	80	3	100	50	90	80	2
41	5	100	30	90	82	4	81	7	100	30	84	52	2
42	5	100	30	90	84	4	82	5	100	30	90	82	2
43	5	100	30	90	86	4	84	5	100	30	90	84	2
44	5	100	30	90	88	4	85	4	100	50	96	68	2
45	7	100	50	70	30	4	86	5	100	30	90	86	2
46	5	100	30	90	92	4	87	7	100	30	84	58	2
47	5	100	30	90	94	4	88	5	100	30	90	88	2
48	5	100	30	90	96	4	90	7	100	30	70	50	2
49	5	100	30	90	98	4	91	3	100	70	72	52	2
50	7	100	50	84	40	4	92	5	100	30	90	92	2
51	4	100	30	96	68	2	93	7	100	30	84	62	2
52	5	100	30	90	52	2	94	5	100	30	90	94	2
54	5	100	30	90	54	2	95	4	100	50	96	76	2
55	4	100	50	96	44	2	96	5	100	30	90	96	2
56	5	100	30	90	56	2	98	5	100	30	90	98	2
57	4	100	30	96	76	2	99	10	100	30	80	44	2
58	5	100	30	90	58	2	100	7	100	50	84	40	2
60	7	100	30	84	40	2	102	5	100	30	60	68	2

Contributed by Racquet.

II.—TABLE FOR BLOCK OR MULTIPLE INDEXING.

Teeth to be cut	Number Indexed at once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disc	Teeth to be cut	Number Indexed at once	First Driver	First Follower	Second Driver	Second Follower	Turns of Locking Disc
104	5	100	60	90	52	2	152	5	100	60	90	76	2
105	4	100	70	96	60	2	153	5	100	68	80	60	2
108	7	100	30	70	60	2	154	5	100	56	72	66	2
110	7	100	50	84	44	2	155	6	100	50	72	62	2
111	5	100	74	80	40	2	156	5	100	60	90	78	2
112	5	100	60	90	56	2	160	7	100	50	84	64	2
114	7	100	30	84	76	2	161	5	100	70	60	46	2
115	8	100	50	96	46	2	162	7	100	60	84	52	2
116	5	100	60	90	58	2	164	5	100	60	90	82	2
117	8	100	30	96	78	2	165	7	100	50	84	66	2
119	3	100	70	72	68	2	168	5	100	60	90	84	2
120	7	100	50	70	40	2	169	6	96	52	90	78	2
121	4	60	66	96	44	2	170	7	100	50	84	68	2
123	7	100	30	84	82	2	171	5	70	42	80	76	2
124	5	100	60	90	62	2	172	5	100	60	90	86	2
125	7	100	50	84	50	2	174	7	100	60	84	58	2
126	5	100	50	50	42	2	175	8	100	50	96	70	2
128	5	100	60	90	64	2	176	5	100	60	90	88	2
129	7	100	30	84	86	2	180	7	100	60	70	50	2
130	7	100	50	84	52	2	182	9	90	56	96	52	2
132	5	100	88	80	40	2	184	5	100	60	90	92	2
133	4	100	70	96	76	2	185	6	100	50	72	74	2
134	5	100	60	90	67	2	186	7	100	60	84	62	2
135	7	100	50	84	54	2	187	5	100	44	48	68	2
136	5	100	60	90	68	2	188	5	100	60	90	94	2
138	5	100	92	80	40	2	189	5	100	60	80	84	2
140	3	50	50	90	70	2	190	7	100	50	84	76	2
141	5	100	94	80	40	2	192	5	100	60	90	96	2
143	6	90	66	96	52	2	195	7	100	50	84	78	2
144	5	100	60	90	72	2	196	5	100	60	90	98	2
145	6	100	50	72	58	2	198	7	100	50	70	66	2
147	5	100	98	80	40	2	200	7	60	60	84	40	2
148	5	100	60	90	74	2							
150	7	100	60	84	50	2							

Contributed by Racquet.

MACHINERY.

October, 1908.

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS—2.

W. P. SARGENT *

IN the previous article of this series, the author dwelt at length on the controlling influence of the engineer in the planning of extensive improvements. In order to maintain the personal tone, the following observations, while of general interest, will be addressed to the engineer in charge.

It is highly improbable that a corporation, with the wisdom and caution acquired by successful growth, will expend large sums of money for improvements without having at hand information covering "the existing state of the art." The engineer, therefore, should spend considerable time visiting the best and largest examples of recently built plants for metal-working, and also, from the first moment that extensions are considered, gather together all information possible bearing on the subject from technical papers. It is well to formulate an outline of the essential points affecting, first, the efficiency of the plant; second, the adaptability for systematic extension; third, the expense attending the operation; fourth, the construction of buildings; and fifth, the cost of plant.

The following points are suggested as covering such information as will be of use in planning new shops. Other things will suggest themselves if some particular branch of the manufacturing is "lame" in the shops for which improvements are under consideration, as, for instance, the forge shop or power plant, which are often neglected in shops otherwise highly efficient. Under the head of efficiency, look for the adaptability of the buildings to the equipment within them; as to whether or not there is sufficient height and span of cranes over the erecting space, as often provision is not made for increase in size of the product; and in the machine shop space, look at the reservation of space near machines for work in progress, so that expensive machines may not be held up waiting for castings to be brought from some remote part of the works. Such provision well justifies the cost of the additional width of bay required. Then, as to shipping, look out for space and handling facilities that will obviate the use of the valuable productive erecting space for tracks and boxing. The handling of work affects the productive efficiency according to the amount of non-productive time spent by producers in waiting for cranes and getting work on and off machines; therefore, attention should be given to the number of traveling cranes in relation to the floor space served by them, to the use of industrial tracks and column jib-cranes, and to the operating speeds of the various handling apparatus. This question of handling work may perhaps be considered a question of equipment, but it is involved in the arrangement of space and affects the amount of space and dimensions a great deal.

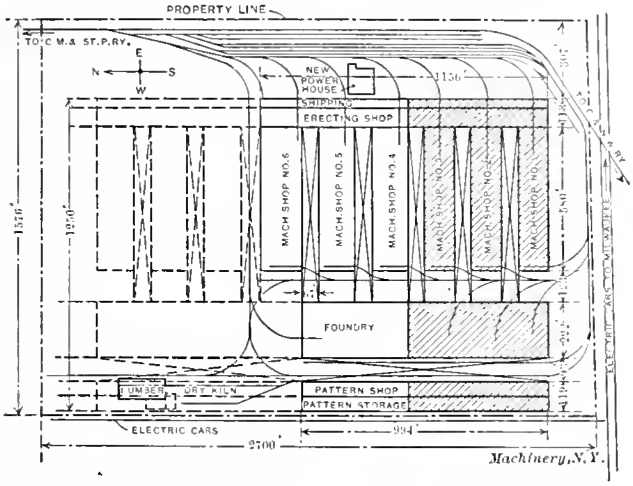


Fig. 4. Plan of Allis-Chalmers Co.'s Plant at West Allis, Milwaukee, Wis.

Under the head of future extension, observe the area of the site in relation to space covered by the buildings, and how the works' system of trackage is planned in connection with the trunk lines of the various railroads serving the city where the site is located. Observe the points that bear on the labor supply; such as homes, street-car facilities, and the proximity to large manufacturing sections from which the better class of workmen can be drawn.

Under expense of operation, study the arrangement of space and the length of haul within the works of the bulk of the material handled, the rapidity of handling, and the course of the product through the works; also the arrangement of trackage, and facilities for storage and unloading which tend to keep down demurrage charges. The type of buildings has also a bearing on the expense factor through the variation of insurance rates. The length and efficiency of power transmission lines, and the efficiency of the power plant and heating apparatus, are large factors in the expense of operation.

The details of building construction, when brought together for comparison, show the trend of the best thought, inasmuch as particular features that may be found in *all* or *nearly all* of the later plants, and which also conform to the recommended standards of the underwriter's and fire-protective associations, certainly are good examples to follow. The writer has almost come to regard the recommendations of the factory mutual fire insurance companies as axioms, and to judge building construction accordingly. The fact that the fire losses for the past ten years in plants insured in the older factory mutual companies, and conforming to their standards, has been but four cents per hundred dollars annually compared with sixty cents in other properties, seems sufficient justification for this opinion. The framing, walls, roofs, floors, galleries, fire-proofing, and lighting should all be studied, and their relative costs. Railroad shops should not be neglected in one's investigations, as the size of some of the latest shops is such that almost all of the problems that arise in planning any metal-working shop have been handled on a large scale in planning them.

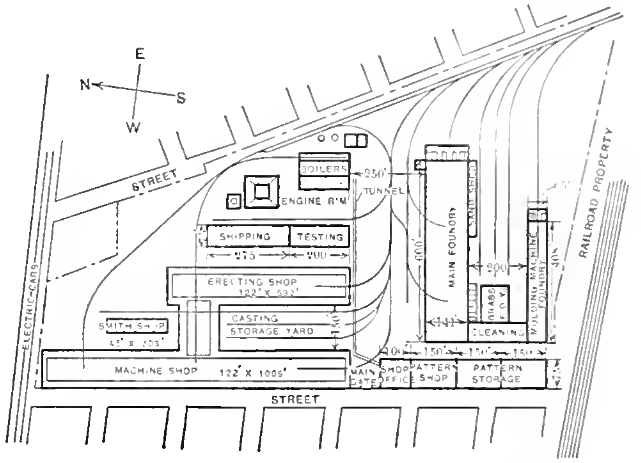


Fig. 5. Plan of Worthington Shops, Harrison, N. J.

The points outlined above will aid in getting at the meat of many published articles, and in gathering definite facts, rather than general knowledge without a definite application in mind. The following resumé of the leading features of some of the later plants will emphasize the bearing of these points on various factors affecting the planning of new shops.

Study of Recent Plants.

A site for a new plant may be selected from a number of sites by its preponderance of advantages affecting the following heads: Adaptability for future extensions; railroad facili-

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ties; labor supply; water supply; cost of foundations; cost of power.

The West Allis plant of the Allis-Chalmers Co. at Milwaukee, Wis., is pre-eminent in meeting the requirements under most of these heads. Fig. 4 shows the general plan. The original buildings are shown by the shaded portion, the recent additions by the full lines, and the possible limits of extensions in conformity with the predetermined plan, by the dotted lines. The arrangement and type of buildings are such that this layout of extension can be followed even if the nature of the product should be entirely different from the present lines. This plant is served by two railroads, and the activity of the rival freight agents in endeavoring to secure the lion's share of the business naturally tends toward a liberal supply of cars even when there is a general car shortage. As regards the labor supply, Milwaukee is the principal manufacturing city in this section of the country. Locally, the site is in a recently improved community, just outside of the city limits.

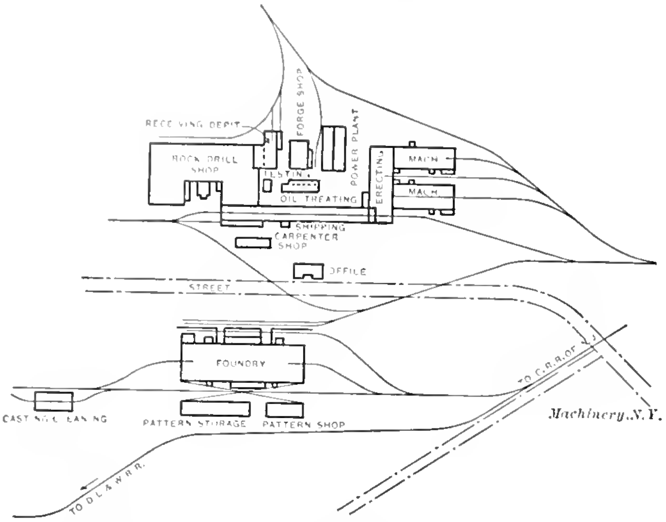


Fig. 6. The Ingersoll-Rand Plant, Phillipsburg, N. J.

TABLE V. COMPARISON OF PLANT ARRANGEMENTS.

	West Allis Works, Plant No. 6.	Worthington Works, Plant No. 7.	Ingersoll-Rand Works, Plant No 8.
Rectangular space, sq. ft.	1,445,000	1,000,000	1,562,500
Covered by buildings	746,000	450,000	400,000
Percentage covered by buildings	51	45	26
Yard space under cranes	305,000	None	25,000
Percentage	21	None	1.6
Percentage remaining	28	55	72.4
Minimum distance between foundry and machine shops.	123 ft.	250 ft.	560 ft.
Maximum distance between extreme points of foundry and machine shops	1,500 ft.	1,750 ft.	2,000 ft.
Average haul of castings	810 ft.	1,111 ft.	1,280 ft.
Maximum distance of power transmission (electric)	1,500 ft.	1,100 ft.	1,600 ft.
Distance of transmission when ground floor space was 400,000 square feet	600 ft.		

The well lighted and well ventilated shops, together with these other advantages, make the plant attractive to a high class of mechanics. The site chosen was a nearly level field of two hundred acres, and as a good bearing soil lay within a few feet of the surface, very little grading was necessary, and the foundation cost was relatively low. The item of foundation cost as effected by a proposed site is important, as the cost of one foot of foundation in depth will pay for two or more feet of brick wall above the foundation.

Referring to Fig. 4, the great area of yard space served by yard cranes will be noticed, as shown by the diagonal lines between the various buildings, and this space is as effectively used as if under roof; the storing of castings inside the shop long in advance of the time when the machines are ready for them is avoided.

Arrangement of Buildings.

It has previously been stated that the arrangement of departments is one of the major factors affecting shop efficiency, and the facilities for handling materials another. The more effective use of space at the West Allis plant (Fig. 4) compared with the Worthington Works at Harrison, N. J. (Fig. 5), and the Ingersoll-Rand Works at Phillipsburg, N. J. (Fig. 6), is shown by the following: The rectangle formed by the buildings indicated by the dimensions 1,156 feet north and south, and 1,250 feet east and west contains 1,445,000 square feet; the buildings in Fig. 5 are contained in a rectangle 1,550 by 800 feet, and deducting east of the smith shop leaves approximately 1,000,000 square feet. The buildings in Fig. 6 are contained in a rectangle 1,250 by 1,250 equaling 1,562,500 square feet. The ground space covered by buildings within these areas is 746,000 square feet for Fig. 4 or 51 per cent, 450,000 square feet, or 45 per cent for Fig. 5, and 400,000 square feet, or 26 per cent for Fig. 6. Then again, Fig. 4 has 21 per cent of the remaining space within the rectangle under yard cranes, Fig. 5 is without yard cranes, and Fig. 6 has but 25,000 square feet or less than 2 per cent under yard cranes. These percentages with other items pertaining to the handling of materials are compared in Table V.

TABLE VI GENERAL DIMENSIONS AND DESCRIPTION OF RECENTLY BUILT PLANTS.

Building.	Plant No. 6.		Plant No. 7.		Plant No. 8.
Erecting Shop—			High.	Low.	
Crane-track span	70′		58′	59½′	112′
Crane-track, height	60′		62′		35′
Floor to roof truss	72′6″		72′		44′
Width of building	72′		126′	122′	
Machine Shop.					
Large work—	Nos. 1-2.	Nos. 4-5.			
Width of building	122′	145′	122′		100.
Width of bays	26′-69′-26′	69′-71′	30′ 62′-30.		30′-40′-30′
Crane-track span	67′	67′	59½′		38′
Crane-track, height	26′	44′6″	30′		25′
Floor to truss	34′	52′	50′		
Under gallery floor—					
Crane track span	25′6″	38′6″	28′		No galleries.
Crane track, height	13′	17′	13′		
Floor to ceiling.	18′	21′3″	15½′		
Gallery Floor—					
Above main floor.	21′4″	26′2″	18′4″		
Head-room	14′8″	16′	12′		
Machine Shop.					No galleries.
Small work—	4 Stories.		Galleries in shops.		Saw-tooth roof.
Width of floors	53′ Inside		31½′		18 bays 25′ wide.
Head-room—					
1st story	21′4″		15′6″		13′6″-16′6″
2d story	14′2″		12′6″		Ventilating bays run N. and S. 20′ wide, 29′ high. See Fig. 15.
3d story	14′3″		12′6″		
4th story	12′8″				
Roofs	Flat pitch. Center skylights. No monitors. Wood sheathing. Tar and gravel.		Flat pitch. Center skylights. No monitors. Wood sheathing. Composition.		Pitch 1 in 5. Center skylights. Monitors.
Framing	Steel.		Steel.		Steel.
Walls	Brick.		Brick.		Brick.
Pattern Shop.	One story brick. Steel frame fireproofed. Flat pitch concrete roof. Wire-glass windows with metal frames. Fire-doors automatic.				Slow-burning mill construction. Wood floors with asbestos paper between. Plank roof covered with 4-ply slag roofing.
Pattern Storage.	Four stories. Same construction as pattern shop.				Four stories. Pattern shop is a part of this building.
Foundry.	Brick and steel. Roof—Flat pitch, plank covered with tar and gravel.		Brick and steel. Flat pitch.		Brick and steel. Pitch 1 in 5.
Width of building	222 feet		141 feet.		160 feet.
Width of main bay	80 "		60 "		69 "
Crane track span	78 "		58 "		65 "
Crane track, height	28 "				32 "
Floor to roof truss	49 "		38 "		46 "
Side bays	Center skylights. One 68′ wide. Two 32′ wide. Skylights.		Center skylights. Two 40′ wide. Skylights.		Side skylights. Two 46′ wide. Skylights.
Height of charging floor	23 feet.		21 feet.		18 feet.
Sand and supply storage	On sand floor at level of charging floor inside of building.		In lean-to outside of main space.		Outside storage bins.
Cleaning	No separate building.		Large work inside. Small work separate building.		Separate building.
Moulding machine foundry	Part of main foundry.		Separate building, sand-mixing below.		Part of main foundry.

A visit to the West Allis plant will dispel any doubt, because of the compact arrangement of space, as to there being sufficient yard room. The sectional book-case idea is noticeable in the lay-out of the Ingersoll-Rand plant as well as the West Allis works, and the relation of departments will be unchanged despite additions that may be made.

An advantage peculiar to the layout of wing machine-shops at right angles to the erecting shop with yards between lies in what may be called the side-feed of unfinished materials to the machine-shops. Castings are stored in these yards adjacent to the door nearest the interior point where they will be machined. This side-feed requires the least amount of crane and truck handling and provides the shortest possible inside route to the erecting floor, and eliminates in a measure the well known scene in end feed shops when all of the cranes are tied up at one end while the furthermost crane is getting a large casting for transportation to the other end of the shop.

The future methodical extension of all the departments does not seem to have been considered necessary for Plant No. 7, Fig. 5, as only the smith shop, low erecting shop, and molding machine foundry have lee-way.

These three plants have the problem in common of the economical production of large, medium and small work in large quantities, and the Table VI indicates the manner in which different designers have met the conditions.

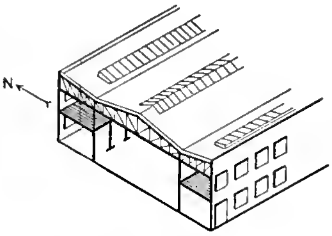


Fig. 7

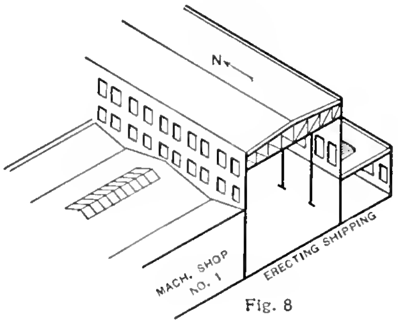


Fig. 8

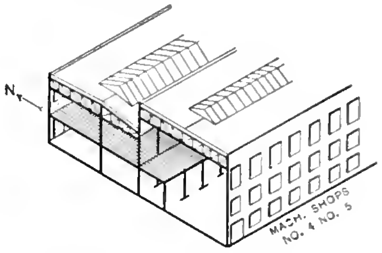


Fig. 9

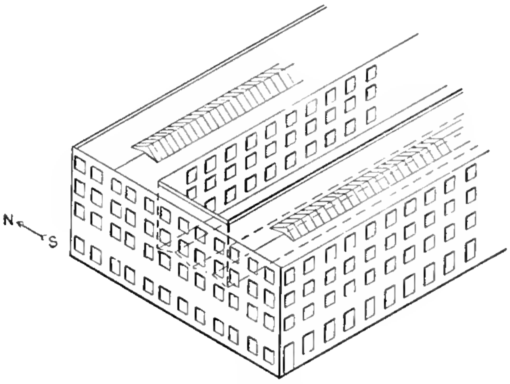


Fig. 10

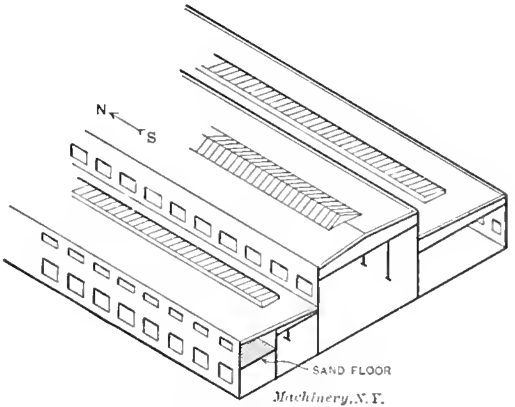


Fig. 11

Fig. 7. Machine Shops Nos. 1 and 2 of the Plant shown in Fig. 4. Fig 8. Erecting and Shipping Department. Fig. 9. Machine Shops Nos. 4 and 5. Fig. 10. Machine Shop No. 6. Fig. 11. Foundry.

The heating of these three plants is through the medium of hot water under forced circulation, the heaters being in series with regular condensers, the vacuum on the engines being broken in proportion to the temperature of the outside atmosphere. The relative areas of departments and the power requirements of these and other large plants will be given later.

The following information is derived mainly from articles in past issues of Machinery. The Hooven-Owens & Rentschler Co. works at Hamilton, Ohio, was described in the January, 1904, number. This firm builds vertical and horizontal Corliss engines. The plant is exceptionally well equipped as the maximum size of work is limited only by the machine tools, of which the 20 x 20-foot boring-mill and a planer 14 x 12 x 35 foot traverse are the largest. The shops are of brick and steel, and the lighting and ventilation are good. The main erecting bay is 75 feet wide and 57 feet from floor to lower chord of roof truss. The main machine bay has the same dimensions. The roofs of the two bays are of one-sixth pitch, of plank and slate, and with skylights except on the slope next the west wall, the skylight area being approximately 5 per cent of the slant area. The machine bay at right angles to the main bay is 73 feet wide and 34 feet to the roof truss, and the machine bays parallel with the main bay are 44 feet and 35 feet wide and 22 feet to the trusses. The foundry main bay is 75 feet wide and 40 feet to roof truss; the roof is slate on plank and pitched 1 in 6. The lean-to bay is 39 feet wide and 24 feet to the truss, roof slope 1 in 10, and of plank covered with tar and gravel.

The Ball Engine Works, Erie, Pa., is interesting in the comparison of the buildings with those of the Hooven plant. Fig. 16 shows the erecting shop, 200 feet long, 74 feet wide, 44 feet to trusses; roof slope, 1 in 4, of plank covered with slate. The machine shop bays are at right angles to the erecting space and consist of alternate flat and pitch roofs 20 feet wide, forming a unique type of saw-tooth roof. This form of saw-tooth, supplemented as it is by the windows in the walls, has a more pleasing architectural effect than the severely plain type of saw-tooth roof shown in Fig. 17 which represents the erecting shop and machine bays of the Ridgeway Machine Tool Co. at Ridgeway, Pa. These latter shops are without side-wall windows except in the north wall. The roof of Fig. 16 is far superior as regards ventilation on account of the opportunity for using movable sash in the vertical frames; and the elimination of gutters and consequent freedom from troubles, caused by melting and freezing of snow, common to the cheaper forms of the regular saw-tooth, is a strong point in favor of this modified type. The crane tracks project into the erecting space in both the shops shown in the two figures.

The B. F. Sturtevant Shops.

The new B. F. Sturtevant plant at Hyde Park, Mass., has many interesting features in the composite type of buildings. New England mill construction forms the base and is modified by the use of steel interior columns for the first story, a 20-foot column spacing, steel main girders and 12 x 16-inch wood floor beams on 4-foot centers for gallery floors, and by the transverse saw-tooth skylights over the high erecting floor and inner portions of the galleries. The erecting bay is 40 feet wide and 30 feet from floor to truss. The galleries on either side are 40 feet wide and have 15 feet head-room under and over the gallery floor. The ground floor is of 3-inch hemlock on tar concrete; the gallery floor for 250-pound load is of 2½-inch hard pine with 1-inch maple top floor, and of 2-inch pine and 1-inch maple for 200-pound load. The roofs

are ½-inch pitch, 3-inch hard pine planking covered with tar and gravel. There are no wall columns as the walls of brick are 20 inches thick to the gallery floor and 16 inches thick from there to the roof.

The Jones & Lamson Shop.

An excellent example of economical fire-proof construction is afforded by the machine shop of the Jones & Lamson Company at Springfield, Vt. The product of this shop is the well-known flat turret lathe. The building is three stories high, 150 feet long, 75 feet wide, with 14 feet headroom for first floor, 11 feet for second floor, and 11 feet for the third or top floor. A monitor 25 feet wide assists in lighting this floor. About 60 per cent of the wall area is glass, which is the same percentage as the window area of the new Pratt & Whitney machine shop at Hartford. The frame is of steel fire-proofed with concrete, floors and roof are of reinforced concrete, and the curtain walls are of brick.

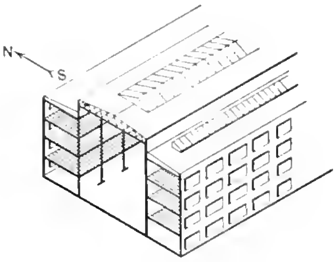


Fig. 12

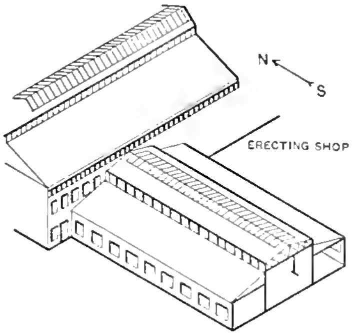


Fig. 13

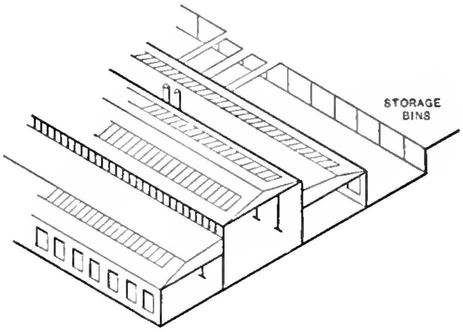


Fig. 14

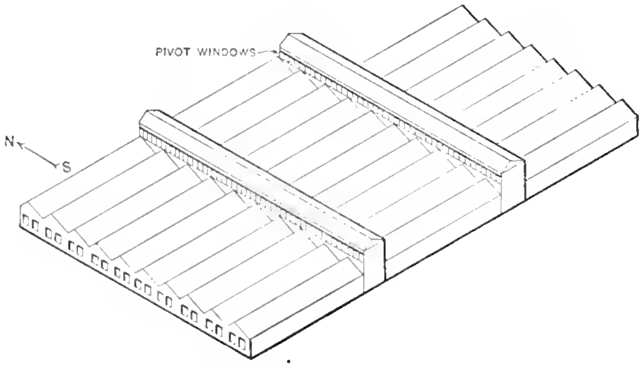
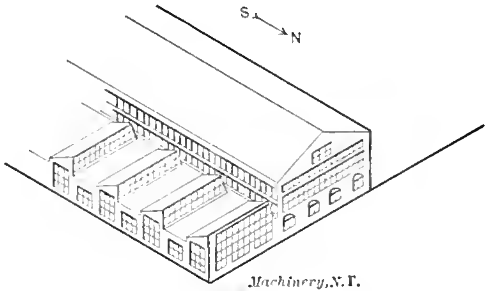


Fig. 15



Machinery,N.Y.

Fig. 16

Fig. 12. High Erecting Shop of Plant shown in Fig. 5. Fig. 13 Machine Shop of Plant shown in Plan in Fig. 6. Fig. 14. Foundry of same Plant. Fig. 15. Machine Shop, Ingersoll-Rand Plant. Fig 16. Modified Saw-tooth Construction, Ball Engine Co., Erie, Pa.

The Pencoyd Works of the American Bridge Co.

This shop is remarkable for its massive construction as evidenced by the loads for which the gallery floors are designed: the first gallery for 500 pounds per square foot, and the second for 300 pounds per square foot. The central bay is 60 feet wide and the gallery bays 25 feet wide. Concrete is used for walls and extends from web to web of the columns. The window area is 60 per cent of the wall area, and all but the lower sash are glazed with ribbed glass. The headroom under the first gallery is 13 feet, under the second, 12 feet, and 11 feet under the roof. The crane arrangements are most unique. Over the 25-ton crane of 56-foot span in the main bay are two 10-ton cranes of 30-foot span running parallel, the trucks of these cranes away from the columns running on tracks supported from the roof trusses. Under each gallery are two parallel runways suspended from the main floor girders and on these runways are electrically operated jib cranes with 5-foot radius arms. These cranes pick up work from trucks in the gangways and swing it over into the machines. Tar concrete is used under the wood block top floor for the first story under the gallery, the tar being used for its preservative effect on the wood.

Pratt & Whitney Shop.

A shop that is representative of many of the recently constructed New England factory buildings for light and medium work is that of the Pratt & Whitney Company at Hartford, Conn. It is an extremely rigid building with brick walls having about 60 per cent window area, steel frame, and concrete floors with the concrete of the floor slab-haunched down to the lower flange of the supporting I-beams, thereby fireproofing them partly and adding about 50 per cent to their strength.

The roof is nearly flat, of plank covered with tar and gravel roofing. Top floors are of clear 1⅛-inch maple laid on sleepers which are embedded in the concrete. The ground floor consists of 3 inches of concrete, then a damp-proof course of tarred felt, then 9 inches of concrete in which are embedded the 4 x 4-inch sleepers as in the upper floors, and between the concrete and maple there is a stratum of asphalt composition applied hot, thus giving the wood flooring a solid bearing.

The building is very rigid, as the steel work is designed sufficiently strong for an additional story. It is a five-story L-shaped building, one wing being 65 feet wide and the other 75 feet wide, with a double row of interior columns giving a center passage-way 25 feet wide for cranes. The first story has a clear headroom of 18 feet 4 inches and all of the other floors have a headroom of 13 feet 4 inches (considerably more than in most other multi-storied shops), and as the windows come up to the under side of the floors the lighting is excellent. A comparison of this shop with a single-story saw-tooth shop will be given later. As the benches, offices, and toolrooms are next the walls, and sprinklers are installed, the noticeable absence of wooden cupboards and other combustibles near the interior columns will lead an unbiased observer, I am sure, to pronounce this shop sufficiently fireproof to compare with, and in details to be of a higher class than, a reinforced concrete structure.

The foundry is situated across the tracks of the New York, New Haven & Hartford Railroad, and is connected with the machine shops by a concrete tunnel which has the double function of affording a passageway protected from the weather for castings and for the distribution of heat, light, and power between the various buildings.

Hoefer Manufacturing Company.

The machine shop of the Hoefer Mfg. Co., described in MACHINERY December, 1905, is three stories in height, of modified mill construction with wooden columns spaced on 20-foot centers each way, and with wood floor beams. The floors consist of a ⅞-inch maple top floor laid on 3-inch yellow pine under planking; the walls are of brick, 17 inches thick for the first story and 13 inches thick for the two upper stories. The cost is given as $22,000, or a little less than $1.00 per square foot of floor space.

Colburn Machine Tool Co.'s Machine Shop, Franklin, Pa.

This shop is typical of many of the medium-sized plants making machine tools and requiring traveling cranes. The shop is of brick and steel with a slate roof laid on plank. The main bay is 37 feet wide and 31 feet to the roof truss; the side bays are each 30 feet wide and 14 feet to the trusses. The glass surface is about 65 per cent of the area of the side walls. This shop was described in MACHINERY, February, 1906, and details and specifications were also given. The machine shop portion of Fig. 13 illustrates this type of shop.

United Shoe Machinery Co.'s Plant, Beverly, Mass.

The designers and owners of this plant have adopted a purely reinforced concrete construction. The floor space covered is about 17 acres, and the floors, roofs and columns of all buildings are of concrete. About 90 per cent of the entire wall area is of glass. There should be some great advantages in this exceptionally large glass surface to justify the greatly increased cost of heating, but these advantages are too deeply hidden to be excavated by the author. Sprinklers are installed only where combustibles are used or stored, and no insurance is carried.

The Aiken Roof Type of One-story Shop.

This peculiar type of roof construction is shown in Fig. 18. The advantages possessed by this form over the ordinary saw-tooth roof for buildings of very large areas are found in low first cost and maintenance. The lighting is not so uniform, but is very good. The shops of the Standard Steel Car Company at Butler, Pa., are of this type, the main building being 400 feet by 1,612 feet. The National Malleable Castings Company shop of this type is 225 feet wide and 750 feet long. In this type of roof, sections are almost flat, the high sections being carried on the upper chord members and the lower sections attached to the bottom chord members of the trusses. The writer believes that even the strongest advocates of saw-tooth construction will admit the lower cost and superior natural ventilation of this type, at least on single buildings of large area.

Multi-storied and Saw-tooth Roof Shops Compared.

The Pratt & Whitney machine shop compared with a saw-tooth shop of equivalent floor area (125,000 square feet) has better natural ventilation, is cooler in summer, has 25,000 square feet of the simplest form of roof against 125,000 square feet of skylights, and has 80 per cent less underground piping to maintain. Heat, light, and power distribution is more economical both in first cost and in transmission losses. The greatest distance that a truck-load of material would traverse on elevator and floor from the receiving point in one corner to the extreme corner of the upper floor is 300 feet against 450 feet from corner to corner of a one-storied structure.

As regards lighting, the saw-tooth shop undoubtedly possesses an advantage in the better diffusion of light, and consequently the strain on the eyes is greatly minimized. This advantage may be offset in a degree by the use of ribbed glass in the upper sash or windows and by the necessary window shades on east and south sides of a five-story building. The writer has yet to find that the productive efficiency in any saw-tooth shop is greater than in the many two or more storied shops in the manufacturing cities throughout the country. The writer recently has had experience in handling a maze of fine cotton yarns in a side-lighted shop and can fully appreciate the necessity of a soft, even light for textile work, but cannot see the necessity for better lighting in machine shops than can be obtained by side lighting.

Comparative Cost.

The cost of saw-tooth shops may be 40 to 50 cents less per square foot of floor space than the high-class Pratt & Whitney shop described, but not less than a shop of slow-burning mill construction. The cause of this 40 or 50 cents difference per square foot is partly shown by the Table VII. These items, of course, do not make up the entire cost. The column *A* is for a high-class five-story machine shop for light and medium work and with a floor space of 125,000 square feet, gravel roof on plank sheathing on wooden purlins supported by steel roof beams. Column *B* is a saw-tooth shop of 125,000 square feet, roof slopes covered with slate.

Much of this apparent saving on buildings may be offset by the extra cost of sewers, piping and wiring, so that a fair comparison of cost cannot be made except for shops for manufacturing like products, and ready for operation.

Reinforced Concrete as a Building Material

For underground work reinforced concrete is unsurpassed, for instance for tunnels, foundations, retaining walls, and vaults. Pattern shops and pattern storage buildings should be of real fire-proof construction and therefore concrete is an ideal material for their construction. Concerns making light work are as well housed in one type of construction as another, but for machine shops and foundries necessitating high roofs and wide spans, brick and steel construction is better suited. Despite their strongly presented claims of low cost, leading concrete construction companies in New England and the Central West, in 1906, could not meet the steel companies on cost and time of erection, but undoubtedly concrete construction methods have been very much perfected since then. As the allowable stress per square inch of section in columns of reinforced concrete and steel is in the ratio of one to thirteen, a concrete column occupies twice as much space as a steel column, and by casting broader shadows affects the lighting adversely. The writer is loth to believe that concrete should be adopted as the sole material of construction for large plants. As to cost, Mr. Leonard C. Wason writing in the *Engineering Magazine*, June, 1907, states that reinforced concrete construction will cost 10 to 25 per cent more than mill construction, and 20 to 30 per cent less than fire-proofed steel frame buildings. On account of the great variation of bids on reinforced concrete construction, the writer is unable to give reliable information on cost.

TABLE VII. COST IN CENTS PER SQUARE FOOT OF FLOOR AREA.

	A	*B*
Land—based on $435 per acre..........	0.2	1.0
Floors	26.0	22.0
Steel work	65.0	16.0
Walls and foundations	31.0	8.4
Roofs	3.6	40.0
	125.8	87.4

Conclusions.

The engineer before commencing work on tentative plans should visit the West Allis plant, even if he never investigates another large works, as he will find that the problems here have been well thought out and logically handled. It will be difficult to find another plant (having so few buildings) capable of turning out a million dollars' worth of work per month within a year after the buildings were completed. The arrangement of space is most excellent, the work is handled economically and expeditiously, the power transmission is economical, and the interior equipment is in keeping with the high class character of the buildings.

For light work, not requiring traveling cranes to serve many of the machine tools, a three-, four-, or five-storied shop with a light court, as shown in Fig. 10, is recommended where compactness of plant is desired or necessitated through lack of ground space or high cost of land.

Mill construction is cheapest for multi-storied shops, and if built to comply with the rules of the factory mutual companies will cost from $1.00 to $1.10 per square foot of floor area. Steel frame construction, not fire-proofed, will cost from $1.40 to $1.60 per square foot, and reinforced concrete will cost from $1.30 to $1.50 per square foot. If the nature of the contents is combustible, automatic sprinklers should be provided, and the insurance rate will be from 20 to 35 cents per $100 per annum on either of the three classes of buildings. Corrugated iron or steel covered buildings are naturally eliminated from consideration for these buildings, because they are not sufficiently warm or permanent except at a high cost of maintenance.

For light and medium work, saw-tooth single-story shops of 40,000 square feet area and an average height of 25 feet can be built for approximately $1 per square foot, but one must be content with a severely plain building, forbidding in appearance.

For medium and heavy machining, or for light and medium machining and erecting, the gallery type shown in Figs. 7, 9,

and 12, is common to most large plants. For building machines up to 15 tons weight the type of building shown in Fig. 13 houses all departments of many plants of 25,000 to 50,000 square feet of floor space. For heavy work, demanding separate machine and erecting shops, the best results are obtained when the machine shops are at right angles to the erecting shop with the cranes projecting into erecting space as in Figs. 8, 13, 16, and 17.

Very high shops of wide span, and with galleries, are uniformly of brick and steel and cost from $1.60 to $2.00 per square foot according to the crane capacity and the gallery floor loads for which the buildings are designed.

Pattern storage buildings are generally 2, 3, or 4 stories in height with fire-walls dividing the space into compartments. Slow-burning mill construction, fire-proofed steel, and concrete are all used, the wooden construction leading; as in all such buildings, automatic sprinklers are the main reliance for the protection of the contents, and given that they protect the contents they will protect the buildings. The writer believes that concrete with metal window frames and wire-glass windows will be the standard construction in the future. In that event no insurance need be carried on the buildings. One very important thing should be remembered in designing pattern storage buildings and that is to design the shelving and racks first, and then determine the window spacing and column spacing.

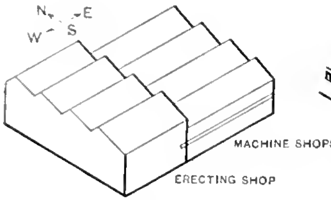


Fig. 17

Fig 17 Plain Saw tooth Roof.

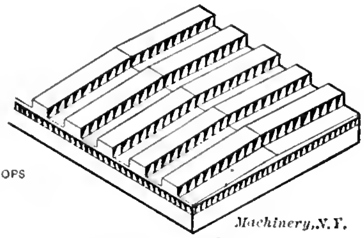


Fig. 18

Fig. 18. Aiken Roof.

Another thing that has been impressed on the writer's mind very strongly is to avoid outside down-spouts. This is best accomplished by extending the walls above the roof in the "parapet wall construction" recommended by the insurance companies, at the same time securing a more finished appearance. The down-spouts should have copper wire strainers at least 10 inches high and saddles should be built against the parapet avoiding sharp bends in the roofing felt, and the counterflashing should be built into the brickwork. Down-spouts inside will not freeze, and may be of galvanized iron to within about eight feet of the floor, where they should enter heavy cast-iron piping which should continue to the horizontal drains. The writer has seen, during the past winter, gangs of men with steam hose and fires, engaged in almost futile attempts to thaw out the outside spouts around a large plant.

Roofs of large areas generally require a great deal of attention, and the roofs giving the least trouble are of very flat pitch and covered with tar and gravel or with tar and slag.

Floors in single-story shops are now mostly laid on concrete with a coating of coal tar between the concrete and the planking, and maple top floors are laid on the under planking to give a hard wearing surface and to facilitate repairs. Monolithic concrete floors are fast superseding other kinds for galleries and upper floors, as they add much to the rigidity of a building and can be built to stand heavy loads at a low cost.

Books that are most in demand for information pertaining to the design and construction of shops are: Cambria Steel Company's, Jones & Laughlin's or Carnegie Steel Co.'s handbook, Kidder's "Architects' and Builders' Handbook," and Ketchum's "Mill Buildings."

The preceding matter throughout is written with the dominant idea in mind that the difference between cost and selling price is the principal object in manufacturing, and the writer has endeavored to present principally the points affecting this difference, rather than those tending toward artistic perfection.

DIAGRAMS FOR DESIGNING SPIRAL GEARS.*

FRANCIS J. BOSTOCK †

Great difficulties are usually experienced in designing spiral gears, and these difficulties are greatly accentuated when one has to design them for two shafts whose center distance cannot be altered to suit the gears, and also when the angle between the shafts is not a right angle, and the speed ratio is not equal. The general practice is to work out the gears by lengthy mathematics, and should the answer not come out as desired, then a new trial is made, varying either one or the other factor, until the angles and diameters are correct. This method of "cut-and-try" entails a great deal of work and waste of time. The following method, together with the diagrams used with it, will remove some of the difficulties, and enable one to arrive at the data required in a very short time. The method adopted is graphical, but the results may be checked by simple figuring.

As the pitch diameter, spiral angle, and circular pitch are interdependent, they cannot be considered as a starting point in solving the problem, because they are not known. The starting point, therefore, must be the speed ratio, and some idea of the strength required, together with the center distance. These factors, as a rule, can easily be ascertained. As it is common usage to employ ordinary spur gear cutters of regular diametral pitches for cutting spiral gears, the normal pitch, or distance from one tooth to the next, measured at right angles to the tooth, must be the same as the pitch of a spur gear for which the cutter to be used is intended; therefore, the corresponding diametral pitch and the speed ratio must be the initial data, all others being obtained afterwards.

Three diagrams are given for the graphical solution of spiral gears. The diagram in Fig. 1 shows the relation between the quotient of number of teeth ÷ diametral pitch, spiral angles, and pitch diameters. The quotient $\frac{\text{number of teeth}}{\text{diametral pitch}}$ is commonly termed "equivalent diameter," and will be so referred to in the following. The diagram in Fig. 2 shows the relation between the diametral pitch, the number of teeth, and the equivalent diameter. Finally, the diagram in Fig. 3 shows the relation between the pitch diameter, the spiral angle, and the lead of the helix. We will now proceed to give some typical examples illustrating the use of the diagrams.

Example 1. Given a gear having 24 teeth, 6 diametral pitch, and a spiral angle of 40 degrees. Find the pitch diameter.

First obtain the value of the ratio, number of teeth ÷ diametral pitch, which, in this case, can be obtained without referring to diagram Fig. 2, being simply $24 \div 6 = 4$. Locate 4 on the horizontal line in diagram Fig. 1, and project vertically until the line from figure 4 intersects the line for 40 degrees spiral angle. Then follow the circular arc from this point, either to the right or downward, reading off 5.22 on the corresponding scale, this being the pitch diameter. Should the diameter be required accurately, we can figure it by the formula

$$\text{Pitch diameter} = \frac{\text{No. of teeth}}{\text{Diametral pitch}} \times \frac{1}{\text{cos spiral angle}}$$

$$= 4 \times \frac{1}{\text{cos 40 deg.}} = 5.222 \text{ inches.}$$

This also gives a check of the result obtained by means of the diagram. The lead of the helix is now obtained from Fig. 3, by projecting the pitch diameter 5.22 horizontally to the radial line for the spiral angle, and then, following the vertical line to the lead scale at the bottom of the diagram, we find, in this case, a lead of 19.6 inches. Of course, the outside diameter of the blank would be $5.222 + 2 \times 1/6 = 5.555$ inches, which is the pitch diameter + 2 times the addendum.

Example 2. Required two gears which are to be equal in all respects, the diametral pitch being 8, and the centers to be approximately 4 inches apart.

As the centers are not fixed, the gears in this case may be

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* For additional information on this and kindred subjects, see the article published in the April, 1908, issue of MACHINERY on the "Derivation of Formula for Determining Spur Gear Cutter Number for Spiral Gears," and other articles there referred to.

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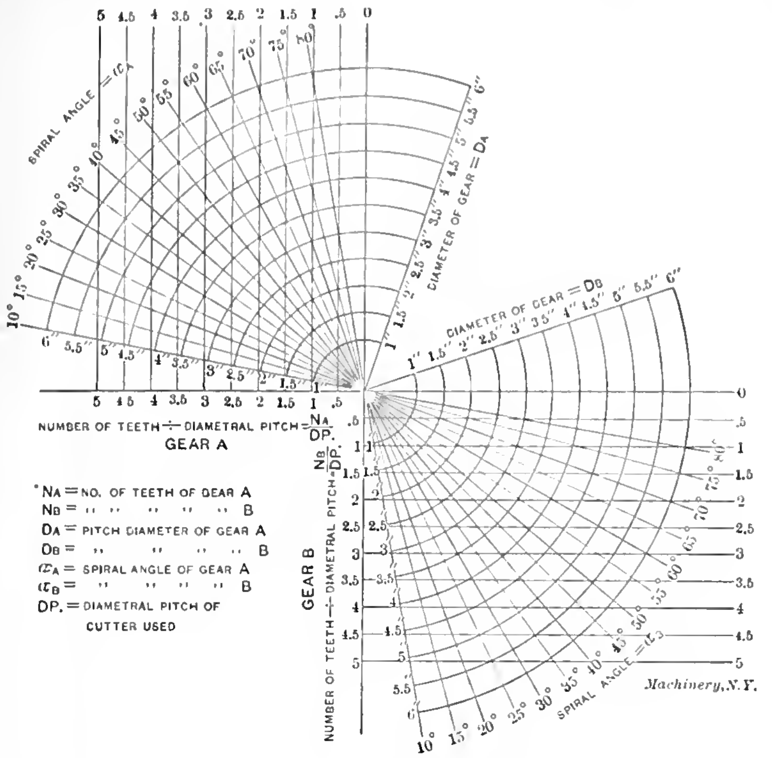

Fig. 1. Diagram for Solution of Spiral Gears.

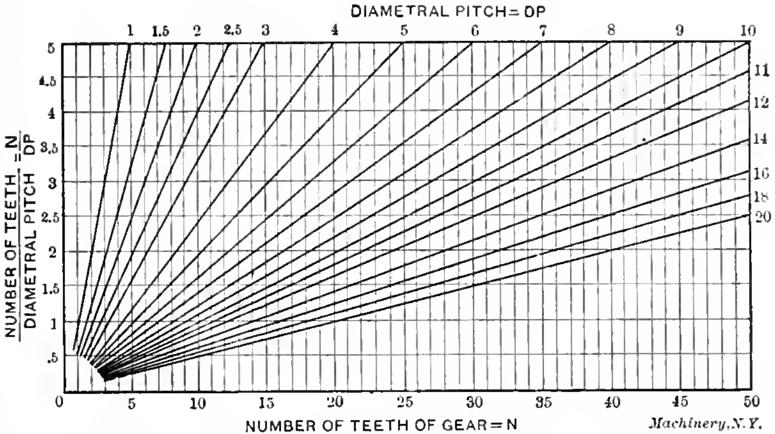

Fig. 2. Relation between Pitch, Number of Teeth, and Equivalent Diameter

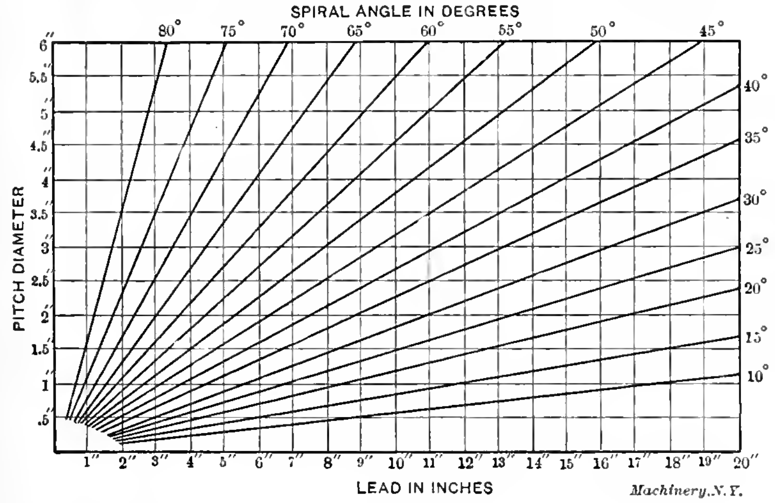

Fig. 3. Relation between Pitch Diameter, Spiral Angle, and Lead of Helix.

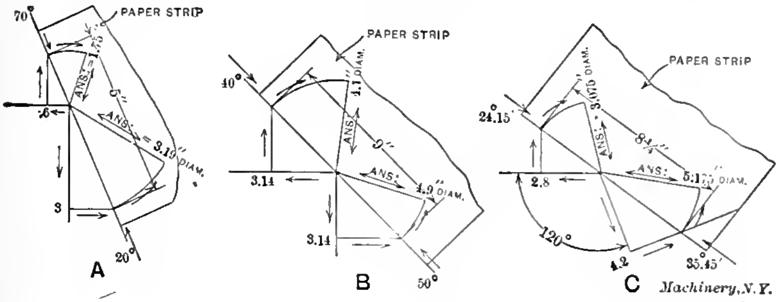

Fig. 4. Separate Diagrams for the Solution of some of the Problems Presented.

made with 45 degrees spiral angle, and the center distance may be slightly adjusted to suit the pitch diameters. Referring to Fig. 1, follow the circular arc from diameter of gear = 4 inches, until it intersects the radial line for 45 degrees spiral angle; then follow the vertical line down to the scale of the ratio between the number of teeth and diametral pitch, which is found to be 2.82. Then, from Fig. 2, we find that with this ratio and 8 diametral pitch, the number of teeth is not a whole number, but the nearest number is 23, giving a ratio of 2.875 instead of 2.82, which, by reversing the process and referring to diagram Fig. 1, gives a pitch diameter of 4.07 inches. These results may be checked as follows

$$\text{Pitch diameter} = \frac{\text{No. of teeth}}{\text{Diametral pitch}} \times \frac{1}{\cos 45 \text{ deg}}$$

$$= 2.875 \times \frac{1}{0.707} = 4.07 \text{ inches.}$$

The outside diameter is $4.07 + 2 \times 0.125 = 4.32$. The lead, as obtained from diagram Fig. 3, in the same way as in Example 1, is 12.8 inches.

Example 3. Required a pair of spiral gears having a normal pitch corresponding to 10 diametral pitch, having a given center distance of 2½ inches approximately, the sum of the spiral angles being 90 degrees, and the speed ratio equal to 5 to 1.

In this case both portions of diagram Fig. 1 are used, the upper part being employed for one gear and the lower part for the other, the easiest way being to get a strip of paper with two lines marked on its edge 5 inches (twice the center distance) apart, drawn to the same scale as the diagram. Move this strip of paper on the diagram (so that the edge of the strip passes through the center), as indicated at *A*, Fig. 4, until the lines marked coincide with points where the ratio of the equivalent diameters equals 5 ÷ 1, and then determine from Fig. 2 that these diameters also give whole numbers of teeth with 10 diametral pitch. We find that 0.5 and 2.5 at 78 degrees and 12 degrees are two such positions, and also 0.6 and 3.0 at 70 degrees and 20 degrees. If we use the latter values, we will have 6 teeth and 30 teeth at 70 and 20 degrees angle, respectively. The exact diameters can now be determined, as in our previous problem, and are 1.75 and 3.19 inches, respectively, the outside diameters being 0.2 inch larger, or 1.95 and 3.39 inches, respectively. This gives the center distance 2.47. These values can now be figured from the formulas as before, and the leads obtained.

Example 4. Required a pair of spiral gears, having a fixed center distance of 4.5 inches, running at equal speeds, the diametral pitch being 7.

The method of procedure is similar to that of the last example, using a strip of paper having a distance of 9 inches marked on the edge in the proper scale, as indicated at *B* in Fig. 4. At about 40 degrees spiral angle we find in Fig. 1 the ratio of number of teeth to diametral pitch to equal 3.14. This ratio is adjusted on diagram Fig. 2, as previously shown, so as to enable one to get a whole number of teeth with 7 diametral pitch, this number being in this case 22. The ratio is then 3.143, and following from this in Fig. 1 to the 40-degree line, one obtains a pitch diameter of about 4.1 inches for one gear, and at 50 degrees, about 4.9 inches for the other. The spiral angles should now be carefully checked mathematically as follows:

cos spiral angle (first gear)

$$= 3.143 \times \frac{1}{4.1} = 0.766; \text{ spiral angle} = 40 \text{ deg.}$$

cos spiral angle (second gear)

$$= 3.143 \times \frac{1}{4.9} = 0.642;$$

spiral angle = 50 deg., nearly.

Now obtain the leads from diagram Fig. 3 in the same way as before, giving the leads of the gears 15.4 and 12.9 inches, respectively.

Example 5. Required a pair of spiral gears, the axes of which are at an angle of 120 degrees; center distance, 4.125; the ratio of equivalent diameters should be as 2 to 3, and the diametral pitch 5.

We require first of all two numbers representing the equivalent diameters, these two numbers bearing the ratio to each other of 2 to 3, and giving a whole number of teeth with 5 diametral pitch. These two numbers, when projected onto two spiral angle lines in a diagram made up as in Fig. 1, the sum of the angles of which lines equals 120 or 60 degrees, give two diameters whose sum equals the center distance multiplied by 2, or 8.25. In this case we cannot use both parts of the diagram Fig. 1, as it is made up for shafts at 90 degrees angle, and for this reason we must take the two readings from the same part of the diagram. The ratios 3 and 4.5 at 30 degrees give corresponding diameters of 3.5 and 5.2, the sum being 8.7. The ratios 2.8 and 4.2 giving 14 and 21 teeth at 25 and 35 degrees, respectively, have diameters of 3.1 and 5.15 (equals 8.25). From this we see that we can use 14 and 21 teeth and the ratios 2.8 and 4.2. The diameters and spiral angles can now be obtained graphically, and more accurately in this manner:

Draw two radial lines, as shown at *C* in Fig. 4, at 120 degrees angle, on a separate piece of paper, and lay off on these to some scale the equivalent diameters, marking the end points 2.8 and 4.2 as shown at *C*, Fig. 4. From these points draw lines at right angles to the radial lines. It is now necesssary to find the position of a line 8.25 inches long, terminating upon these perpendicular lines, and passing through the center. A strip of paper is used in the same manner as before, and upon careful measuring of the respective distances from the center to the lines, one obtains the distances 3.075 and 5.175 inches, which represent the respective diameters, the sum being 8.25. The spiral angle is obtained by measuring or calculating as follows:

$$\text{cos spiral angle of first gear} = 2.8 \times \frac{1}{3.075} = 0.910;$$

$$\text{spiral angle} = 24 \text{ deg. } 15 \text{ min.}$$

$$\text{cos spiral angle of second gear} = 4.2 \times \frac{1}{5.175} = 0.812;$$

$$\text{spiral angle} = 35 \text{ deg. } 45 \text{ min.}$$

The above examples will show the careful student the manner of working out each kind of gear required, and if the directions are properly followed, this method will be found to be a great time-saver. It may be mentioned that it is advisable to keep the spiral angle as nearly equal in the two gears as possible in order to obtain the greatest efficiency of transmission. It should be noted that when diagrams of this type are to be used for practical calculation of spiral gears, they should be laid out in much larger scale than that shown in the engravings, and it would be advisable to lay out radial lines in Fig. 1 for every degree, and vertical and horizontal lines for every tenth of an inch, and circular arcs for equally fine subdivisions. The same is true of the diagrams in Figs. 2 and 3. In Fig. 2, horizontal lines should be laid out for every tenth of an inch, and vertical lines should be laid out for all whole numbers of teeth. In Fig. 3, the horizontal lines should be laid out for every tenth of an inch, vertical lines for at least every 0.2 of an inch, and radial lines for every degree. This diagram should also be laid out so that leads over 20 inches may be read off, as well as those below this figure.

* * *

Some manufacturing concerns, because of general excellence of product in years gone by, have acquired so great a reputation that they have capitalized their reputation, as it were, using the name to bolster up an output that no longer has superlative merit. So marked is this condition with certain concerns to-day that one whose conversation is marked by greater forcefulness than elegance, remarks: "So-and-so's capitalization of good will and mechanical excellence has a h—— of a lot of water in it."

INSTRUMENTS FOR MEASURING TEMPERATURES.

In an article in *The Engineering Review*, September, 1907, entitled "Practical Pyrometry," the author gives a comparative table of the various types of thermometers and pyrometers in use, explaining the general principles upon which each depends for its working, and stating the limits of temperature between which each type may be used. This table, particularly valuable on account of the concise form in which the information it contains has been put, is reproduced below. At the present time pyrometry is becoming an important subject in industrial life, and is not any longer confined to the scientific laboratory only. It would be difficult to mention many industrial operations that do not involve, during some stage or other, an accurate measurement of temperature. To the engineer, power station manager, foundry operator, metallurgist, and, last but not least, the tool hardener, particularly when he deals with high-speed steel, the judgment of temperature has become of the first importance, as upon it depends the maintenance of efficiency in the highest possible degree, or the perfection of the material under treatment. Guess-work—concomitant with costliness—is now being gradually replaced by scientific thermometry, and manufacturers are realizing the assistance that the physicist is capable of affording them in the vital matter of accurate high temperature measurement.

TYPES OF THERMOMETERS IN GENERAL USE.

Class.	General Characteristics of Action.	Type.	Range in degrees Fahrenheit over which they can be used.
Expansion	Change in volume or length of a body with temperature.	Gas..............	32 to 1800
		Mercury, Jena glass and nitrogen......	—40 to 900
		Glass and spirit or petrol.......	—350 to +100
		Unequal expansion of metal rods...........	32 to 900
		Contraction of porcelain......	32 to 3250
Transpiration and Viscosity	Flow of gases through capillary tubes or small apertures.	The Uehling.....	32 to 2900
Thermo-electric	Electromotive force developed by the difference in temperature of two thermo-electric junctions.	Galvanometric..	32 to 2900
		Potentiometric.	32 to 2900
Electric Resistance	Increase in electric resistance of a wire with temperature.	Direct reading on indicator or bridge and galvanometer. ...	32 to 2200
Radiation	Heat radiated by hot bodies.	Thermo-couple in focus of mirror.	32 to 18,000
		Bolometer.......	32 to 18,000
Optical	Change in brightness or in wave-length of the light emitted.	Photometric comparison........	32 to 3600
		Incandescent filament in telescope	32 to 3600
		Nicol with quartz plate and analyzer.............	32 to 3600
Calorimetric	Specific heat of a body raised to a high temperature.	Copper or platinum ball with water vessel...	32 to 2700
Fusion	Unequal fusibility of various metals or earthenware blocks.	Alloys of various fusibilities.....	32 to 3600

THE DESIGN OF JIB CRANES.*

R. W. VALLS.†

R. W. Valls.‡

Among the various types of jib cranes employed for different services in the industrial field, the simple underbraced type is most common, and has been selected for analysis in this article. In the investigation, the method of design, and all the possible stresses to which this type of crane may be subjected, are considered. The treatise may appear somewhat lengthy for such a simple machine, and although some of the stresses discussed are frequently disregarded in actual practice because of the employment of large factors of safety, yet all stresses should be investigated and provision made for them, especially in cranes of abnormal capacities or proportions, or both, which are frequently met with in practice.

As has often been said, sound judgment is a requisite of a successful designer. No precise rules can ever be formulated to cover all cases as they arise in practice, and the judgment of the designer is called upon repeatedly to decide the correct proceeding where there is no precedent.

The following discussion is of a typical crane, and is treated from a theoretical as well as a commercial standpoint, such as would be followed in the engineering office of a manufacturing company.

The type considered consists essentially of a structure in which *GF*, a mast, rests on a foundation (see Fig. 1), and is supported at the top by a suitable connection. *AE* is a member secured to the mast, and supported at *D* by a strut *DC*, which is bolted or riveted to a gusset plate on the member and mast, or connected to these members either with angles or castings as in Fig. 4. Let us first investigate the stresses produced in these members composing the frame, by the external forces acting on the crane. The member *AE*, commonly called the jib, is subjected to stresses produced by the loads concentrated at the wheels of the trolley, and the weight of the members themselves, which stresses we will proceed to find. The trolley carrying the load is supported by four wheels traveling the length of the jib and producing the loads *p*, *p*, placed at a distance *d* from each other. The constant distance *d* is known as the wheel base. These wheel loads *p*, *p* are equal to the sum of the net load to be lifted, *P*, plus the weight of the trolley, ropes and bottom block, divided by the number of wheels supporting trolley, usually four.

The jib is considered as a beam supported at the joints *A* and *D*, having a cantilever end *DE*, and subjected to axial tensile, eccentric tensile, eccentric compressive, and flexural stresses. The length of the cantilever end from *D* to center line of load, when the load is at extreme outer end of the jib, is frequently made about one-fourth the distance between supports *A* and *D*, since, in general, the maximum bending moment produced by loads *p*, *p* when at the end of the cantilever, and that produced when the load is midway between *A* and *D* are about equal. But, more accurately, this ratio should be proportioned so as to obtain equal maximum fiber stresses in both cantilever and span, and thus a jib having a constant cross-section, such as a rolled beam or channel, can be economically employed. When loads *p*, *p* are acting between *D* and *E*, the maximum reaction *R* at *D*, when the trolley is at the extreme end of the cantilever, is the sum of the products of each of the wheel loads multiplied by the ratio of the long levers *AE* and AE_1 to the short lever *AD*. Expressing *AE*, AE_1, and *AD* in terms of the dimension letters, we have (see Fig. 1) *b*, $(b - d)$, and *l*, respectively. Then taking moments about *A*, the fulcrum of the lever, we have

$$R = p \times \frac{b}{l} + p \times \frac{(b - d)}{l} \qquad (1)$$

This reaction *R* produces a direct tensile stress between the points *A* and *D* of the jib, and a compressive stress in strut *CD*.

Let side *AC* of the triangle *ADC* in Fig. 1 represent the magnitude of this reaction *R*; then side *AD* represents the value of the tensile stress, or

$$\text{Stress in } AD = \frac{\text{side } AD}{\text{side } AC} \times R,$$

and, employing dimension letters *l* and *g*, we obtain

$$\text{Stress in } AD = \frac{l}{g} \times R.$$

Substituting the value of *R* of formula (1) for *R*, we have

$$\text{Stress in } AD = \frac{pb + p\,(b - d)}{l} \times \frac{l}{g} = \frac{pb + p\,(b - d)}{g} \qquad (2)$$

Before the section of the jib can be determined, it is required to find the maximum flexural stresses due to the live and dead load bending moments, and combine them with the axial or direct tensile stresses acting on span *AD*, when the absolute maximum bending moment occurs, that is when the wheel loads *p*, *p* are so placed that the center of the span is midway between the center of gravity of these loads and one of the trolley wheels. They must also be combined with the stresses produced by the eccentric pull of the ropes holding the load.

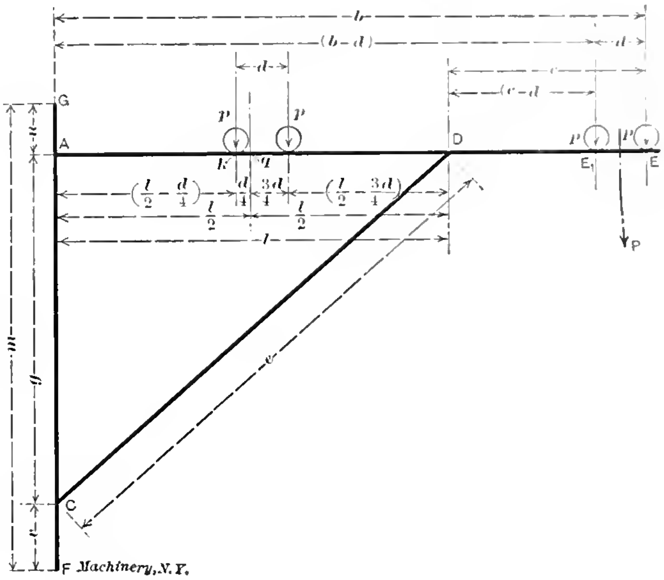

Fig. 1. Diagram of Type o Jib Crane selected for Analysis of Stresses

The direct tensile stress in the jib to be so combined is then not the maximum one just found by formula (2), but that due to the reaction R_1 when the trolley is at the position in the span producing the greatest bending moment, and the value of that reaction R_1 at *D* is found by taking the moments about support *A*, or,

$$R_1 = \frac{p\left(l + \frac{d}{2}\right)}{l}$$

Value of R_2 at *A* is found by taking moments about support *D*,

$$R_2 = \frac{p\left(l - \frac{d}{2}\right)}{l}$$

To obtain the maximum live load bending moment we take

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* For previous articles on this and kindred subjects, see "History of Crane Design," June, 1908; "Power Required for Cranes and Hoists," November, 1907, and other articles there referred to.

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moments about point k under one of the wheels (as shown in Fig. 1); then we have

$$\text{Maximum bending moment} = R_2 \times \left(\frac{l}{2} - \frac{d}{4}\right)$$

But as $R_2 = \dfrac{p\left(l - \dfrac{d}{2}\right)}{l}$, if we substitute this value of R_2 in the last equation, we find the greatest live load bending moment from

$$\text{Live load bending moment} = \frac{p}{2l}\left(l - \frac{d}{2}\right)^2 \qquad (3)$$

$$\text{Dead load bending moment} = \frac{wl}{8} \qquad (4)$$

$$\text{Approximate total bending moment} = \frac{p}{2l}\left(l - \frac{d}{2}\right)^2 + \frac{wl}{8} \qquad (5)$$

where d = wheel base,

w = weight of jib between supports A and D, which weight must be assumed,

$l = AD$, or span.

In regard to formula (5) it may be said that the customary approximate method of adding the maximum live load bending moment to the maximum dead load bending moment is incorrect, except in cases where the maximum live load bending moment occurs at the center of the span. The correct method for this case is to add to the maximum live load bending moment its increment of the dead load moment at that point, and not the maximum value which takes place at the center of the span. The usual method is sufficiently correct for practical purposes, however, as it is on the safe side.

The unit-stress f, due to bending, in pounds per square inch is found from

$$f = \frac{\dfrac{p}{2l}\left(l - \dfrac{d}{2}\right)^2 + \dfrac{wl}{8}}{Z} \qquad (6)$$

The unit-stress due to jib reaction R_1 is found from

$$f_1 = \frac{R_1 \times \dfrac{l}{g}}{a} = \frac{p\left(l + \dfrac{d}{2}\right)}{ag} \qquad (7)$$

Unit-stress f_2, due to tension of rope, is found from

$$f_2 = \frac{T}{a} + \frac{Tz}{Z} \qquad (8)$$

where T = tension in rope in pounds,

R_2 = value of reaction at D when greatest live load bending moment occurs,

z = eccentricity or distance between center line of rope and center line of member, in inches,

Z = section modulus of section,

a = area of section of member in square inches,

w = weight of jib between supports A and D, and

d, g, l, and p designate quantities as indicated in Fig. 1.

The maximum compressive stress in top flange of jib section $= f - f_1 + f_2$, or

$$\frac{\dfrac{p}{2l}\left(l - \dfrac{d}{2}\right)^2 + \dfrac{wl}{8}}{Z} - \frac{p\left(l + \dfrac{d}{2}\right)}{ag} + \frac{T}{a} + \frac{Tz}{Z}$$

or combining

$$f - f_1 + f_2 = \frac{\left[\dfrac{p}{2l}\left(l - \dfrac{d}{2}\right)^2 + \dfrac{wl}{8}\right] + Tz}{Z} + \frac{T - p\,\dfrac{\left(l + \dfrac{d}{2}\right)}{g}}{a} \qquad (9)$$

The maximum tensile stress in the bottom flange of jib when such flange is opposite to the line of action of the rope (see Fig. 3) $= f + f_1 - f_2$ (f_2 in this case being modified to give tensile stress in bottom flange, due to eccentricity of rope loading), or

$$\frac{\dfrac{p}{2l}\left(l - \dfrac{d}{2}\right)^2 + \dfrac{wl}{8}}{Z} + \frac{p\left(l + \dfrac{d}{2}\right)}{ag} - \frac{T}{a} + \frac{Tz}{Z}$$

or combining,

$$f + f_1 - f_2 = \frac{\left[\dfrac{p}{2l}\left(l - \dfrac{d}{2}\right)^2 + \dfrac{wl}{8}\right] + Tz}{Z} + \frac{\dfrac{p\left(l + \dfrac{d}{2}\right)}{g} - T}{a} \qquad (10)$$

These results should not exceed the specified fiber stress for the structure. Before selecting a structural shape to resist these maximum stresses just found, the stresses on the cantilever end should be considered as follows:

f = flexural stress due to bending.

f_1 = tensile stress due to jib reaction,

f_2 = compressive stress due to tension or pull of ropes.

Live and dead load maximum bending moment

$$= (p \times c) + [p \times (c - d)] + \left(w \times \frac{c}{2}\right) \qquad (11)$$

and f, or stress due to bending on cantilever

$$\text{Unit stress } f = \frac{pc + p\,(c - d) + \dfrac{wc}{2}}{Z} \qquad (12)$$

This maximum flexural stress takes place at D, and immediately to the left of D, there exists at the same time the direct tensile stress due to the maximum reaction R, when the trolley is at the extreme end of the cantilever producing this bending stress, found in formula (1), which also must be combined with the stress due to the pull of the rope. Therefore the unit-stress at point $D = f + f_1 - f_2$.

$$\text{Unit-stress } f_1 = \frac{Rl}{ag} = \frac{pb + p\,(b - d)}{ag} \qquad (13)$$

Stress due to pull of ropes $= f_2$.

$$\text{Unit-stress } f_2 = \frac{T}{a} + \frac{Tz}{Z} \qquad (8)$$

Therefore the maximum fiber stress =

$$f + f_1 - f_2 = \frac{pc + p\,(c - d) + \dfrac{wc}{2}}{Z} + \frac{pb + p\,(b - d)}{ag} - \left(\frac{T}{a} + \frac{Tz}{Z}\right)$$

or combining,

$$f + f_1 - f_2 = \frac{pc + p\,(c - d) + \dfrac{wc}{2} - Tz}{Z} + \frac{\dfrac{pb + p\,(b - d)}{g} - T}{a} \qquad (14)$$

where p = wheel load as before,

w = weight of section of jib from D to its extremity (see Fig. 1).

The compressive stress in strut CD is $R \times \dfrac{\text{side } CD}{\text{side } AC}$, of the triangle ADC, or $R \times \dfrac{e}{g}$.

And since R is maximum when the trolley is at the extreme end of the cantilever, or

$$R = \frac{pb + p\,(b - d)}{l} \qquad (1)$$

then the maximum compressive stress in strut =

$$\frac{pb + p\,(b - d)}{l} \times \frac{e}{g} \qquad (15)$$

$$\text{Unit-stress in strut} = \frac{[pb + p\,(b - d)]\,e}{agl}, \text{ (see Fig. 1).} \qquad (16)$$

where a equals area of cross-section of strut.

The allowable unit-stress per square inch of section of this member is found by the usual Gordon formulas

$$\text{for structural steel, } f = 17{,}100 - 57\,\frac{l}{r} \qquad (17)$$

$$\text{for yellow pine, } f = 1{,}200 - 18\,\frac{l}{t} \qquad (18)$$

However, a satisfactory reducing formula of the Rankine type, extensively used by bridge companies, and specified by some railroad companies, is recommended. It is as follows:

$$\text{for structural steel, } f = \frac{15{,}000}{1 + \dfrac{l^2}{13{,}500\,r^2}} \qquad (19)$$

$$\text{for yellow pine, } f = \frac{1{,}200}{1 + \dfrac{l^2}{250\,t^2}} \qquad (20)$$

where l = length of strut in inches,
t = thickness of timber in inches,
r = least radius of gyration.

The stress in the strut due to its own weight is neglected as being very small in most practical cases.

Ordinarily the ratio $\frac{l}{r}$ should not exceed 130; however, this ratio is frequently increased if the fiber-stress is well under the one specified, and as long as its departure from straightness will not subject the strut to an appreciable bending moment.

The stresses that may exist in the mast are as follows: (See Fig. 1.)

(1) Axial compression due to reaction R_3 and weight of structure.

(2) Eccentric stress due to R_3 when trolley is at extreme position on jib next to mast for cranes where jib connects to the face of the mast, and not at the center line of gravity of its section.

(3) Eccentric flexural stress due to tension in ropes.

(4) Flexural stress due to direct tension in jib AE, and to the horizontal component of direct compression in the strut DC.

(5) Eccentric flexural stress due to weight of drum and other hoisting machinery. This last stress is usually disregarded, however, except where the jib and hoisting machinery are of abnormally large proportions.

$$\text{Unit-stress } f'_1 = \frac{R_3}{a},$$

$$\text{but} \qquad R_3 = \frac{pl + p\,(l - d)}{l}$$

$$\text{therefore} \qquad f'_1 = \frac{\dfrac{pl + p\,(l - d)}{l}}{a} = \frac{pl + p\,(l - d)}{al} \qquad (21)$$

$$\text{Unit-stress } f'_2 = \frac{R_3}{a} + \frac{R_3 z_1}{Z} \text{ (see Fig. 3),}$$

$$\text{but} \qquad R_3 = \frac{pl + p\,(l - d)}{l}$$

$$\text{therefore} \qquad f'_2 = \frac{pl + p\,(l - d)}{l}\left(\frac{1}{a} + \frac{z_1}{Z}\right) \qquad (22)$$

$$\text{Unit-stress } f'_3 = \frac{T}{a} + \frac{Tz_3}{Z}\cos\theta \qquad (23)$$

$$\text{Tension in jib} = H = \frac{pb + p\,(b - d)}{g} \text{ (see Fig. 2)} \qquad (2)$$

The horizontal component of stress in strut is equal to the tension H. The mast is then considered as a beam supported by reactions H and r. (See Fig. 2.)

$$r = \frac{p \times b + p\,(b - d) + w_1 \times j}{m} \qquad (24)$$

where w_1 = weight of structural frame,
j = distance from center of mast to center of gravity of frame,
m = distance between centers of bearings.

The quantity $w_1 \times j$ may be omitted when the frame is not very large. The maximum bending moment in the mast is then $r \times u$ or $r \times v$, whichever is greatest. Distances GA and CF, Fig. 1, should be as small as consistent with the design to obtain economy.

$$\text{Unit-stress } f'_4 \text{ at cantilever } GA = \frac{ru}{Z}$$

$$\text{Unit-stress } f'_5 \text{ at cantilever } CF = \frac{rv}{Z} \qquad (25)$$

The axial compressive stress in the mast due to the whole weight of the structure, should be added to the flexural compressive stress f_4' due to bending when the trolley is at the extreme end of the jib, since that part of the mast immediately beneath C is subjected to both at the same time under these conditions.

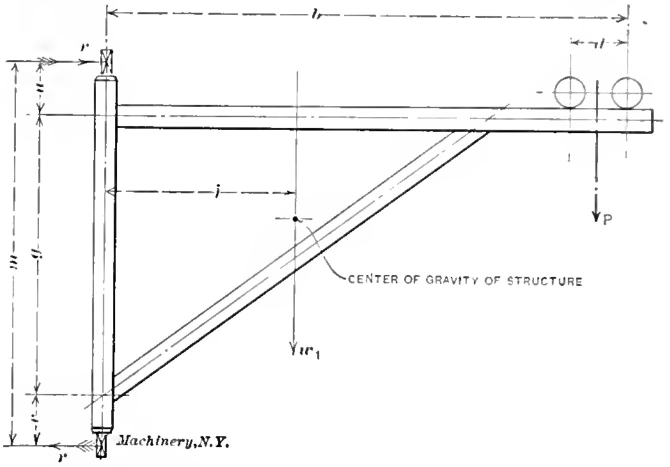

Fig. 2. Outline of Crane for which the Design is Calculated.

The stress f_4' is not added to the stress f_2' as found by formula (22), because they do not take place at the same time, the maximum bending taking place when the trolley is at the end of the jib, and the maximum eccentric compressive stress when the trolley is close to the mast.

It is sometimes required, when long jib members are necessary, to brace the two shapes composing the jib at some intermediate point in order to reduce the ratio $\frac{l}{r}$, and, at the same time, lessen the tendency of the jib members to spread. This is done by securing structural shapes bent clear over the jib trolley. (See Fig. 4.) The ratio $\frac{l}{r}$ should not exceed that above specified.

The pintles at G and F should be made large enough to resist the bending moment on them, and also designed for a safe bearing pressure per square inch of their projected area. This pressure is the quantity r in formula (24).

The jib end connection is subjected to flexural stresses due to the tension of the rope or ropes, which should be taken into consideration. The connection is treated as a beam, and the pull of the rope or ropes as concentrated loads in the middle or at equal distances from the middle, according to the kind of connection employed, the beam in question being supported at both ends.

Example.

Required to design a jib crane of the underbraced type to lift a load of 10,000 pounds at a radius of 21 feet 6 inches; distance between underside of roof truss or top support and floor 13 feet 6 inches; jib to be constructed of two structural steel frames composed of standard size channels and connected together (see Fig. 4); trolley mounted on four wheels running on top flanges of jib member. Maximum fiber-stress 13,000 pounds per square inch, which is allowable for hand-power machines. For a load of 10,000 pounds we will use four parts of 7/16-inch—6 strands of 19 wires—plow steel hoisting rope, having a breaking strength of 17,700 pounds, and will give a factor of safety of $\frac{4 \times 17{,}700}{10{,}000} = 7.08$, which must also take care of the bending stresses in the ropes. This size of rope will require sheaves of 14 inches in diameter, and will allow a wheel base of 36 inches. Two ends of these two lengths of rope will wind on the drum, and the other two ends will be supported at the outer end of the jib by an equalizing beam.

Load to be lifted	10,000 pounds
Approximate weight of trolley, ropes and block	500 pounds
Total	10,500 pounds

which will make the wheel loads $\frac{10{,}500}{4} = 2{,}625$ pounds each.

Distance between mast and joint D, Fig. 3, = 208 inches.

Distance between jib and joint C = 120 inches.

Distance between mast and extreme position of outermost wheels of trolley = effective radius + half the wheel base = 21 feet 6 inches + 1 foot 6 inches = 23 feet = 276 inches.

Let us first assume the trolley at that position in the span AD producing the greatest bending moment (see Fig. 1).

Maximum live load bending moment

$$= \frac{2625}{2 \times 208}\left(208 - \frac{36}{2}\right)^2 = 227{,}793 \text{ inch-pounds.} \qquad (3)$$

By looking at the table of properties of steel channels in any steel company's handbook, we find that a 12-inch channel weighing 20.5 pounds per foot, with an area of 6.03 square inches, has a section modulus about the axis perpendicular to the web of 21.4, and this value divided into the live load bending moment will give a stress of 10,644 pounds per square inch, which leaves us a margin for the other stresses yet to be considered. Therefore, we will temporarily select the above shape for the purpose of finding the bending-moment due to the uniform weight of the member itself.

Weight of channel between A and D $= \frac{208}{12} \times 20.5 = 355$ pounds.

$$\text{Dead load bending moment} = \frac{355 \times 208}{8} = 9{,}230 \text{ inch pounds.} \qquad (4)$$

Approximate total bending moment

$$= 227{,}793 + 9{,}230 = 237{,}023 \text{ inch-pounds.} \qquad (5)$$

Unit stress due to bending

$$= \frac{\frac{P}{2l}\left(l - \frac{d}{2}\right)^2 + \frac{wl}{8}}{Z} = \frac{237{,}023}{21.4} = 11{,}076 \text{ pounds per square inch.} \qquad (6)$$

Unit-stress due to reaction R_1

$$= \frac{2625 \times \left(208 + \frac{36}{2}\right)}{120 \times 6.03} = 817 \text{ pounds per square inch} \qquad (7)$$

$$\text{Tension in ropes} = \frac{10{,}000}{4} = 2{,}500 \text{ pounds.}$$

Unit-stress due to tension in rope

$$= \frac{2{,}500}{6.03} + \frac{2{,}500 \times 8}{21.4} = 1{,}348 \text{ pounds per square inch.} \qquad (8)$$

Total stress on top flange $= f - f_1 + f_2 = 11{,}076 - 817 + 1{,}348 = 11{,}607$ pounds per square inch (9), which stress is under the one specified; the shape tentatively selected may therefore be used for this member of the crane.

Weight of cantilever end of jib $= \frac{93}{12} \times 20.5 = 159$ pounds.

Unit stress due to bending

$$= \frac{2{,}625 \times 68 + 2{,}625 \times 32 + 159 \times \frac{93}{2}}{21.4} = 12{,}613 \text{ pounds per sq. inch.} \qquad (12)$$

Unit-stress due to reaction R

$$= \frac{2{,}625 \times 276 + 2{,}625 \times (276 - 36)}{120 \times 6.03} = 1{,}872 \text{ pounds per sq. inch.} \qquad (13)$$

Unit-stress due to pull in rope

$$= \frac{2{,}500}{6.03} + \frac{2{,}500 \times 8}{21.4} = 1{,}348 \text{ pounds per square inch.} \qquad (8)$$

Total unit-stress on top flange of cantilever =
$12{,}613 + 1{,}872 - 1{,}348 = 13{,}137$ pounds per square inch, **(14)** which is 137 pounds per square inch more than the specified stress. In practice, this will not be considered of sufficient importance to change the design.

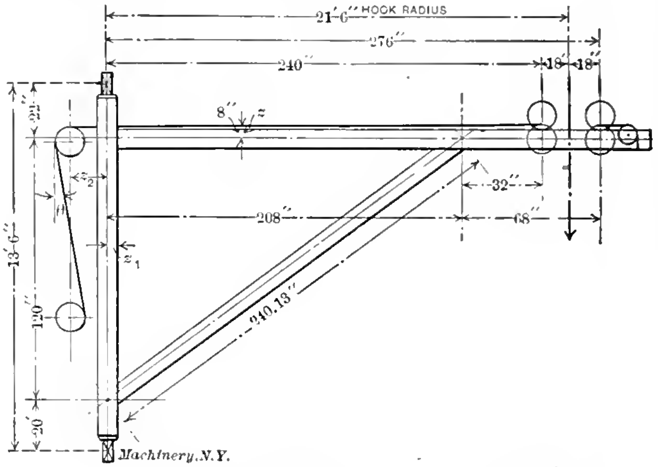

Fig. 3. General Dimensions of Crane to be Designed.

Total length of jib member = 25 feet 1 inch, or 301 inches.

Least radius of gyration of 12 × 20.5 pounds channel = 0.81.

The ratio $\frac{\text{length}}{\text{least radius of gyration}} = \frac{301}{0.81} = 371$, consequently the channels of the two frames should be braced at least at a point midway between the end connection and the mast. (See Fig. 4.)

Length of strut $DC = \sqrt{120^2 + 208^2} = 240.13$ inches. Selecting a 15 × 33-pound channel having a cross-sectional area of 9.9 square inches, and least radius of gyration of 0.91, for strut, we have the compressive unit-stress

$$= \frac{[2{,}625 \times 276 + 2{,}625\,(276 - 36)] \times 240.13}{208 \times 120 \times 9.9} = 1{,}316 \text{ pounds per square inch.} \qquad (16)$$

$$\text{Allowable stress} = \frac{15{,}000}{1 + \frac{240.13^2}{13{,}500 \times 0.91^2}} = 2{,}440 \text{ pounds per sq. inch.} \qquad (19)$$

The ratio of the length of the strut to its least radius of gyration is $\frac{240.13}{0.91} = 264$, which is excessive; the maximum unit-stress, however, is very low, only 1,316 pounds per square inch, or hardly more than half of that allowed by the formula (19). As there is not a channel rolled by any mill with a greater "least radius of gyration" than the one we have employed, we may stiffen the strut laterally by riveting an angle to its web in the inside or back of channel. Unless the ratio 130 must be adhered to, the channel should be left as it is as long as the member shows no great deflection under load.

Let us now investigate the stresses existing in the mast, which we assume is composed of two 12 × 20.5-pound channels. The distance from center of mast to nearest wheel when the trolley is at the extreme position next to mast = 11 inches.

$$\text{Then } R_3 = \frac{2{,}625\,(208 - 11) + 2{,}625\,(208 - 11 - 36)}{208} = 4{,}518$$

pounds.

As the two vertical shapes composing the mast are latticed together, we will take the two equal reactions R_3 (one which acts on one channel and the other on the opposite one) to be resisted by the two shapes combined, therefore the least radius of gyration of the mast as built is then that perpendicular to the web of the channels, whose value is 4.61.

Then the allowable compressive stress

$$= \frac{15{,}000}{1 + \dfrac{162^2}{13{,}500 \times 4.61^2}} = 13{,}761 \text{ pounds per sq. inch.} \quad (19)$$

Unit-stress f'_1

$$= \frac{2{,}625\,(208 - 11) + 2{,}625\,(208 - 11 - 36)}{6.03 \times 208} = 749 \text{ pounds per square inch.} \quad (21)$$

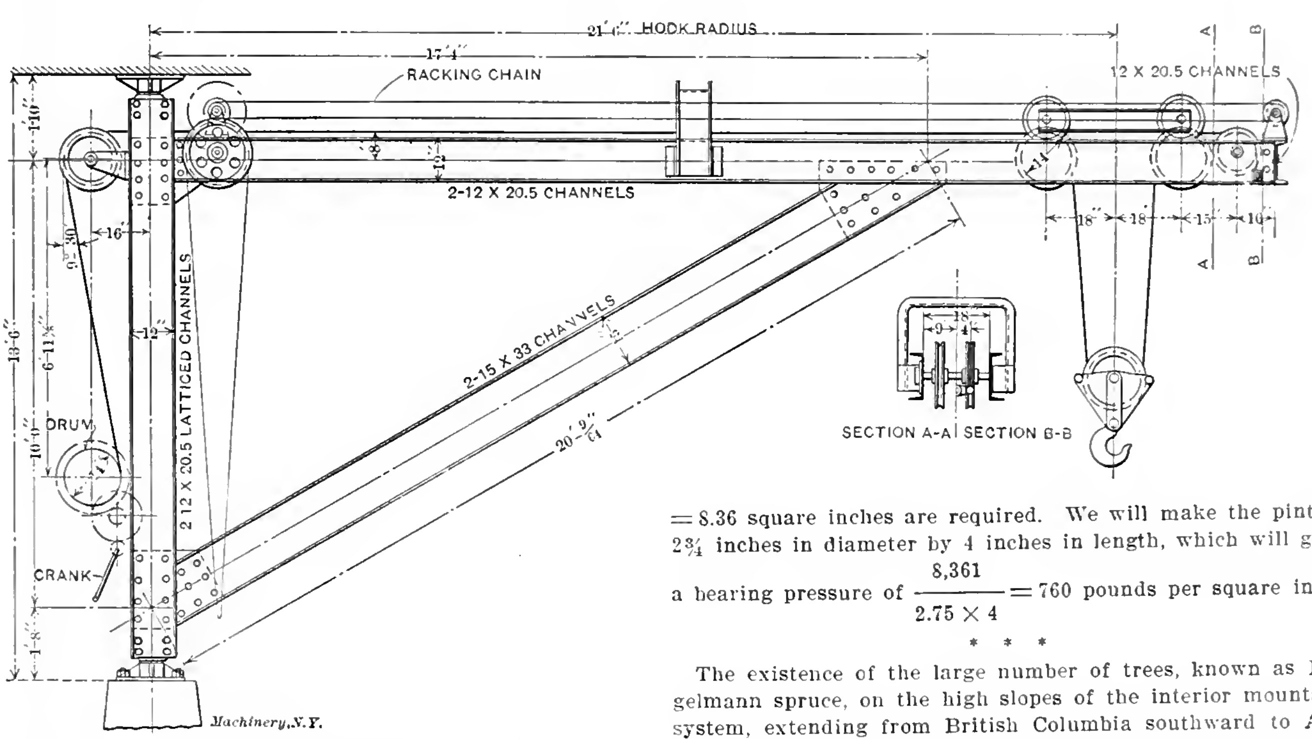

Fig. 4. Crane calculated to lift a Load of 10,000 Pounds at a Radius of 21 feet 6 inches.

Stresses f'_2 do not take place in this gusset-connected frame.

Unit-stress f'_3 due to tension of rope

$$= \frac{2{,}500}{6.03} + \frac{2{,}500 \times 16}{21.4} \times \cos 9 \text{ deg. } 30 \text{ min.} \quad (23)$$

$= 2{,}257$ pounds per square inch. (See Fig. 4.)

Horizontal reaction at top and bottom of mast when load is at extreme outside end of jib =

$$r = \frac{2{,}625 \times 276 + 2{,}625\,(276 - 36)}{162} = 8{,}361 \text{ pounds.} \quad (24)$$

Unit-stress f'_4 due to bending moment at top of mast =

$$\frac{8{,}361 \times 22}{21.4} = 8{,}548 \text{ pounds per square inch.} \quad (25)$$

Maximum unit-stress immediately beneath point A of mast $= f'_4 + f'_3 = 8{,}548 + 2{,}257 = 10{,}805$ pounds per square inch.

For the end connection of the jib at E we select a 12-inch × 20.5 pounds channel for the sake of symmetry, and proceed to investigate the bending stress to which it is subjected due to the pull of the ropes. The distance between the jib members is 18 inches. The pull on the ropes is 2,500 pounds. The section modulus of the channel in consideration about an axis parallel to the web is 1.75. Two ropes, both four inches from the center of connecting channel are used (see Fig. 4).

Maximum bending moment on channel $= 2{,}500 \times (9 - 4) =$ 12,500 inch-pounds

$$\text{Unit-stress} = \frac{12{,}500}{1.75} = 7{,}143 \text{ pounds per square inch.}$$

Horizontal reaction on pintles

$$r = \frac{2{,}625 \times 276 + 2{,}625\,(276 - 36)}{162} = 8{,}361 \text{ pounds.} \quad (24)$$

Assuming the pintles to be 4 inches long, and taking moments about a lever arm from the center of the bearing to the support (= 2 inches), we have, bending moment = 8,361 × 2 = 16,722 inch-pounds. Unit-stress on pintles should not exceed 9,000 pounds per square inch for machine steel.

$$\text{Section modulus of a circular section} = \frac{\pi d^3}{32} = 0.098 d^3,$$

where d = diameter of section.

$$\text{Diameter of pintle} = d = \sqrt[3]{\frac{16722}{0.098 \times 9000}} = 2.66 \text{ inches.}$$

The bearing pressure on pintles should not exceed 1,000 pounds per square inch of projected area. Therefore $\dfrac{8{,}361}{1{,}000} = 8.36$ square inches are required. We will make the pintles $2\frac{3}{4}$ inches in diameter by 4 inches in length, which will give

$$\text{a bearing pressure of } \frac{8{,}361}{2.75 \times 4} = 760 \text{ pounds per square inch.}$$

* * *

The existence of the large number of trees, known as Engelmann spruce, on the high slopes of the interior mountain system, extending from British Columbia southward to Arizona and New Mexico, has induced the U. S. Forest Service to undertake experiments to determine whether this tree, which is comparatively small and which is not considered a very valuable timber tree, can be used for making paper pulp. Samples have been received from the national forests of Wyoming, Colorado and Utah, and these have been treated by the sulphite process, and pulp obtained from which is secured paper fully as good as that made from Eastern spruce. The results of preliminary trials on seasoned wood shows that it gives a fiber fully as valuable as that from its Eastern relative. The fiber of Engelmann spruce seems to be slightly shorter than that of the Eastern spruce, but it is of sufficient length to be used for the latter in nearly all the manufactured products, and there is apparently no reason why it should not be so used provided that other conditions of manufacture and transportation are favorable.

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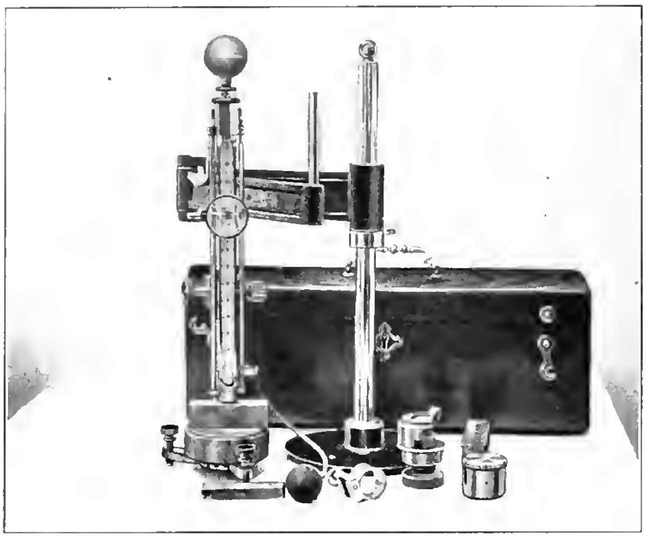
It is stated in the *English Mechanic and World of Science* that an English company has succeeded in obtaining photographic films where the natural colors of the objects photographed are reproduced. The photographs are obtained by a direct method, and are made for use in a moving picture apparatus. The company has given an exhibition of the results obtained to members of the press, and it appears that this invention marks a decided advance in color photography.

A NEW MECHANICAL TEST FOR HARDNESS.*

J. F. SPRINGER †

Even when men first began to harden steel, they probably sought some method of ascertaining in particular cases whether their object had been accomplished. Perhaps the testing tool was nothing more than a fragment of flint or another piece of steel known to be hard. Certain jewels—as the diamond—are well suited to a process which depends upon scratching. In fact, this process is in common use everywhere even at the present day. The test by filing is not to be despised as it is easily applied, and if the file is a good one, the results are sufficiently accurate and reliable for a considerable class of work. But the file is an instrument inadequate to the requirements of modern metallurgists and manufacturers. This is true for two reasons: First, the alloy steels seem to possess the property of being able to resist a file, apart from hardness. Thus, a piece of manganese self-hardening tool steel may be, in reality, softer than a specimen of a pure carbon steel, and yet resist the attacks of the file equally well. In explanation of this phenomenon, it has been suggested that the hard manganese resists the file while the iron substratum remains soft. The combination as a whole would not be so hard, although able to withstand the file. This, however, seems really to involve the proposition that such steel is not a perfect chemical combination, but that particles of manganese are held imbedded in iron or an iron alloy. Perhaps this may be so; but if it is true, then the action of such steel on the file is very similar to that of an emery wheel. The emery itself is very hard, but is held in a matrix that is soft. However, whether we accept this explanation or not, it is doubtful whether we have good reason to contend that a specimen of alloy steel is as hard as a piece of pure carbon steel, merely because it resists the file equally well.


The Scleroscope—An Instrument for Testing the Hardness of Metals.

The second objection to the file is that it affords no reliable means of making accurate comparisons between different degrees of hardness. It is sometimes of importance in cases where one element of a machine slides against another to ascertain which of the two is the harder. The difference may be very slight, yet it will readily be granted that this difference might become of importance if lubrication failed. For, the harder piece would then cut or wear the softer. If such a contingency is possible, then it is important that the more expensive part shall be the harder. A little reflection will convince one that this principle of associating a harder valuable part with a softer less valuable part, has application everywhere in machine construction; but in order to apply this principle widely, it is necessary to be able to determine differences in hardness where these differences are quite small in amount.

A modern instrumental means of testing for small differences in hardness is that known as the Brinell device. In accordance with this method, a steel ball is pressed against the specimen to be tested. The permanent indentation formed is then measured—say, for depth. Assuming that, with the compression the same and with a ball of the same size and hardness, the variations in depth of indentation furnish a means of quantitatively determining variations in the degree of hardness; it only remains to measure these depths with sufficient accuracy, and we shall obtain, by referring to a previously calculated table, a series of numerical values expressing the variations in hardness. Of course, the deeper the indentation, the softer the substance; so that if it is desired that the numbers increase with the increase in hardness, we have only to take the reciprocals. This mechanical test for hardness has found pretty extended introduction. But it may well be questioned whether hardness is really tested by the slow formation of an indentation. There can be no doubt that resistance to slow penetration is tested by this procedure, but is resistance to slow deformation what we mean by hardness? I scarcely think so.

A piece of sealing-wax resists deformation but feebly if the deforming procedure is applied gradually. We should hardly say that the hardness of this substance is of so low a degree as this slight resistance to slow displacement of its particles would indicate. Then again, it is quite conceivable that toughness might so contribute its assistance in withstanding a slow deformative process that the result could not be looked on as an accurate indication of hardness alone. Now what we call toughness appears to be slow in its operation. That is, at the beginning of a deformative effort there is a yielding of the particles; this is followed by resistance to further displacement. But time seems to be required for the development of this resistance. What we call hardness appears to be, on the contrary, a resistance that is instantly available. That is to say, in hardness there is an instantaneous resistance to displacement of particles. This conception of the difference between hardness and toughness as the difference between an instantaneous and a slower recovery of particles, seems to strike close to the truth. Adopting this distinction as a true criterion, we should derive a test for hardness by testing for the instantaneous recuperative power of metals.

In the process employed by Mr. Shore (Shore Instrument & Mfg. Co., 226 W. 24th St., New York City), carried out by means of the hardness-testing instrument (the scleroscope—see Fig. 1) which he has developed, the energy of resistance at the moment when the elastic limit is exceeded seems to be the thing measured. And this would appear to be just about what we mean by hardness. A tiny hammer, pointed at the lower end, falls from a fixed height upon the specimen, striking a blow exceeding the elastic limit. The rebound is then measured.

In the first experiments, a steel ball was used as the hammer, but the results were only partially satisfactory. In fact, the inventor was well-nigh on the point of giving up when he met a French expert in metals by the name of Dr. Herould. Following out certain of his suggestions, Mr. Shore has succeeded in producing an instrument which apparently gives great promise of solving the problem of the testing of hardness. The difficulty with the ball-shaped hammer was that it was incapable of striking a sufficiently hard blow to get adequate results, especially with hardened tool-steel, so the area of contact was reduced, although the weight was kept large in comparison. In fact, the blow struck by the sharper of the two varieties of hammer used in the scleroscope, is estimated at 75,000 pounds per square inch. The point which strikes is, however, so small on the tip that with a fall of ten inches the weight of the whole hammer is required to be but a small fraction of an ounce.

But the determination of these points, while important, was not by any means a complete solution. A great difficulty arose in connection with the material for the hammer; it was necessary to have extraordinary hardness combined with a non-crystalline structure. The diamond was found unequal to the requirements of the case, and after much investigation in which the scleroscope—although itself still imperfect—assisted, a method of treating tool steel was developed, which

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* For additional information on this subject, see the article on "The Brinell Method of Testing the Hardness of Metals" published in the September, 1908, issue of MACHINERY.

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produces, under favorable conditions, a very hard steel capable of the exacting duty required. The absolute weight of the entire hammer is little, but relatively to the striking area it is very great. This hammer, having a cylindrical body, is guided in its fall by a glass tube. Great difficulty has been experienced in getting tubes with a sufficiently perfect bore. There seems to be no commercial method of manufacturing such tubes, so the method of test-and-reject is employed, resulting in a very great waste.

The tube is secured to a frame in a vertical position with the lower end open. Upon exhausting the air by means of a rubber bulb connection, the hammer is drawn to the top where it is held by a suitable catch. When it is desired to release the hammer, a hook, seen in Fig. 1 at the top and to the left, is drawn downwards by the left hand while the right compresses a second rubber bulb, seen on the table. Upon releasing the bulb, the hammer drops and its point strikes sharply the piece of metal to be tested. The rebound of the hammer is measured against a scale graduated from 0 to 140, secured in position back of the glass tube. To aid in reading the rebound, a magnifying glass is supplied. After some practice, its assistance may be dispensed with, if desired. However, to use it, it is secured in such position as to cover the possible region of the expected reading. The rod to the left of the tube is the support to which the magnifying attachment is secured and along which it is adjustable. The rod to the right of the tube is a plumb-rod; it swings freely from a point of attachment above, and enables the operator to keep the tube vertical.

Fig. 2. Shaft and Box of a Lathe being Tested to determine the Relative Hardness.

The instrument proper—that is, apart from the supporting stand—may be used to test parts of machinery in position. In this way a shaft and box may be tested to determine the relative hardness. See Fig. 2. In using the instrument with the stand, the specimen is placed on the table or secured in a holder. It is necessary that the actual point tested should be clean and horizontal, and that the piece should be firmly held. If the specimen is quite irregular, it may be held in a support of asphaltum and tar. This combination; while yielding to slow pressures, is quite unyielding when the blow is instantaneous—as with the scleroscope hammer. Of course, the upper part of the specimen at the point to be tested must be horizontal. If necessary to test more than once, the piece should be slightly moved so as to expose a fresh point to the hammer. The indentation made is, however, very minute, so that several are usually unobjectionable.

The scale, as already mentioned, runs from 0 to 140. The hardness of the finest steels ranges from 100 to 110. Porcelain and glass have higher grades, while unhardened steels, brass, zinc, and lead show lower and lower degrees. Unhammered or unrolled lead produces a rebound of but two graduations. The question may arise with some whether the graduations should all be of equal size—whether, in fact, they should not progressively increase as one goes from one end of the scale to another. It seems that there should be no difference. What it is desired to measure is the energy of the rebound. Now the energy of falling (or rebounding) bodies varies with the first power of the space traversed, so that with equal increases of energy we shall have equal increases of the space rebounded. The scale may be regarded, then, as affording readings which are strictly proportional to the energy of resistance of the metal being tested, when the elastic limit is exceeded. If we regard this energy of resistance as indicative of what we mean by hardness, then the scleroscope seems to fulfill the requirements of a scientific measurer of this important property of metals.

One of the great results of the introduction of scientific methods of precise quantitative measurement of hardness, promises to be in the determination of the relation of the cutting tool to the work to be machined. We are all aware that the tool must be harder; but how much harder? And how express this relation in intelligible language? The scleroscope, it is hoped, will afford a pretty definite answer to this problem. The law has been laid down that the comparative hardness between tool and work as determined by scleroscope readings, should be in the ratio of 3 to 1 or 4 to 1, in order to secure the best commercial results. In illustration of this point, we may take the case of work to be machined consisting of a 1 per cent carbon tool steel. Unannealed, such steel is found upon testing to disclose a hardness varying from 40 to 45 points. According to the above law, the cutting tool should be at least about 120 to 135 hard; but the same steel properly annealed, is only about 31 hard. Consequently, it is not at all difficult to find a suitable material for the cutting tools. Thus, a fine quality of pure carbon tool steel, well hardened, has a hardness of 95 to 110, and is consequently suitable to cut material of a hardness of 31. Now if this principle as to relative hardness necessary, can be thoroughly established for all kinds of metals, an element of scientific certainty will be introduced into machine practice. This will make for economy of time and tool.

Again, it is, of course, to be expected that if two metal parts wear or rub against each other, the harder of the two will cut the softer, whether the difference is small or great, so that it is often important to know whether the more expensive part is really the harder. The scleroscope would seem to afford a means of determining with precision slight differences in hardness, thus enabling the manufacturer to assemble contacting moving parts on the principle of a harder expensive piece in association with a softer cheaper one. Thus in an electrical repair shop, instances may readily be found of the steel shaft cut by the brass box, the box cut by the shaft, and a pretty even wear of both. From an economical point of view, it is much better to have the brasses worn than the shaft, and with such an instrument as the scleroscope it would be possible to predetermine this economically better result. It would seem an easy matter for an automobile manufacturer, say, so to specify the hardness of the gear wheels used, that the gear manufacturer could supply him with a uniform product.

A further illustration, which suggests itself, is the possibility of assembling the outer and inner rings of ball bearings so as to equalize the wear of the two raceways. Other things being equal, the inner raceway wears more rapidly because the convex ball contacts with a rather sharply convex raceway (convex as seen transversely), while in the case of the outer raceway the convex ball contacts with a more gradual and concave curve. By adjusting this inequality through association of a hard inner ring with a softer outer ring, the wear may be equalized.

An important application of quantitative hardness tests, would appear to be in connection with high-speed steels. Now such steels disclose upon testing with this instrument, a

hardness varying from 80 to 105. This is at ordinary temperatures, however, and shows scarcely as high a degree as the best of the pure carbon steels. The effectiveness of high-speed steels depends largely upon the fact that at temperatures of 600 to 1,000 degrees, at which pure carbon steels would lose their temper, they retain a high degree of hardness, amounting, say, to 75 on the scleroscope scale. This is sufficient—following the principle of 3 to 1—to do heavy machining on annealed machinery steel measuring 25 on the same scale. But, if the heat developed by high speed and heavy cuts, succeeds in lowering the high-speed steel of the tool much lower than 75, then it is no longer an effective tool. It becomes of importance then to test high-speed steels for their effectiveness under temperature conditions obtaining in actual service. It is a small matter to know that a certain tool of high-speed steel is very hard when cold; what is its condition when hot? By heating the tool to the required temperature, and then testing with the scleroscope, its condition may be determined. It is thought that thus the real effectiveness of the high-speed steels may be determined in advance of their use or even of their purchase.

It is deserving of serious consideration that the scleroscope method is not limited to particular metals. It seems applicable to practically all the metals, not only for comparing different varieties of the same metal, but for comparing specimens of different metals. Thus, as already pointed out, brass may be compared with steel.

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BAND AND BLOCK BRAKES.

A. L. CAMPBELL.*

Formulas for band and block brakes are not easily obtained, because many mechanical hand-books do not give any information on this subject. In order to supply a possible need in this direction, the formulas given in the current supplement have been compiled. These formulas are based on, and agree in form with, the formulas for these classes of brakes given in "Des Ingenieurs Taschenbuch," published by the Hütte Association, Berlin, Germany.

In any band brake, such as shown in Fig. 1 in the Supplement, where the brake wheel rotates in a clockwise direction, the tension in that part of the band marked x equals $P\dfrac{1}{e^{\mu\theta}-1}$; and in that part marked y, the tension equals $P\dfrac{e^{\mu\theta}}{e^{\mu\theta}-1}$. In these expressions,

P = tangential force in pounds at rim of brake wheel,
e = base of natural logarithms = 2.71828,
μ = coefficient of friction between the brake band and the brake wheel,
θ = angle of contact of the brake band with the brake wheel expressed in radians (one radian = $\dfrac{180 \text{ deg.}}{\pi}$ = 57.296 degrees).

For simplicity in the formulas presented, the tensions at x and y (Fig. 1, band brakes) are denoted T_1 and T_2, respectively, for clockwise rotation. When the direction of the rotation is reversed, the tension in x equals $T_2 = P\dfrac{e^{\mu\theta}}{e^{\mu\theta}-1}$ and the tension in y equals $T_1 = P\dfrac{1}{e^{\mu\theta}-1}$, which is the reverse of the tension in the clockwise direction.

The value of the expression $e^{\mu\theta}$ occurring in these formulas may be most easily solved by means of logarithms. The value of $e^{\mu\theta}$ is found by multiplying the logarithm of e by the product of the numerical values of μ and θ, and finding the number whose logarithm is equal to the result of this multiplication. The procedure may be best illustrated by an example.

In a band brake of the type in Fig. 1 in the Supplement, dimension $a = 24$ inches, and $b = 4$ inches; force $P = 100$ pounds; coefficient $\mu = 0.2$, and angle of contact = 240 degrees, or $\theta = \dfrac{240}{180} \times \pi = 4.18$. The rotation is clockwise. Find force F required.

$$F = \frac{Pb}{a}\left(\frac{e^{\mu\theta}}{e^{\mu\theta}-1}\right) = \frac{100 \times 4}{24}\left(\frac{2.71828^{0.2\times 4.18}}{2.71828^{0.2\times 4.18}-1}\right) =$$

$$\frac{400}{24} \times \frac{2.71828^{0.836}}{2.71828^{0.836}-1} = 16.66 \times \frac{2.31}{2.31-1} = 29.4.$$

The formulas given for the brakes in the Supplement are not empirical, but are theoretically correct. They can be mathematically verified. By means of calculus the values represented by T_1 and T_2 for the band brakes may be deduced, while the various expressions for F are obtained by equating the moments of the forces involved about any point of the brake, preferably about its fulcrum, or fixed point. For the block brakes the whole question is one of moments. For example, in Fig. 3, for clockwise rotation, by taking moments about the fulcrum we obtain $F(a + b) - Pc = \dfrac{Pb}{\mu}$,

From which

$$F = \frac{\dfrac{Pb}{\mu} + Pc}{a + b} = \frac{Pb}{a + b}\left(\frac{1}{\mu} + \frac{c}{b}\right)$$

TABLE OF VALUES OF $e^{\mu\theta}$.

Proportion of Contact to Whole Circumference. $\frac{\theta}{2\pi}$	Steel Band on Cast Iron, $\mu = 0.18$	Leather Belt on			
		Wood.	Cast Iron.		
		Slightly Greasy. $\mu = 0.47$	Very Greasy. $\mu = 0.12$	Slightly Greasy. $\mu = 0.28$	Damp. $\mu = 0.38$
0.1	1.12	1.34	1.01	1.19	1.27
0.2	1.25	1.81	1.16	1.42	1.61
0.3	1.40	2.43	1.25	1.69	2.05
0.4	1.57	3.26	1.35	2.02	2.60
0.425	1.62	3.51	1.38	2.11	2.76
0.45	1.66	3.78	1.40	2.21	2.93
0.475	1.71	4.07	1.43	2.31	3.11
0.5	1.76	4.38	1.46	2.41	3.30
0.525	1.81	4.71	1.49	2.52	3.50
0.55	1.86	5.63	1.51	2.63	3.72
0.6	1.97	5.88	1.57	2.81	4.19
0.7	2.21	7.90	1.66	3.43	5.32
0.8	2.47	10.60	1.83	4.09	6.75
0.9	2.77	14.30	1.97	4.87	8.57
1.0	3.10	19.20	2.12	5.81	10.90
1.5	5.45	.....	....	....	.... .
2.0	9.60	.....	....	....	.....
2.5	16.90	.....	....	....	.....
3.0	29.80	.....	....	....	.....
3.5	52.40	.....	....	....	.....

The calculations for determining the value of $e^{\mu\theta}$ are rather cumbersome, and the accompanying table is appended in order to save the computation of this value for certain values of μ, and certain angles θ.

* * *

An interesting little slide rule has been brought out by Kolesch & Co., New York. This slide rule is only about half as long as the ordinary slide rule, and its weight does not exceed 1½ ounce; but it can be used to the same advantage, with equal reliability and accuracy, as the larger rules. The subdivisions are the same as those of the larger instruments, and in order to make it possible for the eye to read off the results with the same convenience as on a larger rule, a magnifying glass is placed in the runner, so that the divisions appear to the eye as clearly as those of larger slide rules.

* * *

Somebody asked the successful business man how he managed to accomplish so much. He smiled as he told them that the secret lay in always doing the next thing next.—*The Silent Partner.*

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* Address: Solvay Process Co., Engineering Dept., Detroit, Mich.

METHOD OF LAYING OUT AND CUTTING CAMS.*

HERBERT C. BARNES.†

Working by guess, or by the rule of thumb, is practiced quite as much, if not more, in the making of cams as in any other kind of machine work. Possibly this is so because a little leeway is generally given for the action of cams in the design of many machines, and the time-honored cut and try methods are relied on to bring the movements within necessary limits. It is certainly a fact that many a man who has laid out and cut cams does not know just what their performances will be until they are assembled in their machine and tested.

In this article we will consider the method of laying out a cam the requirements of which are as complicated in principle as any ordinarily used. We will then review a process for making the master cam, which is generally used, and also another process not generally employed, but of much greater service.

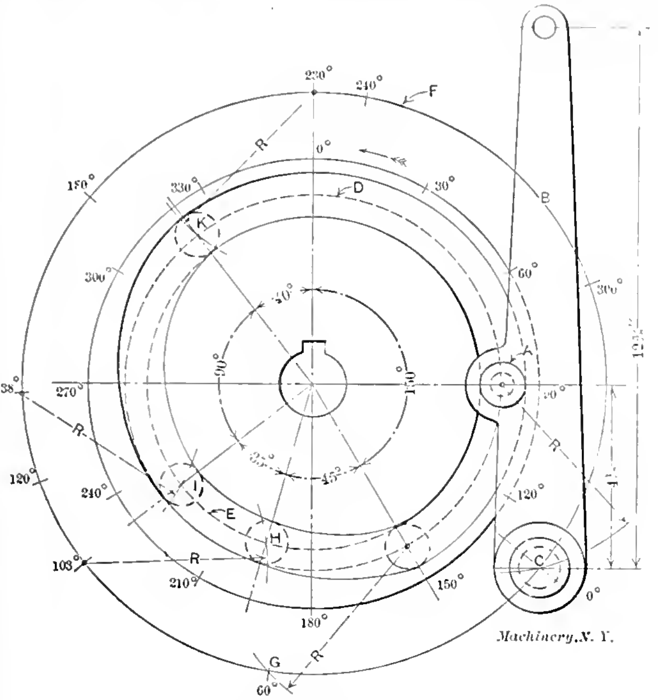

Fig. 1. Layout of Cam.

The cam which we will lay out is seen in Fig. 1. It turns toward the left and moves a 1-inch roller *A* which controls the lever *B* swinging on the stud *C*. The cam is to be keyed to a shaft, together with several other cams, in all of which the keyway is at the beginning of the cycle. The requirements which follow are selected to illustrate as simply as may be the method employed. The head of the lever *B*, which is 12¾ inches long, is to remain at rest until the cam has turned 150 degrees from the zero point or beginning of the cycle; it is then to advance 1½ inch in 43 degrees; then it will dwell for 35 degrees more, and, finally, retreat 1½ inch in 92 degrees, after which it will dwell for the remainder of the cycle. In Fig. 1 it is seen that the roller *A* is located at one-third of the distance from the pivot of the lever to its head. Hence a movement of one-half inch is required of the roller in the cam to move the lever head 1½ inch.

Layout of Cam.

We will now begin the layout. Draw first the circumference of the cam; its diameter we will make 10 inches. With the keyway on the vertical diameter, draw a line through its center. With this line as zero, divide the circumference into 30 degree sections, as shown, and number them. Now draw the circle *D* with a radius of 4 3/16 inches, to show the extreme outer position of the center of the roller, and the circle *E* with a radius of 3 11/16 inches, to show the extreme inner position of the center of the roller. Next, with the center of the cam as its center, draw the circle *F*, so that it will pass through the center of the stud *C*. Beginning with the center of the stud *C* as zero, divide this circle into sections and number them, as shown, for each 60 degrees. Such further sub-divisions as may be needed later may be made when required.

Proceed now with care to place the needle of a pair of good compasses in the center of the roller *A*, and adjust them so that the pencil point will pass through the center of the stud *C*. We will call this radius *R*. Now having in mind the requirements stated above, one being that the cam should turn 150 degrees from its zero before the roller moves place the end of the compasses at 150 degrees on the circle *D*. Holding the needle here, with the radius *R* draw an arc intersecting the stud circle *F* at the point *G*. It is seen that the point of intersection is at 60 degrees on the circle *F*. Now place the needle point 43 degrees further along on the stud circle, or at 103 degrees, and with the radius *R* draw an arc intersecting the circle *E* at the point *H*. The point *H* marks the halt of the advance of the roller, and the beginning of its dwell. Now move the needle 35 degrees further along the stud circle to 138 degrees, and with the radius *R* draw another arc intersecting the circle *E* at the point *I*. This point marks the end of the dwell and the beginning of the retreat. Now move the needle 92 degrees further along the stud circle to 230 degrees and with the radius *R* draw an arc intersecting the circle *D* at the point *K*. This point marks the end of the retreat and the beginning of the dwell for the remainder of the cycle.

The points *H*, *I* and *K* being marked, draw radii through them extending to the circumference of the cam circle. Knowing that the roll begins to advance at 150 degrees on the cam, the advance is seen to continue for 45 degrees. The roll then dwells for 35 degrees and retreats in 90 degrees, after which it dwells until the next advance begins. It is proper that these figures do not agree with the figures for the lever movement stated above. Barring possible slight errors in the layout, they are correct for the cam.

The radius of the inner wall of the raceway or groove is, of course, ½ inch less than that of the path of the cam center. Hence the radius of the inner wall of the outer dwell is 3 11/16 inches, and that of the inner dwell is 3 3/16 inches. This inner wall is the counterpart of the master cam which will be used to cut the cam groove.

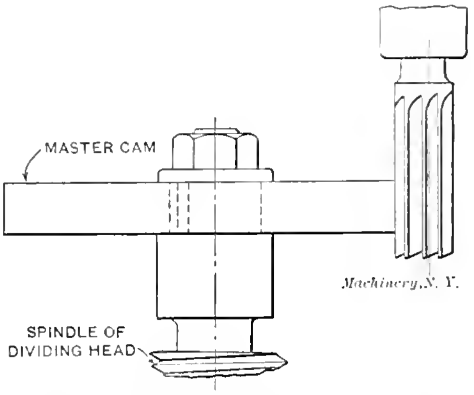

Fig. 2. Common Method of Milling Master Cams.

Common Method of Making Master Cams.

Assuming that the master cam has been properly machined and roughed down, we will consider briefly the generally used method of finishing it. This method comprises mounting the master cam in the dividing head of a universal milling machine, and gearing the head with the feed-screw of the table so that the table will advance in proper ratio with the turning of the work in the dividing head. In Fig. 2 the master cam is mounted as above described, and held against a cutter in the vertical spindle milling attachment on a milling machine. This cutter is of the same diameter as the roll which will be used in the cam.

The process is as follows: Feed the work against the cutter until the cutter is 3 11/16 inches from the center of the master cam. Now, with the key-slot of the master cam which is the "zero" of the cam, directly in line with the cutter, turn the work 150 degrees. This finishes a part of the outer

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* For additional information on this subject, see "Laying Out Cams for Rapid Motions," February, 1908, and other articles there referred to.

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dwell of the cam. The next operation is to feed the work against the cutter ½ inch while the dividing head turns 45 degrees. Since 45 degrees is ⅛ of 360 degrees, or one turn, we want gears which will turn the work ⅛ of a revolution while the table advances ½ inch. This is equal to one turn of the work while the table advances 4 inches. The gears on a feed-screw with four threads per inch, and 40-tooth worm-gear in the dividing head are,

Gear on worm 36,
First gear on stud 36,
Second gear on stud 28,
Gear on screw 70.

Having connected these gears with care, feed the work against the cutter 0.500 inch. The gears will at the same time turn the work 45 degrees. This will give the advance of the cam. Now, with the table clamped where it is, turn the work 35 degrees further. This will give the inner dwell of the cam. Now change the gears so that the work will turn 90 degrees while the table is backed away ½ inch. This may be done by removing the first gear on the stud with 36 teeth and replacing it with a 72-tooth gear. Having done this with care to avoid disturbing the work during the change, back the work away from the cutter 0.500 inch. The gears will have turned the work 90 degrees more, the intermediate having been properly adjusted. This will give the retreat of the cam. Now, with the table clamped where it is, turn the work until the cutter reaches the part already finished.

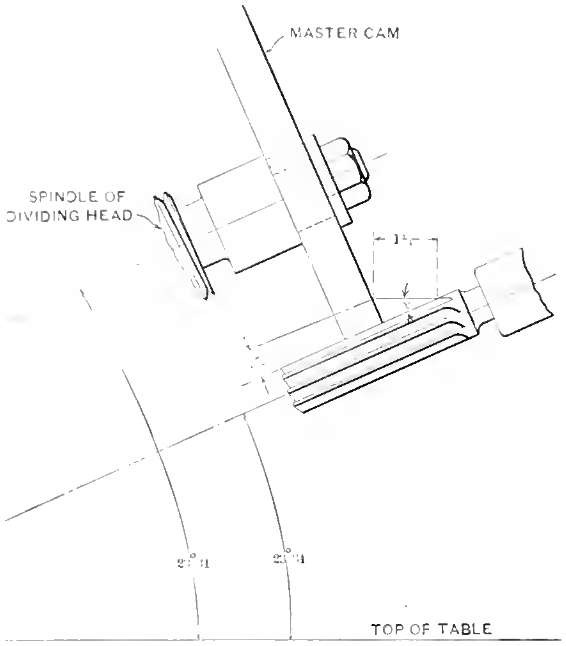


Fig. 3. Improved Method of Milling Master Cams.

This method, which has just been described, is very convenient when the change gears will give the combinations that are necessary, but it will often happen that the desired combination cannot be made with even an approach to accuracy. This difficulty may be overcome, however, by a method which is not in general use, but by which any desired result may be obtained.

Improved Method for Producing Master Cams.

For convenience we will suppose that the master cam could not be cut with the gears named or with any others, in the vertical position. We will proceed as follows: Mount the roughed out master cam as before in the dividing head, and place a 1-inch end mill in the vertical milling attachment, but, instead of setting them in a vertical position, incline each at an angle of 23 degrees 34 minutes, as shown in Fig. 3. The reason for this will appear later.

By inspection we see that if the work be fed against the cutter, Fig. 3, the cutter will enter the work and approach the mandrel. We also see that if the angle of inclination be increased or reduced, the rate with which the cutter approaches the mandrel will vary likewise. A convenient combination of gears to use in this case is one which will turn the work 360 degrees while the table advances 10 inches. This result may be obtained by using four 36-tooth gears to turn the work.

Having milled the master cam for the first 150 degrees to a radius of 3 11/16 as before mentioned, we must find the correct distance to feed the table forward in order to make the cutter approach the mandrel ½ inch while the work turns 45 degrees. The computation is done as follows: Forty-five degrees is ⅛ of 360 degrees. Since the table is geared to advance 10 inches while the work turns 360 degrees, the table will advance ⅛ of 10 inches while the work turns 45 degrees. Thus the advance is 1¼ inch to the 45-degree turn of the work. By inspection we see that in Fig. 3 the cutter and the work-face form two sides in a right angle triangle with a hypothenuse of 1¼ inch and one side of ½ inch. By solving, we find the angle a to be 23 degrees 34 minutes, as mentioned above. Having now properly connected the gears to mill the advance on the cam, feed the table ahead 1.250 inch. As just stated, this will make the cutter approach the mandrel ½ inch while the gears will have turned the work 45 degrees. Now with the table clamped where it is, turn the work 35 degrees more. We are then ready to begin the retreat of the cam. We must arrange gears which will turn the work 90 degrees while the table is backed 1¼ inch. By removing the 36-tooth gear from the screw and replacing it with a 72-tooth gear, we get this result. Carefully make the change so as not to disturb the work, and then back the table 1.250 inch. The gears will have turned the work 90 degrees further. Now, with the table clamped where it is, turn the work until the master cam is completed.

This system for making cams may be used only where uniform movements are required. While we have used it to entirely finish a master plate cam, any part of any cam requiring uniform motion may be milled in this way with a degree of accuracy not readily obtained in any other way. In fact, the work should be as true as the machine on which it is done. The same system may be used to make a master cam for a drum cam, as shown in Fig. 4. Note, however, that the work is set 23 degrees 34 minutes from the vertical position, while the cutter inclines at right angles to, instead of parallel with, the axis of the mandrel. The same combinations of gears would be used if the drum cam action were similar to the one which we have discussed. The exceedingly low cost of making master cams by this method makes it profitable to provide a master cam for cutting the groove in a single cam.

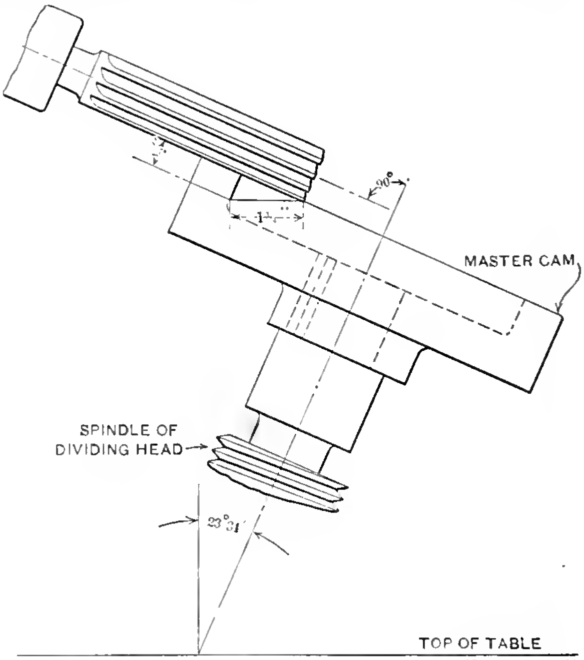


Fig. 4. Milling a Master Cam for a Drum Cam.

Special Cutter for Finishing Grooved Cams.

A source of constant annoyance in milling grooves in cast iron cams lies in the fact that finishing cutters quickly wear and become under size. They must then be laid aside

or used for taking the roughing cuts, while a new cutter of full size is used for finishing. We will not discuss the practice of putting a piece of paper in the collet to make the small cutter run out of true. Another source of trouble, even with cutters with spiral flutes, is the tendency of the cutter to chatter, unless it is perfectly ground and all other conditions are exactly right. Still a third trouble is in the tendency of the cutter to cut more on one side than on the other and to dig out stock in spots in the groove.

In Fig. 5 is shown an extremely simple tool, the usefulness of which cannot be overestimated for finishing grooves in cast iron cams. It is a piece of tool steel, suitably machined to mount on an arbor. It is turned on the outside, with enough stock left on for grinding, after which the spiral grooves shown in the developed surface are milled with an angular cutter. The piece is then hardened and ground to size. The cam groove which we are to finish is roughed out from 0.002 inch to 0.012 inch below size; the roughing cutter is removed from the spindle of the cam-cutting machine, and this special tool is mounted in its place. The cam is then fed against the tool until the tool reaches the bottom, when the cam is turned one complete revolution. The tool will leave a true groove exactly the right size, and without chatter marks or hollows.

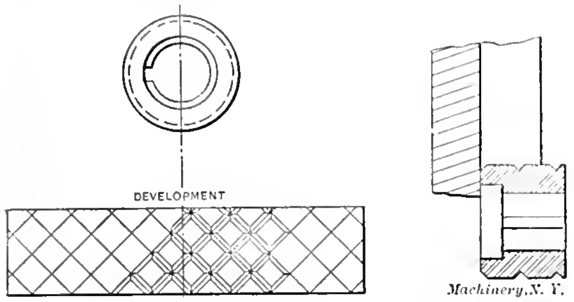


Fig. 5. Special Finishing Cutter for Cam Grooves.

By reason of the form of the cutting or scraping edges, it will outlast many ordinary cutters. Used in connection with it, a single roughing cutter may be repeatedly sharpened before it becomes too small for good results.

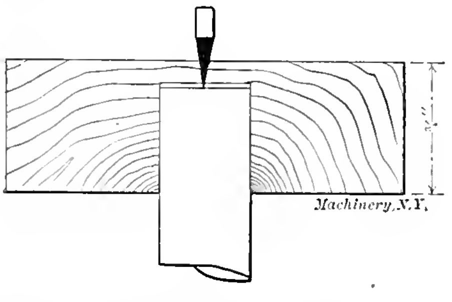
* * *

TO FIND THE CENTER OF A SHAFT.

The ways of amateurs are interesting—and sometimes instructive. The machinist will find the following question and answer, clipped from the column of a worthy contemporary, whose name we forbear to publish, interesting, somewhat amusing, but scarcely instructive, however—that is from a practical standpoint. Imagine a mechanic with a tool box filled with auger bits of various diameters for boring blocks of wood so that he could center all sizes of shafts likely to come his way! Following is the sketch with the question and answer referred to:

What is a good method for finding the center of a shaft?—A. G.

In a block of wood three-fourths inch thick bore a hole with an augur bit, just the size of the shaft. Allow the point of the bit to just show through the block. Place the block over the end of the shaft, and the center may then be marked with a sharp pointed prick punch.



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The Cincinnati Shaper Co., Cincinnati, O., informs us that it has a patent pending on its shaper key-seating attachment illustrated and described in our September issue.

ELECTRO-CHEMICAL CLEANING BATHS.

In a paper presented before the American Brass Founders' Association, by Mr. Charles H. Proctor, Arlington, N. J., the electrolytic process of cleaning metals was described. The process is comparatively new, the first published account of it appearing about three years ago, and, although used by many large concerns, it is not as generally known as it should be considering the good results obtained and the cheapness of the process.

Alkaline substitutes, such as sodium carbonate, potassium carbonate, potassium hydroxide and sodium hydroxide in solution in varying degrees of concentration, and with small portions of potassium cyanide, develop sufficient hydrogen, with a current of 4 to 8 volts, with the bath at nearly boiling temperature, to entirely remove all organic substances from the surface of metal, leaving same chemically clean. The use of this method has been constantly increasing, and at the present time very few large concerns, particularly those engaged in the manufacture of hardware, are without electrochemical cleaning baths.

The action of an electro-cleanser is similar to the action of an electroplating bath. The only difference as far as the development of gases is concerned, is that no metal being in solution and the anode being insoluble, no metal is deposited, but with a strong current a copious evolution of oxyhydrogen gas is developed upon the articles, which attack the organic matter upon the surface, practically lifting it off and by rapid evolution of the gases carries it to the surface. The small quantity of potassium cyanide contained in solution absorbs the slight oxidation that might be upon the surface, and by the combined action produces a surface clean enough, after washing in clear water, for any deposits.

The arrangement of an electro-cleaning bath is very simple. Prepare a wrought-iron tank of proportions best adapted to the amount of work to be cleansed. This should be heated with steam coils of iron. Across the top of the tank an insulated frame should be constructed. Upon this frame place three conducting poles, as on the regular plating bath. To the two outside poles the positive current should be carried direct. This can best be accomplished with at least ½-inch copper wire flexible cables. To the center pole the negative current is connected with a cable of the same dimensions; no rheostats are necessary. The stronger the current the greater the evolution of gases and the quicker the cleansing operation is accomplished.

Although direct contact can be made with the positive current to the tank itself, in practice better results have been obtained with anodes of sheet iron not more than 6 inches wide and of a length in proportion to the depth of the tank.

The electro-cleaning solution should consist (for ordinary purposes) of 3 to 4 ounces caustic potash to each gallon of water, and to every 100 gallons of solution 8 ounces cyanide of potassium. This can be varied according to conditions. It is advisable to add at least ¼ pound of cyanide each week. Where the articles, such as iron or steel, contain much oil or grease upon the surface, the density of the solution can be increased. For articles of brass, copper or bronze that have been polished, use a solution of carbonate of soda in the proportion of 2 ounces soda and ½ ounce caustic potash to each gallon of water, with the addition of 4 ounces of cyanide to every 100 gallons of solution. If much organic matter is upon the surface of the articles to be cleansed, it is advisable, where an air pressure can be obtained from an ordinary blower, to arrange a pipe so that the current of air can be deflected upon the surface of the solution, thus keeping the center of the solution clear of the insoluble substance that arises to the surface. When the cleanser is at rest, as much of this matter as possible should be removed.

It should be the aim of the operator to use the same methods of avoiding all unnecessary contamination as he would in electro-depositing baths. It is obvious even to those who have not practiced this method of cleansing metallic articles that large quantities of work can be treated very rapidly, and this is the case especially where frames or racks are used in the plating operations.

CABLE HAULING ON THE NEW MANHATTAN BRIDGE.

From the windows of the Industrial Press business office the construction of the new Manhattan Bridge, spanning the East River, can be plainly seen. This is the fourth great bridge between Manhattan and Long Island, the others being the Brooklyn Bridge and Williamsburg Bridge, both completed, and the Blackwell's Island Bridge, nearly finished. The latter is of the cantilever type, and the other three are of the well-known suspension form. The towers of the Manhattan Bridge are built of structural steel and were completed a few months ago. At the present time the process of "spinning" or hauling the cables is going on. Preliminary to spinning the cables, temporary foot-bridges were erected, these being suspended on $1\frac{3}{4}$-inch cables. These cables support four foot-bridges on which the workmen stand, and also sustain the hauling rope supports which guide and control the spinning of the wire composing the four main

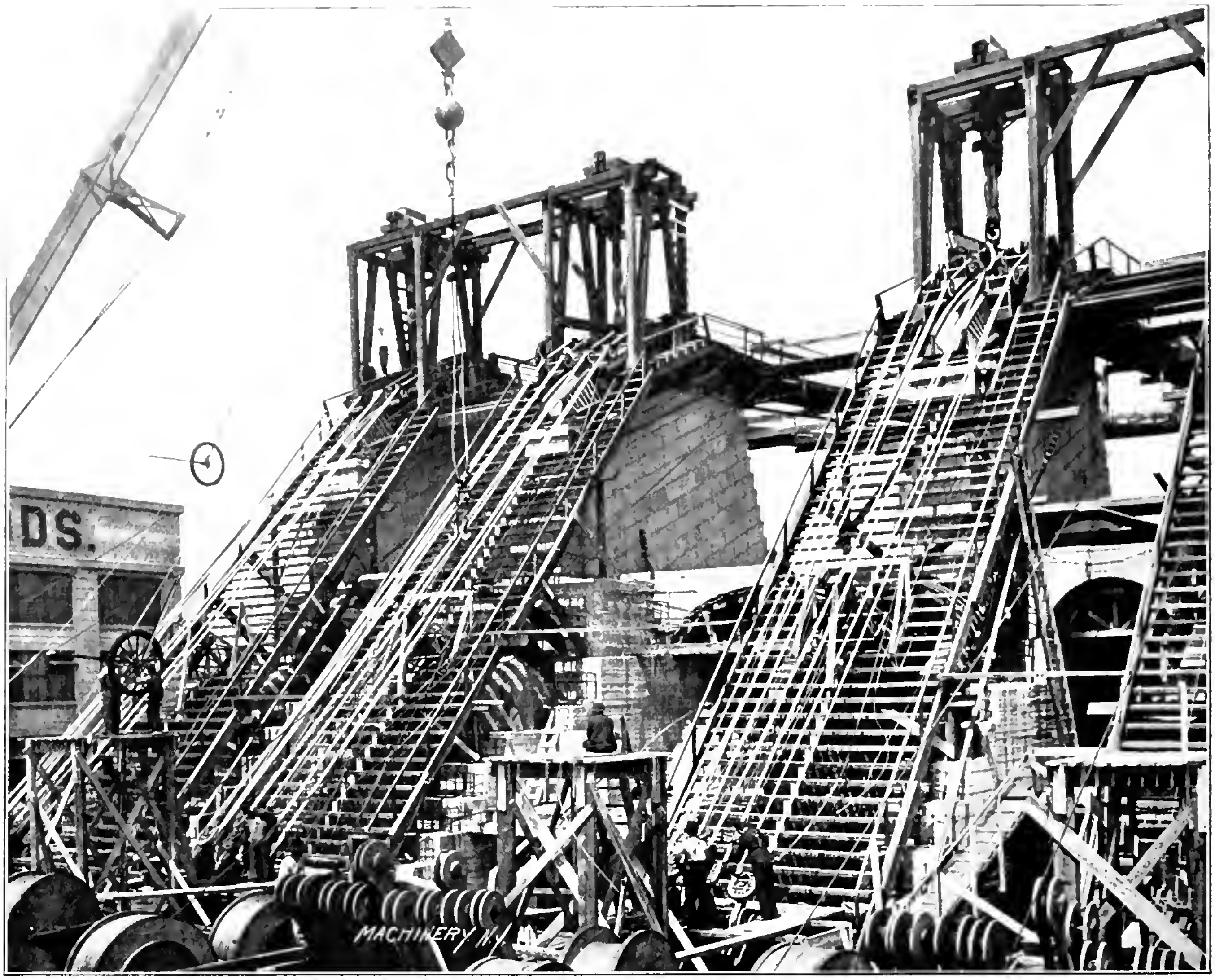


Fig. 1. View of One of the Anchorages of the Manhattan Bridge, showing the Strands which are to form the Main Cables, resting in Temporary Saddles.

Fig. 2. [illegible] Sheave used for Hauling the Small Steel Cable Wires across the River.

Fig. 3. View of the Temporary Foot-bridges which Support the Hauling Cables.

cables. Each cable will contain 37 strands of 256 wires each, a total of 9,472 wires per cable, which must be strung wire by wire. The enormous amount of work involved will be done by machinery driven by electric motors.

The stringing of the wires in each cable is accomplished by means of two traveling sheaves carried on opposite legs of an endless steel rope. Each sheave consists of a three-foot grooved wheel fastened to the hauling rope by means of wrought iron brackets, as shown in Fig. 2. The hauling rope is three-quarters inch diameter, and runs above the position of the bridge cables on heavy rollers supported on uprights on the temporary foot-bridge. See Fig. 3. There are five of these hauling rope supports on the center span, two on each end span and one on each tower. The hauling sheaves move back and forth across the bridge from anchorage to anchorage, a distance of 3,223 feet. They are attached one to each leg of the hauling rope so that they move in opposite directions.

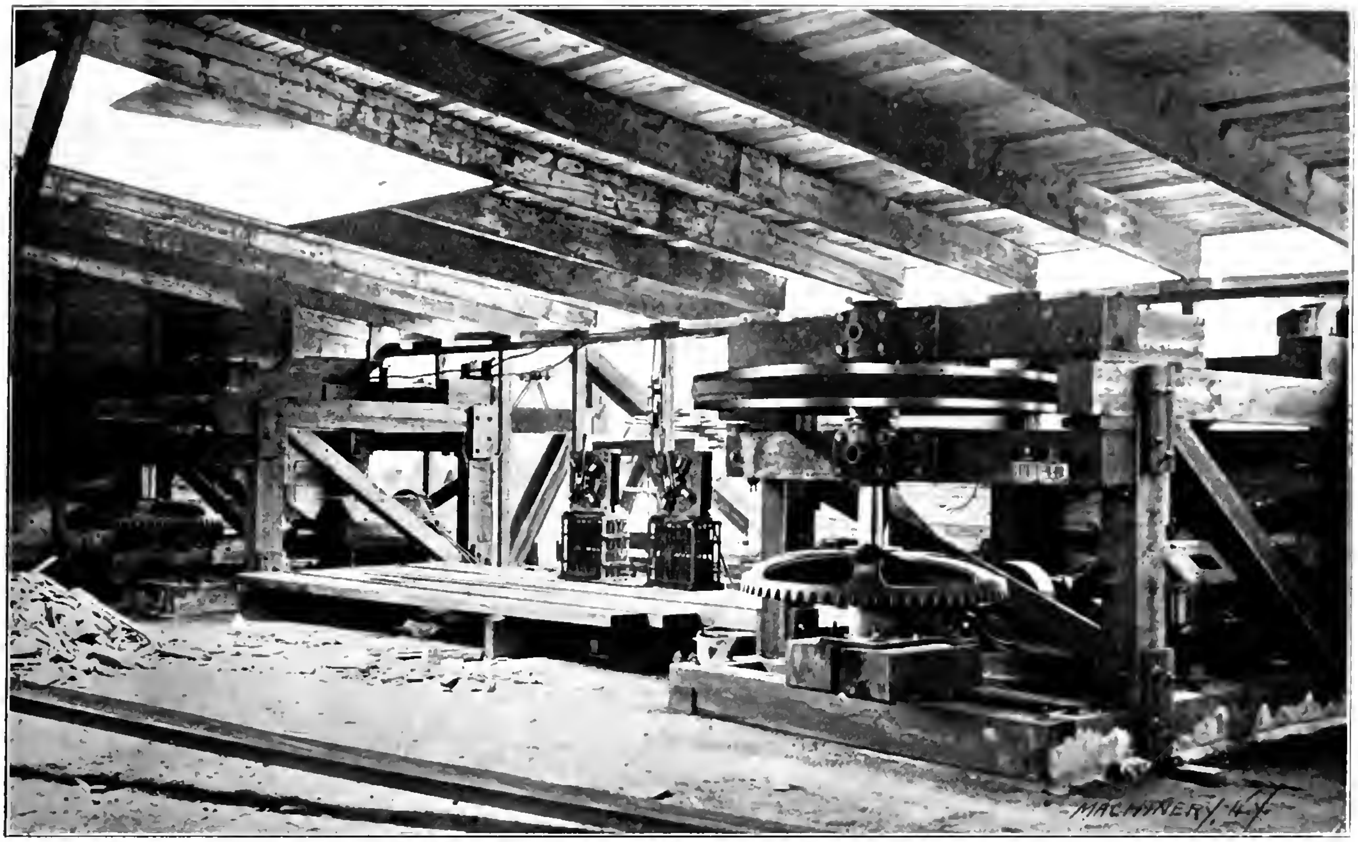


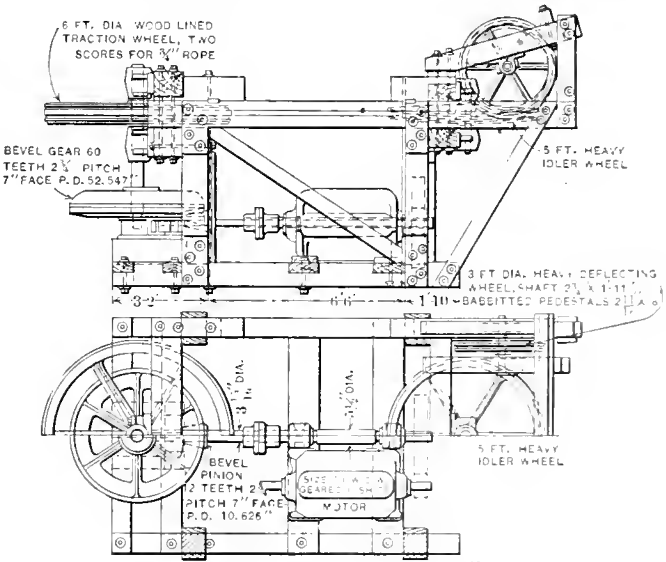
Fig. 4. Cable Hauling Machinery, Brooklyn Anchorage Manhattan Bridge.

The wire, which is 0.192 inch in diameter (No. 6 Roebling gage), is delivered to the bridge on enormous reels or spools, weighing three tons each. Half of these reels are placed at each end of the bridge. The end of the wire from a reel at each end of the bridge is put over the hauling sheave at that end and fastened to the anchorage. The machinery is then started and the sheaves move across the bridge, unwinding one wire from each reel. Two wires are thus strung by each sheave every time it crosses the bridge. When the sheave reaches the opposite side of the bridge the bight of the wire is taken off and made fast to that anchorage, and a new wire hauled from that side on the return trip.

The wires are laid in temporary saddles of four grooved pulleys at each anchorage. See Fig. 1. As the hauling of each strand of 256 wires is completed, the wires are bound together at intervals, and the strand is lifted from the temporary saddle by means of a chain hoist and laid in its proper place in the permanent saddle. Two strands of each cable are strung simultaneously by the two sheaves of each hauling rope.

There is a separate hauling mechanism for each of the four bridge cables, so that they are strung independently of each other. Delays are, therefore, not cumulative. The delays in one cable affect that cable alone, and the work proceeds on the others. This results in a very considerable saving of time.

Each hauling rope is driven by a 50-H.P. 220-volt Crocker-Wheeler form W motor. This is the type of motor designed by the Crocker-Wheeler Company for rolling mill duty, and is well adapted to work of this kind where sudden overloads and frequent starting and stopping are likely. The motors are fully enclosed and capable of withstanding all kinds of weather and rough handling. The driving mechanism is shown in Figs. 4 and 5. Each motor is geared to a counter-shaft at a ratio of 5 to 1, and the counter-shaft is bevel geared to the driving shaft at a 5 to 1 ratio. On the driving shaft, above the gears, is a wood-lined, grooved, six-foot traction wheel, which drives the hauling rope. A five-foot idler wheel is also provided so that the hauling rope passes the traction wheel twice, to produce the necessary grip. The driving motors are all located on the anchorage at the Brooklyn end of the bridge.



Machinery, N.Y.

Fig. 5. Elevation and Plan of the Cable Hauling Machinery.

The hauling rope moves at a speed of approximately 480 feet per minute. It carries the sheaves across the river in about seven or eight minutes. Allowing for the time used in attaching wires at each end, about three trips are made per hour. It is estimated that at this rate the work of hauling

will occupy four months, some time being consumed in fixing guide wires for each strand and in adjusting the wires after they are hauled.

The reels of wire, as already stated, are stored at both ends of the bridge. The wire was delivered by John A. Roebling's Sons Co., the same firm which delivered the wire for the old Brooklyn Bridge thirty years ago. The work of building the cables is being carried on by the Glyndon Contracting Co., of New York City.

The hauling equipment for this bridge differs from any previously used. It will be remembered that in hauling the cables for the Williamsburg Bridge two steam engines were used, connected to the same driving shaft. It later became necessary to cut this shaft and use the engines independently to avoid cumulation of delays. Even with that arrangement only two cables could be hauled simultaneously. The Glyndon Company's cable hauling plant has doubled the capacity, and besides being electrically- instead of steam-driven, it is easier of manipulation and control.

* * *

FITCHBURG COOPERATIVE INDUSTRIAL SCHOOL COURSE.

The Fitchburg Iron Workers' Association, Fitchburg, Mass., recently tendered a banquet to the members of the Fitchburg city government and school board, and laid before them the plans for an industrial school to be incorporated in the present high school system, which was readily taken up by the city government, and has been put into operation.

The idea is somewhat unique, and bids fair to become an essential factor in industrial education in towns and cities of limited size throughout the country. The plan, as outlined, is in a form of an apprenticeship system whereby boys having passed the first year in high school, take up during three years, a mechanical course studying one week in the school, and the following week working in the shops. A special instructor has been employed, and special text-books provided. The boys are taken in pairs by the manufacturing companies, and the boy who has studied in school a week, on Saturday morning at 11 o'clock goes to the shop and learns on what particular job the other boy has been working, and how it is handled, so that he can come in the following Monday morning and begin work where his mate left off, thus following the shop course without necessitating instruction on the part of the shop foreman.

Mr. Hunter, the man in charge of this work, has had more applications than could be taken care of the first year, and at the present time all the boys are working in the shops and will continue to do so until the school opens. The cooperative industrial high school course is as follows:

FIRST YEAR, ALL SCHOOL WORK.

English	4	periods	per	week.
Shop Mathematics	5	"	"	"
Mechanics	5	"	"	"
Freehand and Mechanical Drawing	5	"	"	"
Current Events	2	"	"	"

SECOND YEAR, SCHOOL AND SHOP WORK.

English	4	periods	per	week.
Shop Mathematics	5	"	"	"
Chemistry	4	"	"	"
Electricity and Heat	4	"	"	"
Freehand and Mechanical Drawing	8	"	"	"

THIRD YEAR, SCHOOL AND SHOP WORK.

English	4	periods	per	week.
Shop Mathematics	4	"	"	"
Commercial Geography, Business Methods and Conditions	4	"	"	"
Advanced Chemistry or Industrial History	5	"	"	"
Freehand and Mechanical Drawing	8	"	"	"

FOURTH YEAR, SCHOOL AND SHOP WORK.

English	4	periods	per	week.
Civics and American History	5	"	"	"
Applied Mathematics	5	"	"	"
Mechanics and Freehand Drawing	8	"	"	"
Discussion of Current Mechanical Appliances	2	"	"	"

Shop work consists of instruction in the operation of lathes, planers, drilling machines, in bench and floor work, and in other machine work according to the ability of the apprentice as pertaining to the particular branch of manufacture in the shop where he is employed.

Copy of the rules and conditions of this system is given below:

Rules and Conditions.

Under Which Special Apprentices Taking the Four-Year Coöperative Industrial Course at the High School of Fitchburg Are Received for Instruction at the works of

Blank Machine Co.

1. The Applicant for apprenticeship under this agreement must have satisfactorily met requirements for entrance to this course at the high school.

2. The apprentice is to work for us continually, well and faithfully, under such rules and regulations as may prevail, at the works of the above company, for the term of approximately 4,950 hours, commencing with the acceptance of this agreement, in such capacity and on such work as specified below:

Lathe Work,
Planer Work,
Drilling,
Bench and Floor Work.
And such other machine work, according to the capacity of the apprentice, as pertains to our branch of manufacturing.

This arrangement of work to be binding unless changed by mutual agreement of all parties to this contract.

3. The apprentice shall report to his employer for work every alternate week when the high school is in session, and on all working days when the high school is not in session, except during vacation periods provided below, and he shall be paid only for actual time at such work.

4. The apprentice is to have a vacation, without pay, of two weeks each year, during school vacation.

5. The employer reserves the right to suspend regular work wholly, or in part, at any time it may be deemed necessary, and agrees to provide under ordinary conditions other work at the regular rate of pay, for the apprentice during such period.

6. Should the conduct or work of the apprentice not be satisfactory to employer, he may be dismissed at any time without previous notice. The first two months of the apprentice's shop work are considered a trial time.

7. Lost time shall be made up before the expiration of each year, at the rate of wages paid during said year, and no year of service shall commence till after all lost time by the apprentice in the proceeding year shall have been fully made up.

8. The apprentice must purchase from time to time such tools as may be required for doing rapid and accurate work.

9. The said term of approximately 4,950 hours (three-year shop term) shall be divided into three periods as stated below, and the compensation shall be as follows, payable on regular pay-days to each apprentice:

For the first period of approximately 1,650 hours: 10 cents per hour.

For the second period of approximately 1,650 hours: 11 cents per hour.

For the third period of approximately 1,650 hours: 12½ cents per hour.

10. The above wage scale shall begin the first day of July preceding the apprentice's entrance upon the first year of shop work of the high school industrial course.

The satisfactory fulfilment of the conditions of this contract leads to a diploma, to be conferred upon the apprentice by the school board of Fitchburg upon his graduation, which diploma shall bear the signature of an officer of the company with which he served his apprenticeship.

* * *

AN AMERICAN MECHANIC IN EUROPE.

With reference to installment No. 5 of the above series which appeared in your August issue, we find on page 909 (engineering edition) a reference to ourselves in which it is stated: "The company usually builds the machines in lots of three throughout all departments, only occasionally making a larger number at a time."

We believe the above must be a printer's error or due to a misunderstanding on the part of the author, as we informed him we built the machines in lots of *three dozen*. This applies to machines 3 feet 6 inches, and 4 feet radius, and to a number of lighter machines up to 5 feet and 6 feet radius on special classes of work. The heavy type of machines weighing from 7 to 8 tons and upwards cannot, of course, be put through in such large quantities.

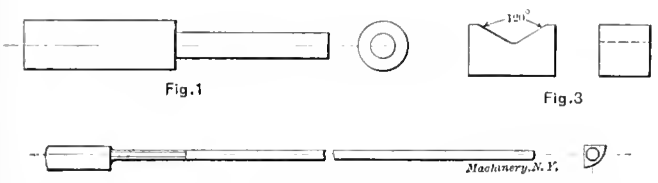
Halifax, England. WILLIAM ASQUITH, LTD.

THE STEAM HAMMER AND ITS USE.

JAMES CRAN [*]

One of the greatest changes in the way of improvement in the art of blacksmithing came with the steam hammer. It made possible the making of heavy forgings from one solid piece of iron or steel, which previously had to be made in sections and welded together. Welding is still necessary on a great many kinds of blacksmith work, but with the steam hammer it can be done in less time and to better advantage than is possible by hand. The majority of people, including blacksmiths, seem to have only one conception of a steam hammer, that of a piece of machinery intended for striking a heavy blow; this is the principal, but by no means the only purpose for which it can be used. With a good equipment of tools and a good operator it is possible to do nearly any kind of machine blacksmithing—all but the finishing touches—at the steam hammer. If necessary it can also be used to do drop forging and as a trimming press, shears, bulldozer, and vise, and for a variety of other purposes.

With all its advantages it is, as a rule, one of the most abused pieces of machinery to be found around a manufacturing plant. For every other kind of machine there is usually a skilled operator. If it happens to be operated by a boy, or any one else who does not thoroughly understand it, he is generally doing so under the directions of a competent man. For the steam hammer, as with every thing else in the blacksmith shop, anything is good enough—an ordinary laborer, a small boy, or any one who comes along, provided he can be hired for a small amount of money, regardless of safety or economy. To get the best results from a steam hammer, however, as with any other kind of machine, it is absolutely essential that the operator thoroughly understands his business. He should be as conversant with the working parts and mechanism as an engineer should be with an engine, and should be able to do all minor repairing, such as packing glands, adjusting guides, valves, etc. As a machine operator, he should be classed with skilled labor, and paid according to his ability. Like all other classes of help, really good steam hammer operators are scarce from the fact that the unskilled laborer usually gets the same rate of wages.



Figs. 1 to 3. Example of Work, and Tools for "Breaking Down" Forgings.

The purpose for which the steam hammer is principally used is to draw iron or steel to smaller dimensions in the making of forgings. This can be done to the best advantage if the dies are slightly crowned in the center, not necessarily over 1/16 inch for each die, and the edges rounded off to about a radius of 3/32 inch. Any one who has done work with a steam hammer will appreciate the advantage of having the dies crowned. In drawing stock with perfectly level dies, the drawing is most in evidence where the edges come in contact with the metal; in the center it is simply spread out, there being nothing in the dies themselves to give it a tendency to draw when a blow is struck by the hammer. With the dies crowned, a blow will be more effective, and the spreading of stock will be reduced to a minimum. It is also an advantage to have the sides of the dies square, so that in making forgings such as are shown in Fig. 1, the shoulder will be as near as possible at right angles with the body of the piece.

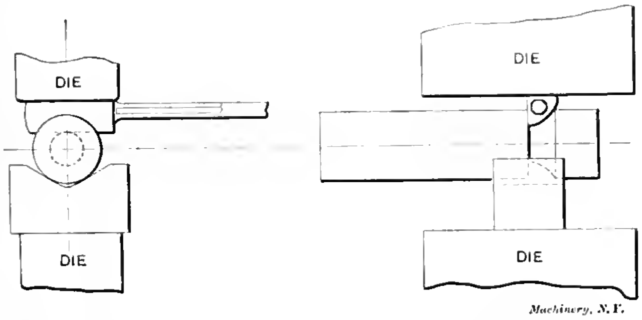


Fig. 4. Use of Breaking Down Tool and V-block in the Steam Hammer.

In "breaking down" stock for a shoulder a tool similar in construction to Fig. 2 should be used, the head or part which does the work being in the shape of one-quarter of a circle, with the edges slightly rounded to prevent cutting. This tool will break down a shoulder square. It can be used either right or left-hand, and its shape gives it a tendency to crowd towards the shoulder which will leave the stock at that point up to, or slightly larger than, the original dimensions. This tool presents decided advantages over the round tool commonly used, as this latter has a tendency to drag down the edges near where it is used, making it necessary to upset and finish the work by hand to get the body of the forging uniform throughout. When round stock is being broken down it is usually placed in a circular tool similar to a swage, which necessitates the using of a different tool for each size of stock. If a tool is used of the style shown in Fig. 3, which is made in the form of a V-block with a circular bottom, it will accommodate several sizes of stock. Four or five such tools of different sizes will cover a large range of work.

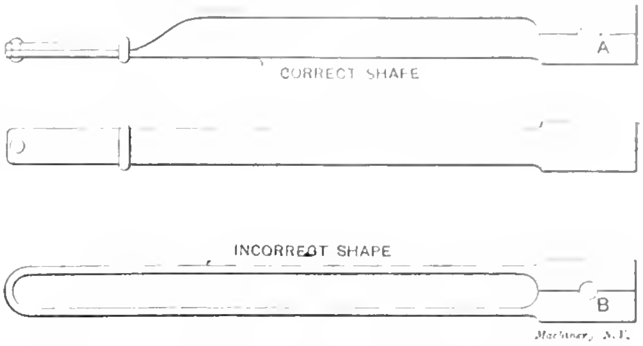


Fig. 5. Correct and Incorrect Types of Swages for Steam Hammer.


Fig. 6

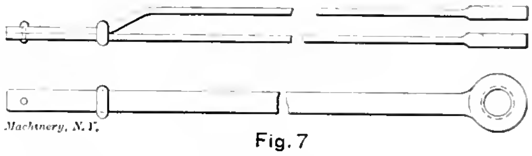


Fig. 7

Fig. 6. Swages for Making Blank-headed Eye-bolts. Fig. 7. Swages for Forging Hubs.

Fig. 4 shows how the breaking down tool and the V-block should be used in the steam hammer. The V-block is placed upon the bottom die, the work is laid in the V-block, and the breaking down tool on top of the work at the point intended for the shoulder. The tool is guided by hand until the piece has been marked all the way around. It can then be driven in, turning the piece continually, until it has reached the required depth. In drawing the shank of a forging, such as is shown in Fig. 1, it should be kept square until it has been reduced to the required size; the corners are then worked in until an octagon shape is obtained; and, finally, the corners are rounded. This procedure prevents the center being "piped."

In finishing round work, it should be done as far as possible at the steam hammer, using spring swages. Of these there are several styles. Fig. 5 shows at the top the style which is simplest and most satisfactory to use. The swages are made in two separate parts and held together by one rivet, and provided with a band to keep them in alignment without having to use a guide pin. The impression in each

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[*] Address: 916 West Third St., Plainfield, N. J.

part should be half the depth of the diameter of the piece the swages are intended to finish, so that it would be impossible to swage a forging under size. The edges or lips should be well backed off to prevent a fin or flash being formed. If a fin or flash is formed upon a piece of work while it is being finished in swages or dies, it is liable to get worked into the forging when it is turned for the next blow of the hammer, forming what is known as a cold shut. This may not be noticed on the forging, but will show up when the work is machined; it is unsightly on machine steel pieces, and renders tool steel useless for all cutting purposes.

Swages of the style shown at the top in Fig. 5 can be made to form collars, ends for connecting-rods, blank-headed eye bolts, forgings with ball ends, and a variety of other pieces. No machine work is necessary on this kind of swage, as it can be made and finished complete in the blacksmith-shop by using a dummy, or a forging made as near as possible to the dimensions of the pieces for which the swage is intended. This sample forging is used for finishing the impression, after it has been partly worked to shape, by heating the swage, and placing the dummy in it. The swage takes its impression from the dummy in the same manner as forgings take their shape from swages or dies. This method of making tools is known as typing, and can be employed to good advantage on a great many kinds of forgings, when the quantity to be made is such that it will justify the making of tools. All forgings made in tools as here described will be duplicates and finished in less time than would be possible by hand.

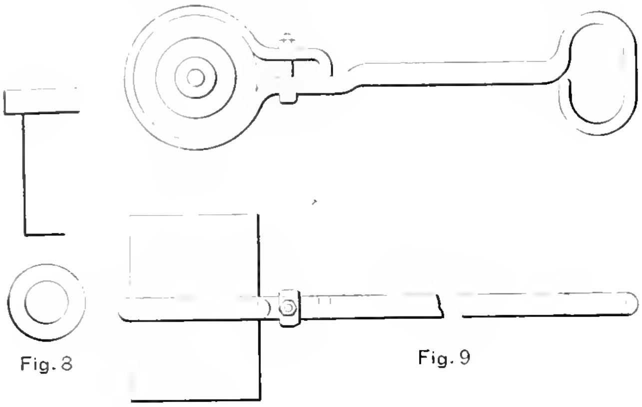


Fig. 8

Fig. 9

Machinery, N.Y.

Figs. 8 and 9. Pin to be Forged, and Tool used for Carrying Out the Operation.

Fig. 6 shows a swage for making blank-headed eye bolts, or any forging with a circular head and a plain round shank. These are different from other swages in that they have the edges of the impression sharp where the head of the forging is formed to insure a perfect circle. A fin or flash may be worked out where the impressions meet, but it will do no harm as it can be trimmed off with a chisel. The edges of the part of the impression where the shank is formed should be rounded off, as a flash formed at that point would cause trouble in finishing with ordinary spring swages.

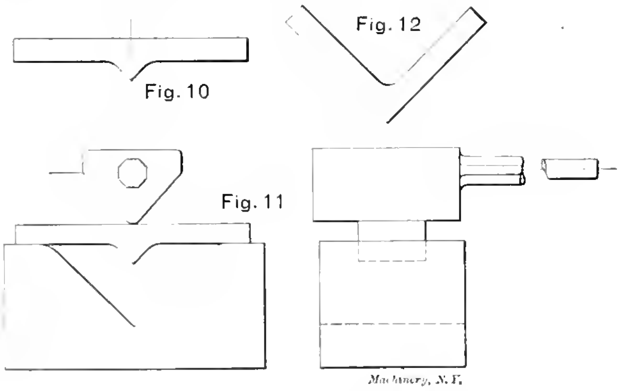


Fig. 10

Fig. 11

Fig. 12

Machinery, N.Y.

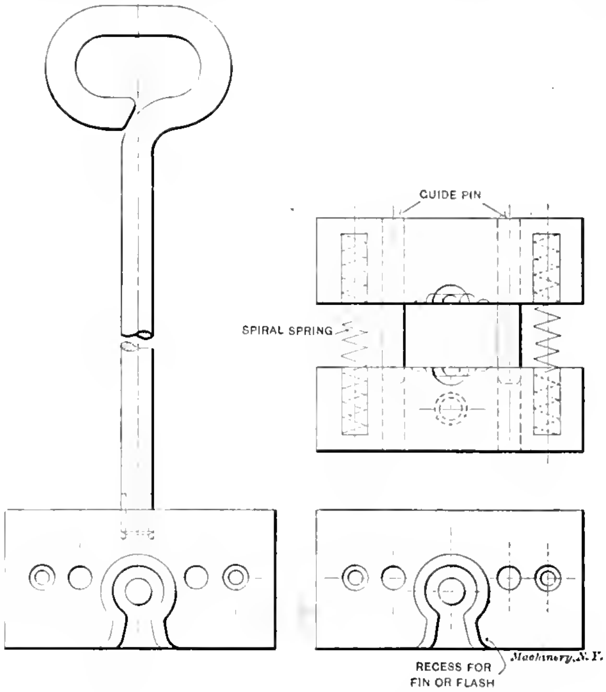
Figs 10, 11 and 12. Forging an Angle Iron.

When forgings with hubs are to be made, ring swages, as shown in Fig. 7, should be used. All that is necessary is to select stock heavy enough to allow the ends of the hubs being finished. The work is heated, placed in the swage, given a few blows by the steam hammer, and the hub is formed, both sides being in perfect alignment. The stock worked out at the sides can be trimmed off with a chisel. This may seem wasteful, but the time saved will more than compensate for the loss of material. For round bosses a tool similar to half the swage, Fig. 7, should be used; or a plain ring made of round stock would answer the purpose, by being placed upon the stock while it is hot, and struck a few blows with the steam hammer. It may be well to explain the difference between hubs and bosses; hubs project on both sides of a forging, while bosses only project on one side.


Machinery, N.Y.

Fig. 13. Tool for Drawing Work too short for Breaking Down under the Steam Hammer.

In making forgings of the style shown in Fig. 8, it is customary to draw them from stock of larger diameter than the shank, and finish them in a heading tool. When a quantity has to be made, it is of advantage to use stock the proper size for the shank, cut in lengths, and to use a tool as shown in Fig. 9. This tool is bored out just deep enough for the length of the shank and counterbored to accommodate the head. The stock should be heated on one end, placed in the tool, a few blows given by the steam hammer, and the forging is completed. A small hole should be drilled through the bottom of the tool, so that it can be turned up side down, and the forging removed with a punch. Six forgings can be made in this way in the same time as it would take to make one, if drawing it from heavier stock.



Machinery, N.Y.

Fig. 14. Dies for Drop Forging under the Steam Hammer.

In making angular forgings, stock of about the right size for the ends of the angles is usually selected, bent, and the corner worked back until it is square. This takes considerable time and careful working, or a cold shut will be formed inside the corner. With a steam hammer, pieces of this shape can be made with very little trouble by using stock heavy enough to allow a solid corner being formed as shown in Fig. 10, which can be done by using a round tool to break down each side of the piece intended for the angle, drawing the ends to the required size. Then the piece is bent in a V-block with a tool made for the purpose, as shown in Fig. 11. The result will be a piece as shown in Fig. 12. The V-block should have an included angle of 90 degrees, and be rounded at the top edges, as shown, to prevent marking the ends. The tool for bending should have the edge or corner rounded so that it will form a fillet inside the forging. Nearly any size of angle can be made with the same tools.

A tool for drawing work which is all broken down to one side, or between shoulders or bosses, when the distance is too short to reach across the dies, is shown in Fig. 13. The head is square, and the corners rounded, each to a different radius, so that fillets of different dimensions may be formed with the same tool.

Small pieces can be drop forged at the steam hammer without changing the ordinary dies, by using dies as shown in Fig. 14. The impressions are sunk the same as in regular drop forging dies. The dies are kept in alignment by two guide pins, and opened by two spiral springs placed on the guide pins. The dies are removed from the hammer dies by means of the handle attached to the back as shown. Forgings made in this style of dies are equal in every respect to regular drop forgings, with the exception that it requires more time making them. The steam hammer can be used to trim the forgings by using a trimming die and punch as shown in Figs 15 and 16. Trimming dies of the style in Fig 15, with open end, should be made heavy enough to prevent spreading, or breaking through the back, as they have no supporting device of the kind provided for dies in the trimming press. They also ought to be deep enough to allow of the forging dropping out of the reach of the punch when it is trimmed. Fig. 16 shows the punch, the face of which should be concaved to fit the forging it is intended to be used for. Fig. 17 shows the forging made in the dies in Fig. 14. The ends of the shanks are left heavy so that they can be finished either for eye-bolts or hooks. When made into hooks the shanks are left longer, finished in spring swages, and bent on a former made specially for that purpose. The style of dies here described can only be used for small work, and only then when the quantity is such that it will justify the expense of making the tools.

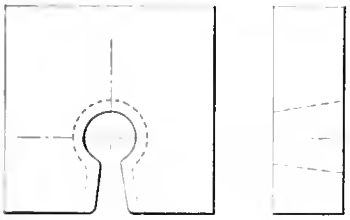


Fig. 15

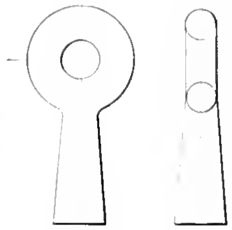


Fig. 17

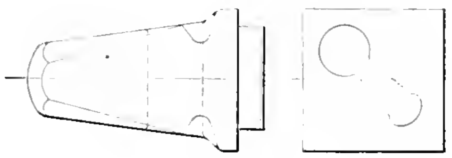


Fig. 16

Figs. 15, 16, and 17. Trimming Die and Punch, and Completed Work.

The steam hammer can be used as a punch press, when that machine is not available, by using a die and punch as shown in Fig. 18. The die is made on the same principle as spring swages, the top part acting as a guide for the punch. The lower part, or die proper, should be thick enough to allow the scrap from the hole and the punch dropping below the level of the guide, otherwise the punch would be liable to be bent or broken. Punches need never be longer than the depth of the die, and should be tapered from the face to give them clearance when being driven through the stock. This style of die and punch can be used on hot work, as for removing the stock between the jaws of wrenches, the centers of eye-bolts when being forged by hand, etc.

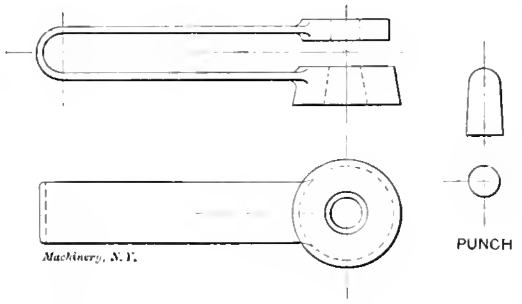


Fig. 18. Punch and Die for Punching Holes under the Steam Hammer.

In shops where there are no shears the steam hammer can be used for cutting off cold stock by using tools as shown in Figs. 19 and 20. Only one tool of each kind is shown, but the tool can, of course, only be used in pairs, one below and one over the stock, so that their edges will just pass by each other, the same as the jaws of shears. Fig. 19 shows the tools used for flat stock, while Fig. 20 shows the shape of tools for round stock. These tools are not as handy as shears, nor quite as safe, but are superior to saw or chisel in cutting up stock for forging.

Fig. 19

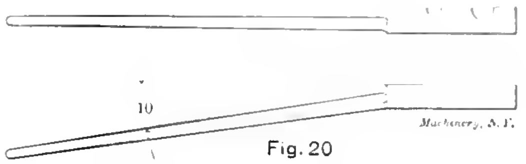


Fig. 20

Figs. 19 and 20. Tools used under Steam Hammer for Shearing Off Stock.

In forging rings of rectangular section it is customary to use stock of about the right dimensions for the section, bend it to shape, and weld it. This is all right for small rings, or large rings with small section; but when the size exceeds 5 inches inside diameter, and the section 1¼ inch square, it is advisable to make the rings from the solid stock for several reasons, principal of which are the saving of time, a more uniform section, and a perfectly solid forging when the ring is finished. This latter is impossible with a welded ring, except at cost and labor out of all proportion with the size of the job. To begin with the ends of the stock must be upset to allow for waste in welding, and bent in the form of a circle, which distorts the shape of the material; the outside is drawn out while the inside is upset or compressed. The only part of the stock which retains its original size is the neutral line at the center of the bar. After the ring has been welded, it has to be flattened and trued up all over to get it anything like uniform. Then, there are always chances of a poor weld, which makes the finished piece useless for all practical purposes.

Fig. 21. Steam Hammer Fixture used when Forging Rings.

When rings are to be made from the solid, the first thing to be done is to find the right amount of stock to use, which can be done by consulting hand-books, or by figuring out the cubic contents of a solid piece having the same diameter and the same thickness as the ring for which it is intended, deducting the number of cubic inches equal to the hole, and allowing enough extra material for waste in forg-

ing, and for finishing in the machine shop. Cut off a piece of round stock the proper length, and upset it under the steam hammer until it is of the same thickness as the face of the ring to be forged. Punch a hole in the center, and "drift" until it is approximately of the diameter required in the finished ring. The lower die should then be removed from the steam hammer, and a fixture of the style shown in the half-tone, Fig. 21, keyed in its place. This fixture is made in the form of a double V-block, the V's being circular in the bottom, and of an angle of about 120 degrees, allowing the use of different sizes of mandrels in drawing the rings to the required size. The ring or piece of stock with the hole punched through it is then placed between the V's, and the mandrel slipped through the hole and turned by means of the handles clamped to the shank. In turning the mandrel, the ring is turned with it, bringing a different point in line with the top die for each stroke of the hammer. This is done until the proper size has been reached, using larger mandrels as the hole increases in size. Rings up to 50 pounds can be made complete in two heats. Larger rings up to the full capacity of the steam hammer can be made by using a larger fixture in the anvil block by removing the chair for the lower die. It is advisable to use hollow mandrels for the larger sizes to facilitate their handling. Rings made from the solid in the manner here outlined can be completed in one-third the time required for welded rings. The section is uniform throughout, and no poor welds or overheated spots show up in the machining.

If the steam or power hammer were used, as it should be, to do the heaviest and most difficult work, the art of blacksmithing would be made more attractive, and the manufacturers' profits would be increased.

* * *

THE GISHOLT SHOP BAND.

The Gisholt band illustrated here is an outgrowth of the Gisholt Club, a social organization of the employes of the Gisholt Machine Co., Madison, Wis. The main object of the club is to promote acquaintanceship and good fellowship among the employes and their families. A room is provided by the company in which various entertainments are given during the year, and lecturers are employed from time to time to speak on topics of general interest. An event of importance is an annual picnic held on ground across Lake Mendota, near Madison. The picnic this year took place on August 8. In all these entertainments the Gisholt band is in evidence, and its members have acquired such proficiency that it plays very good music. A pleasing feature of the club during the summer is the open-air concerts given by the band on a piece of vacant property adjoining the Gisholt works. The club organization and the band auxiliary tend to bind together the employes to work for the common good, and are in line with all sound movements for the promotion of progress in coordinating human interests and manufacturing methods.

Gisholt Machine Co. Band.

JIGS AND FIXTURES—7.

EINAR MORIN.*

EXAMPLES OF DESIGNS OF OPEN DRILL JIGS.

A typical example of an open drill jig, very similar to the one developed and explained in the September issue, is shown in Fig. 73. The work is located against the three locating pins *A*, and held in place against these pins by the three set-screws *B*. The three straps *C* hold the work securely against the finished pad in the bottom of the jig. These clamps are so placed that when the work has been drilled and the clamp screws loosened, the clamps will swing around a quarter of a turn, allowing the work to be lifted directly from the jig and a new piece of work inserted, when the clamps are again turned around into the clamping position, and the screws tightened. These straps are integral parts of the jig; at the same time, they are quickly and easily manipulated, and do not interfere with the rapid removal and insertion of the work. The strength and rigidity of the feet in proportion to the jig should be noted, this strength being obtained by giving proper shape to the feet, without using an unnecessary quantity of metal.

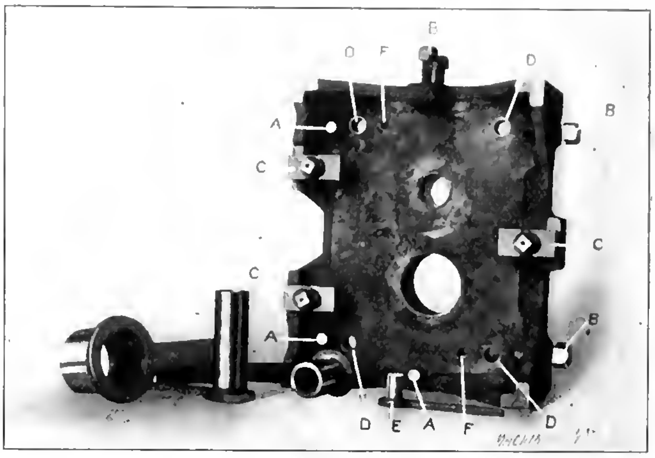


Fig. 73. Example of Open Drill Jig. View showing Front Side.

The jig in Fig. 73 is also designed to accommodate the component part of the work when it is being drilled. When this is done, the work is held on the back side of the jig, shown in Fig. 74. This side is also provided with feet, and has a finished pad against which the work is held. The locating pins extend clear through the central portion of the jig body, and, consequently, will locate the component part of the work in exactly the same position as the piece of work being drilled on the front side of the jig. The same clamping straps are used, the screws being simply put in from the opposite side into the same tapped holes as are used when clamping on the front side of the jig. The four holes *D* are guide holes for drilling the screw holes in the work, these being drilled the body size of the bolt in one part, and the tap drill size in the component part. The lining bushing in the holes *D* serves as a drill bushing for drilling the body size holes. The loose bushing *E*, Fig. 73, is used when drilling the tap holes in the component part, the inside diameter of this bushing being the tap drill size, and the outside diameter a good fit in the lining bushing. The two holes *F*, Fig. 74, are provided with drill bushings and serve as guides when drilling the dowel pin holes, which are drilled below size, leaving about 0.010 inch, and are reamed out after the two component parts of the work are put together. The two holes shown in the middle of the jig in Fig. 73, and which are provided with lining bushings, and also with loose bushings, as shown inserted in Fig. 74, may be used for drilling and reaming the bearing holes for the shaft passing through the work. In this particular case, however, they are only used for rough-drilling the holes, to allow the boring-bars to pass through when finishing the work by boring in a special boring jig, after the two parts of the work have been screwed together.

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The large bushings shown beside the jig in Fig. 73 are the loose bushings shown in place in Fig. 74. It will be noted that the bushings are provided with dogs for easy removal, as explained in the installment in the May issue, and illustrated in Fig. 11. As the central portion of the jig body is rather thin, it will be noticed in Fig. 74 that the bosses for the central holes project outside of the jig body in order to give a long enough bearing to the bushings. This, of course, can be done only when such a projection does not interfere with the work. The bosses, in this particular case, also serve another purpose. They make the jig "fool-proof," because the pieces drilled on the side of the jig shown in Fig. 73 cannot be put on the side shown in Fig. 74, the bosses preventing the piece from being placed in position in the jig.

Attention should be called to the simplicity of the design of this jig. It simply consists of a cast iron plate, with finished seats, and feet projecting out far enough to reach below the work when drilling, three dowel pins, set-screws for bringing the work up against the dowel pins, three clamps, and the necessary bushings. The heads of all the set-screws and bolts should, if possible, be made the same size, so that the same wrench may be used for tightening and unscrewing all of them. It can also be plainly seen from the half tones that there are no unnecessarily finished surfaces on the jig, a matter which is highly important in economical production of tools.

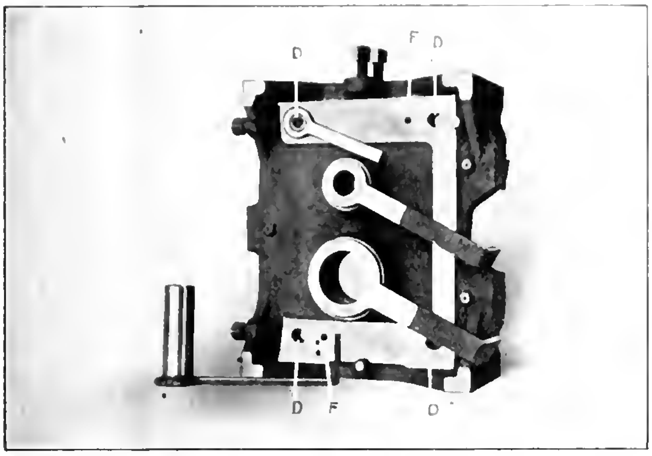


Fig. 74. Rear View of Drill Jig shown in Fig. 73.

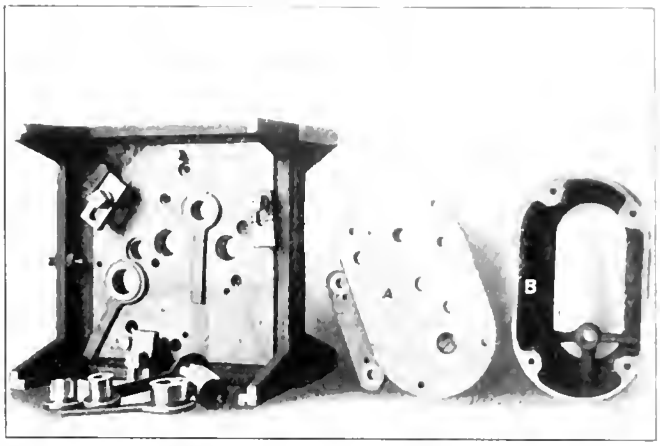


Fig. 75. Drill Jig used for Drilling Work shown to the Right.

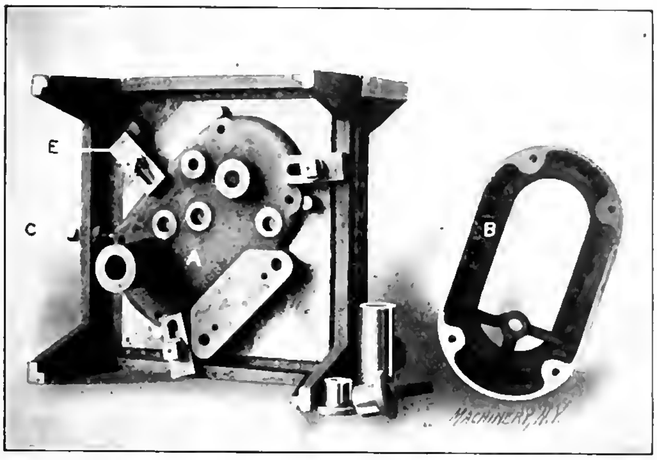


Fig. 76. Drill Jig shown in Fig. 75 with Work in Place.

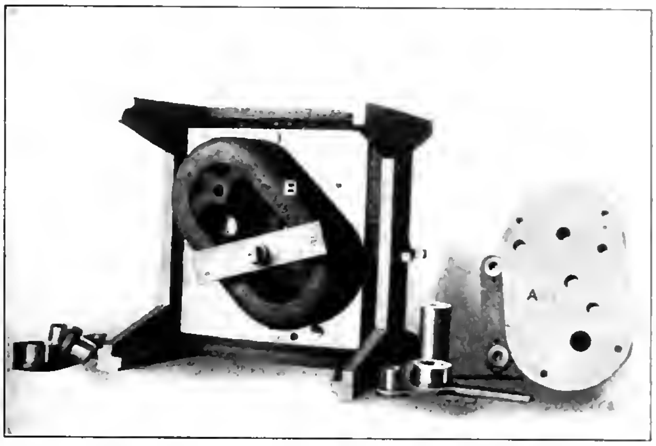


Fig. 77. Rear View of Drill Jig shown in Fig. 75, with Cover to be Drilled in Place.

Fig. 76. Drill Jig for Parts of Friction Clutches which are shown at the Right.

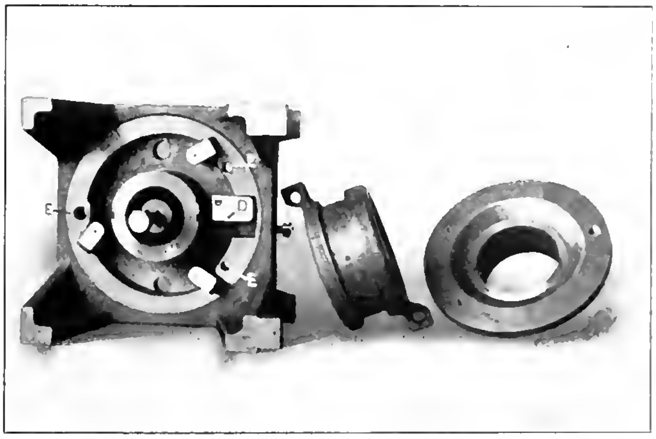


Fig. 79. Drill Jig shown in Fig 78, with one of the Pieces to be Drilled in Place.

Another example of an open drill jig, similar in design to the one just described, is shown in Fig. 75. The work to be drilled in this jig is shown at *A* and *B* at the right hand side of the jig. In this case, the work is located from the circular ends. The two pieces *A* and *B* are component parts, and when finished are screwed together. The piece *A* is located against three dowel pins, and pushed against them by set-screw *C*, and held in position by three clamping straps, as shown in Fig. 76. In this case, the straps are provided with oblong slots as indicated, and when the clamp screws are loosened, the clamps are simply pulled backward, permitting the insertion and removal of the work without interference. It would be an improvement on this clamping arrangement to place a stiff helical spring around the screws under each strap, so that the straps would be prevented from falling down to the bottom of the jig when the work is removed.

At the same time this would prevent the straps from swiveling around the screws when not clamped.

In Fig. 77, the part *B* in Fig. 75 is shown clamped in position for drilling, the opposite side of the jig being used for this purpose. In jig design of this kind it is necessary to provide some means so that the parts *A* and *B* will be placed each on the correct side of the jig, or, as said before, the jig should be made "fool-proof." In the present case, the parts cannot be exchanged and placed on the wrong side, because the cover or guard *B* could not be held by the three straps in Fig. 76, on account of the screws for the straps not being long enough. On the other hand, the piece *A* could not be placed on the side shown in Fig. 77, because the long bolt and strap used for clamping on this side would interfere with the work.

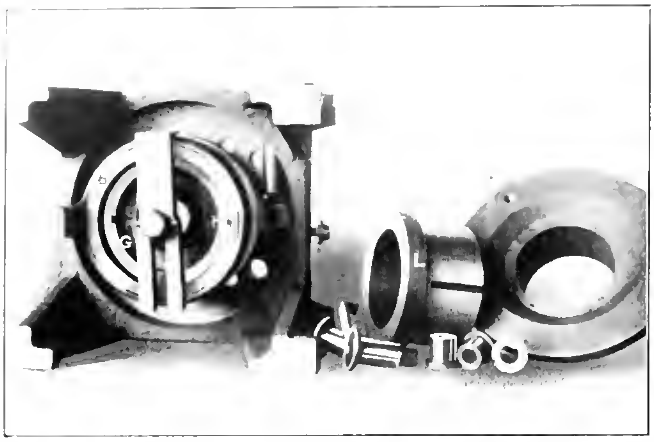


Fig. 80. Drill Jig shown in Fig. 78 used for Drilling Friction Sleeve

It may appear to be faulty design that three straps are used to fasten the piece *A* in place, and only one is employed for holding piece *B*. This difference in clamping arrangement, however, is due to the different number and the different sizes of holes to be drilled in the different pieces. The holes in the piece *A* are larger and the number of holes is greater, and a heavier clamping arrangement is, therefore, required, inasmuch as the thrust on the former is correspondingly greater, the multiple spindle drill being used for drilling the holes. If each hole were drilled and reamed individually, the design of the jig could have been comparatively lighter.

In the design shown, the locating of each piece individually in any but the right way is also taken care of. The piece *A*, which is shown in place in the jig Fig. 76, could not be swung around into another position, because the strap and screw at *E* would interfere. For the same reason the cover or guard *B* could not be located except in the right way. As shown in Fig. 77, the strap and screw would have to be detached from the jig in order to get the cover in place, if it were turned around. The locating pins for the work pass clear through the body of the jig, and are used for locating both pieces. The pieces are located diagonally in the jig, because, by doing so, it is possible to make the outside dimensions of the jig smaller. In this particular case the parts are located on the machine to which they belong, in a diagonal direction, so that the additional advantage is gained of being able to use the same dimensions for locating the jig holes as are used on the drawing for the machine details themselves. This tends to eliminate mistakes in making the jigs as well.

Sometimes, when more or less complicated mechanisms are composed of several parts fitted together and working in relation to each other, as, for instance, friction clutches, one jig may be made to serve for drilling all the individual parts, by the addition of a few extra parts applied to the jig when different details of the work are being drilled. In Figs. 78, 79, and 80, such a case is illustrated. The pieces *A*, *B*, and *C*, in Fig. 78, are component parts of a friction clutch, and the jig in which these parts are being drilled, is shown in the same figure, to the left. Suppose now that we wish to drill the friction expansion ring *A*. The jig is bored out to fit the ring before it is split, and when it is only rough-turned, leaving a certain number of thousandths of an inch for finishing. The piece is located, as shown in Fig. 79, against the steel block *D* entering into the groove in the ring, and is then held by three hook-bolts, which simply are swung around when the ring is inserted or removed. The hook-bolts are tightened by nuts on the back side of the jig. Three holes marked *E* in Fig. 79, are drilled simultaneously in the multiple spindle drill, and the fourth hole *F* (see Fig. 78), is drilled by turning the jig on the side. The steel block *D*, Fig. 79, is hardened, and has a hole to guide the drill when passing through into the other side of the slot in the ring. The block is held in place by two screws and two dowel pins.

When drilling the holes in the lugs in the friction sleeve *B*, Fig. 78, the block *D* and the hook-bolts are removed. It may be mentioned here, although it is a small matter, that these parts should be tied together when removed, and there should be a specified place where all the parts belonging to a particular jig should be kept when not in use. The friction sleeve *B* fits over the collar *G*, Fig. 80. This collar is an extra piece, belonging to the jig, and used only when drilling the friction sleeve; it should be marked with instructions for what purpose it is used. The collar *G* fits over the projecting finished part *H* in the center of the jig, and is located in its right position by the keyways shown. The keyway in the friction sleeve *B*, which must be cut before the piece can be drilled, and placed in the right relation to the projecting lugs, locates the sleeve on the collar *G*, which is provided with a corresponding keyway. A flange on the collar *G*, as shown more plainly at *L* in Fig. 80, locates the friction sleeve at the right distance from the bottom of the jig, so that the holes will have a proper location sideways. Two collars, *G* and *L*, are used for the same piece *B*, this being necessary because the holes *M* and *M* in the projecting lugs shown in Fig. 78 are placed in the same relation to the sides of the friction sleeve. The collars are marked to avoid mistakes, and corresponding marks on the jig provided so as to assure proper location. The friction sleeve is clamped in place by a strap which in this case does not form an integral part of the jig. This arrangement, however, is cheaper than it would have been to carry up two small projections on two sides of the jig, and employ a swinging leaf and an eye-bolt, or some arrangement of this kind. Besides, the strap is rather large, and could not easily get lost. The jig necessarily has a number of loose parts, on account of being designed to accomodate different details of the friction clutch.

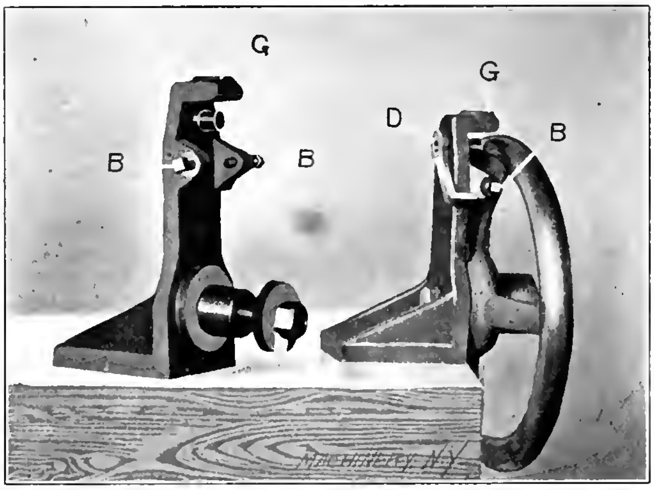


Fig. 81. Drill Jig for Holes in Rim of Hand-wheel.

The friction disks *C*, in Fig. 78, when drilled, fit directly over the projecting finished part *H* of the jig, and are located on this projection by a square key. The work is brought up against the bottom of the jig and held in this position by the same strap as is used in Fig. 80 for holding the friction sleeve. The bushings of different sizes, shown in Fig. 80, are used for drilling the different sized holes in the different parts.

In all the various types of drill jigs described above, the thrust of the cutting tools are taken by the clamping ar-

rangement. In many cases, however, no actual clamping arrangements are used, but the work itself takes the thrust of the cutting tools, and one depends entirely upon the locating means to hold the piece or jig in the right position when performing the drilling operation. It may be well to add that large bushings ought to be marked with the size and kind of cutting tool for which they are intended; and the corresponding place in the jig body where they are to be used should be marked so that the right bushing can easily be placed in the right position.

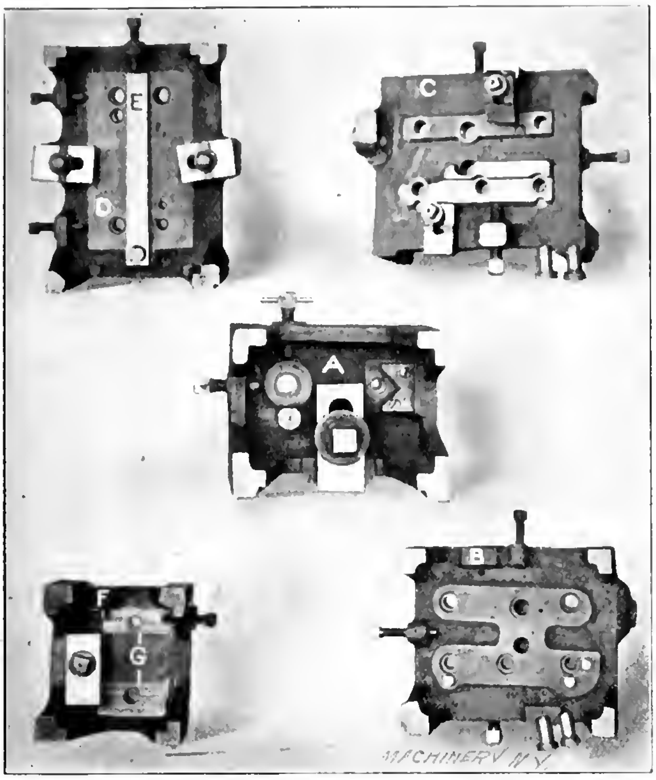


Fig. 82. Miscellaneous Examples of Open Drill Jigs.

A few more examples of open drill jig designs of various types may prove instructive. In Fig 81 are shown two views of a jig for drilling two holes through the rim of a hand-wheel. To the left is shown the jig itself and to the right the jig with the hand-wheel mounted in place, ready for drilling. As shown, the hand-wheel is located on a stud through its bore, and clamped to the jig by passing a bolt through the stud, this bolt being provided with a split washer on the end. The split washer permits the easy removal of the hand-wheel when drilled, and the putting in place of another hand-wheel without loss of time. The hand-wheel is located by two set-screws *B* passing through two lugs projecting on each side of a spoke in the hand-wheel, the set-screws *B* holding the hand-wheel in position while being drilled by clamping against the sides of the spoke. The jig is fastened on the edge of the drill press table, in a manner similar to that indicated in the half-tone, so that the table does not interfere with the wheel. The vertical hole, with the drill guided by bushing *G*, is now drilled in all the hand-wheels, this hole being drilled into a lug in the spoke held by the two set-screws *B*. When this hole is drilled, the jig is moved over to a horizontal drilling machine, and the hole *D* is drilled in all the hand-wheels, clamping the jig to the table of the machine in a similar manner as on the drill press.

In Fig. 82, at *A*, an open drill jig of a type similar to those shown in Figs. 73 and 75, is shown. This jig, however, is provided with a V-block locating arrangement. An objectionable feature of this jig is that the one clamping strap is placed in the center of the piece to be drilled. Should this piece be slender, it may cause it to bend, as there is no bearing surface under the work at the place where the clamp is located, for taking the thrust of the clamping pressure.

At *B* and *C* in the same engraving are shown the front and back view of a drill jig, where the front side *B* is used for drilling a small piece located and held in the jig as usual; and the back side *C*, which is not provided with feet, is located and applied directly on the work itself in the place where the loose piece is to be fastened, the work in this case being so large that it supports the jig, instead of the jig supporting the work.

At *D* in the same engraving is shown a jig for locating work by means of a tongue *E*. This tongue fits into a corresponding slot in the work. This means for locating the work was referred to more completely in connection with locating devices. Finally, at *F*, is shown a jig where the work is located by a slot *G* in the jig body, into which a corresponding tongue in the work fits.

It has not been possible to show actual designs of more than a few types of open drill jigs, the design, of course, varying according to the work to be drilled. The examples shown, however, will indicate the most common constructions, and exhibit plainly the application of the general principles laid down for jig design in the previous installments of this series.

* * *

AUTOMATIC PROFILING MACHINE.

The accompanying half-tones illustrate a profiling machine of the horizontal type, which, while on the one hand being provided with a guiding pin resting on a former, as in ordinary profiling machines, also combines this guiding arrangement with the feature of having a positive rotary as well as linear movement of the work-carrying slide. This permits work of any shape being profiled, either circular or nearly circular, or such having a long, narrow oblong outline. In the latter case, if the machine were not provided with a combination movement of the kind referred to, it would require that the cutter head would rise and fall through a considerable distance. With this combination movement, however, supplementing the movement caused by the guide pin on the former, any shape can be profiled with but a very slight movement of the cutter head.

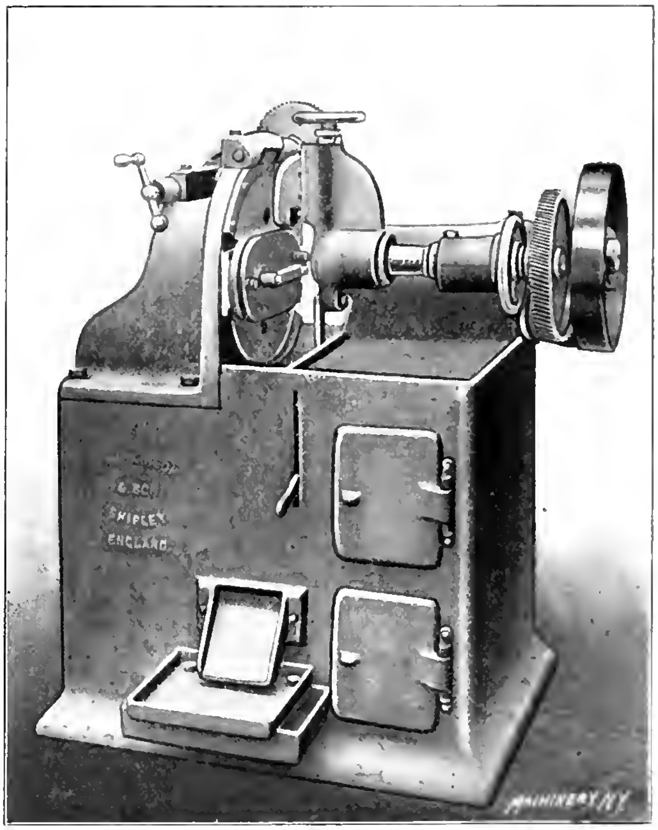


Fig. 1. Automatic Profiling Machine built by Messrs. J. Parkinson & Son, Shipley, England

The machine is built by Messrs. J. Parkinson & Son, Shipley, England, and was originally designed for milling the outline of bicycle cranks and the connecting-rods for small combustion engines. In the accompanying half-tone, Fig. 4, a bicycle crank is shown fastened to the work-carrying slide. The main features of the machine may be stated in a summary manner as follows: The rate of feed is the same on both the rotary and linear movements, so that the rate of output is

governed only by the strength of the cutter and the quality of finish required. It profiles automatically right around the article to be machined either once or as many times as desired; if required, the machine can be set to trip automatically on the conclusion of a portion of a revolution. The alteration for different lengths of linear motion in proportion to rotary motion is made simply by replacing a single pin, while the turning of a tumbler lever converts the action of the machine to a purely rotary one. There is but one trip movement for the double change from rotary to linear motion and back from linear to rotary motion.

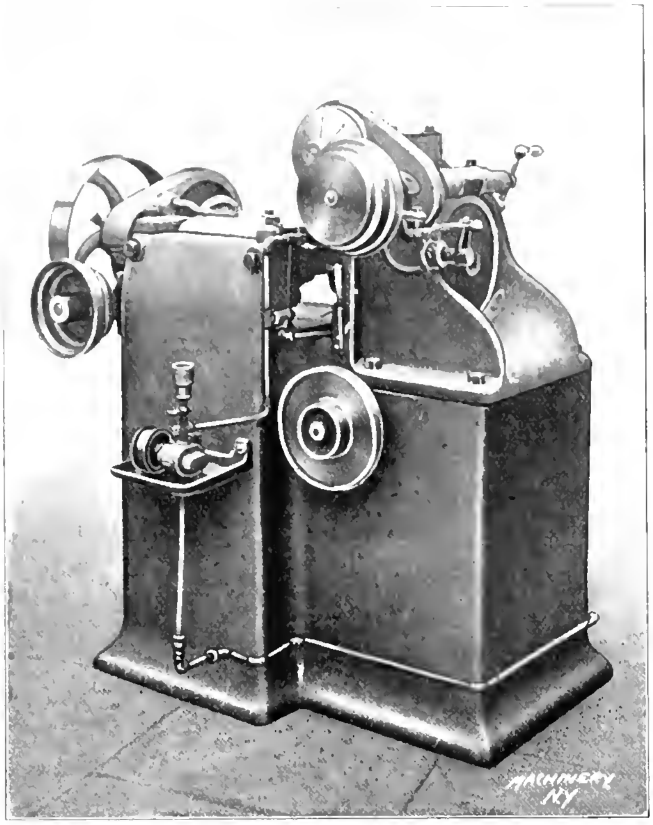


Fig. 2. Rear View of the Automatic Profiling Machine.

The general appearance of the machine is shown in Figs. 1 and 2, the former showing a front view and the latter a back view of the machine. It is driven by a single belt from the counter-shaft, both the cutter spindle and the work-holding head receiving its motion from this pulley. The spindle is carried by a swiveling bracket as shown, and driven by a pair of spiral gears. The cutter can be lifted clear of the work by means of a hand lever indicated at the front of the machine. The former-pin or runner is carried by the same bracket as the cutter spindle, and the latter's path is made to conform to the path of the former-pin by means of a pantograph link thereby transferring the shape of the former geometrically to the work to be machined.

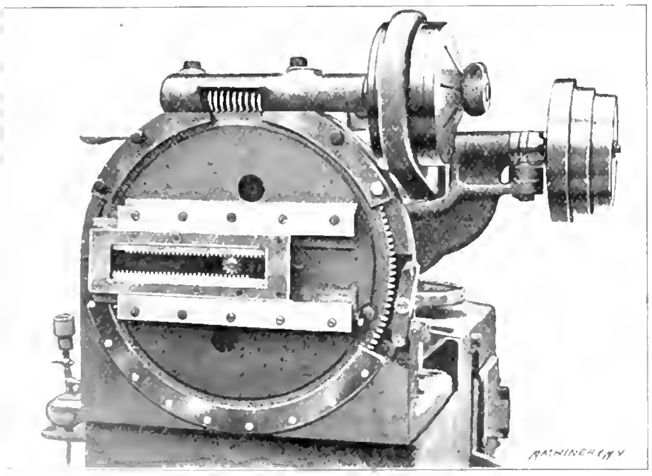


Fig. 3. View of the Work Head showing the Slide for Linear Motion.

The work head is driven from a cone pulley on the back of the machine, which can be connected to or disconnected from the driving mechanism of the head by a clutch. There are two worm-wheels in the head, one at the front and one at the back. These two worm-wheels are driven at exactly the same speed, but the front worm-wheel is only driven intermittently. The front worm-wheel carries the guides in which works the slide for the linear motion, as shown in the half-tones, Figs. 3 and 4. In this slide are fixed two compound racks placed face to face. The racks are made compound in order to be able to compensate for wear and eliminate back-lash. Between the two racks a pinion is placed which is driven directly through a shaft from the back worm-wheel. The pinion is so placed that when in mesh with one rack it just clears the other, as plainly shown in Fig. 3. This arrangement, of course, throws the axis of the two worm-wheels eccentric with each other to an extent equal to the addendum of the rack teeth. In order to understand the action of the machine it should first be kept in mind that the back worm-wheel and therefore the pinion meshing with the rack, are always revolving at a constant speed.

Now, suppose that the front worm-wheel is stationary. The small pinion which rotates with the back worm-wheel will drive the rack with which it is in mesh. When the slide thus driven reaches the desired position in its travel, the screw at the end of the slide comes in contact with a lever by means of which the front worm-wheel is engaged and commences to rotate. This is done either by allowing a friction gear to start driving the worm or by allowing a positive clutch to come into action. Both worm-wheels are now revolving in unison, and therefore the linear movement of the racks and the slide ceases; but inasmuch as the axis of the front worm-wheel is eccentric with that of the pinion, the rack that was in mesh with the pinion is gradually withdrawn, and the other rack is brought in mesh until at the end of half a revolution the pinion is in full mesh with the second rack and the front worm-wheel is brought to a stand-still automatically on account of releasing the pressure on the lever by the screw in the end of the slide.

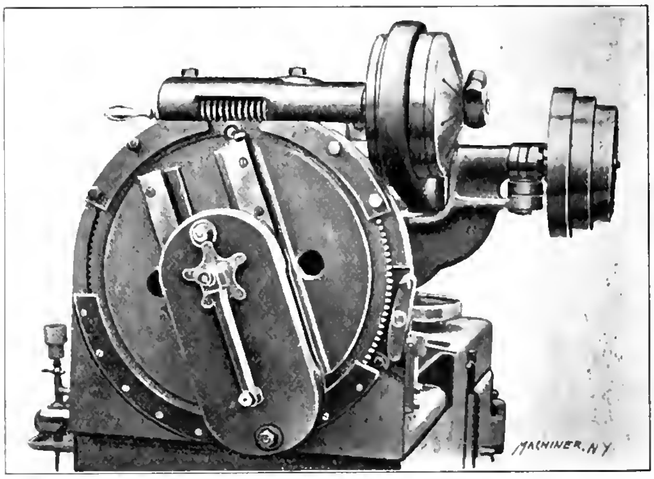


Fig. 4. Bicycle Crank fastened to the Work-carrying Slide.

Immediately when the front worm-wheel ceases to rotate, the slide is once more driven in a linear direction by the pinion, but the motion of the slide is in the opposite direction in relation to its guides on the worm-wheel. This cycle can be repeated any number of times. When a different length of linear motion is required a longer or shorter screw is placed in the end of the slide to act on the stop. When a purely rotary movement is required the stop is permanently removed from the front worm-wheel.

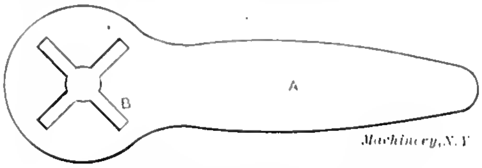
* * *

A creosoted wood conduit was recently removed from Sixth Avenue, New York City, and was found to be in excellent condition after 21 years' use. This conduit, which is the product of the Wyckoff Creosoting Co., was placed in 1887, and had to be removed this year in the excavation for the Hudson River Tunnels. It is in as good shape as when laid, and is being stored for possible future use.

ITEMS OF MECHANICAL INTEREST.

A WRENCH FOR WING NUTS.

Most of us have had to tighten up wing nuts by hand, which, of course, is what they are intended for, but sometimes it is convenient to be able to apply some tool for the tightening up of these nuts. For such a purpose the simple little tool illustrated in the accompanying line engraving, taken from the *Horseless Age*, will be found convenient. The wrench is made of flat stock about 3/16 inch thick. The handle *A* is made in various sizes, according to the size of the wing nut, five times the distance across the wings of the nut being the usual practice. Two slots *B* are cut at right angles to each other in the circular part of the wrench, as shown. At their intersection the central opening is enlarged, so as to permit the screw on which the wing nut turns to enter.



A Wrench for Tightening Wing Nuts.

INTERESTING TYPE OF EMERY WHEEL.

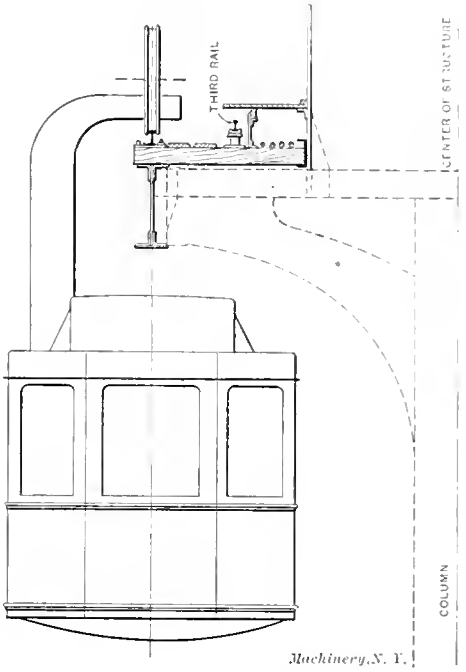
The accompanying illustration, reproduced from *The Mechanical Engineer*, July 17, 1908, shows a type of emery wheel which is claimed to be a decided improvement on the ordinary type of cup wheel made in a continuous ring. The advantages depend, it is claimed, on the fact that the spaces between the teeth, or blocks, of the emery wheel permit the air to freely play around them, thereby keeping them cool, and giving the dust created by the grinding an opportunity to more easily escape. The teeth are, in reality, loose sections or segments, held in a special chuck. Each segment is secured thoroughly by a set-screw which is tapped through the enclosing casing, the screws acting on special clamping plates, forcing the segments down into the opening provided for them, thereby wedging them in place. This type of emery wheel has been patented by Messrs. Luke & Spenser, Ltd., Broadheath, England.

New Type of Emery Wheel which, it is claimed, is Superior to the Ordinary Cup Wheel.

It is difficult to say, off-hand, to what extent a wheel made up in this manner will prove practical. It seems that there are some very strong points in its favor. While it may seem at first sight as if a wheel of this type would be more expensive to make than the ordinary cup wheel, that factor is likely to be offset by the fact that the "teeth" of the wheel shown are very simple parts to make, and the great loss incidental to emery-wheel manufacture due to breakage and cracking during the drying processes are largely eliminated. The same advantages in this respect as are manifest in inserted teeth milling cutters would be gained in this "inserted teeth" emery wheel.

THE BERLIN SUSPENDED RAILWAY

The transportation problem within the city limits has lately commanded a great deal of attention in Berlin, Germany, on account of the rapid extension of the city. The city is already provided with subway and elevated railroads, running from east to west, but has not adequate rapid transit facilities from north to south. It has been concluded that the expenditure incident to a subway would not be warranted by the traffic, and it was necessary to decide upon some kind of an elevated structure. It was considered, however, that the ordinary elevated railroad structure, as found in American cities, shut out too much light from the street below, and the type of suspended railroad, as indicated by the accompanying line-engraving, is projected. The dotted lines indicate one-half of the steel structure, which consists simply of a single column, or pedestal, in the center of the street, being provided at the top with the necessary structure for carrying one rail on each side. As shown in the illustration, but one rail is necessary for the traffic in each direction, the car being suspended below the rail by substantial hangers, and the center of gravity of the car being exactly below the center of the rail. In curves, the car will swing inward or outward, according to the direction of curvature, and the unpleasant sensation to passengers commonly experienced on curves is avoided. The system permits not only much sharper curves than are permissible in ordinary railroad construction to be used, but there is less need of slower speed around the curves, the average speed being twenty miles an hour. In order to make the objection to the elevated structure as slight as possible, an ornamental design has been adopted, and the rails are located 34 feet above the level of the street.



End Elevation of Car resting upon the Single Rail upon which it Travels.

* * *

It is announced in *Figaro* that work has begun on the construction of a central station of wireless telegraphy in Paris to be used in connection with the Eiffel tower. The station itself, which will be provided with receiving and transmitting apparatus of exceptional power, is placed under ground, and is joined by wires with the extreme top of the tower. It is claimed that there are good reasons for believing that with a similar station erected in New York, direct communication between New York and Paris would be possible. Lee DeForest has announced that such a station will be established in the tower of the Metropolitan Life building and that he hopes to establish telephonic as well as telegraphic communication across the Atlantic.

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OCTOBER, 1908.

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COOPERATIVE INDUSTRIAL EDUCATION.

The cooperative educational plan instituted in Cincinnati by which students in the Cincinnati University are enabled to obtain practical knowledge of machine construction and mechanical work in the Cincinnati shops has attracted much favorable attention. Analogous to this plan is a new movement in industrial education just put into effect in Fitchburg, Mass. This, we believe, is one of the most practical plans of industrial education ever formulated, and an account of it will be found on another page of this issue. Briefly, the plan is to educate young men in the machine-shop art and in the high school, simultaneously. The students taking the cooperative course are arranged in pairs, one student spending one week in the high school while his partner works in the shop. The next week the position is reversed, and so on. The lads taken into this course must have previously spent one year in high school, and they are required to take a three-year apprenticeship course in mechanical work, so that a four-year high school course and the machine shop apprenticeship are finished the same year.

The general result of such an educational system should be highly satisfactory, both as regards the manufacturers and the boys. It is common experience that the most active mental state exists with a moderate degree of physical exercise, so that students attending high school one week and working in the shop the next should be in the fittest condition for acquiring the elements of a trade and appreciating the value of an academic education. The condition of such a boy upon graduation is advantageous. He is not necessarily committed to being a machinist all his life, but is as free to enter any other vocation as are his mates who have only the advantage of an academic education. The fact that he is the master of a trade will be a very valuable help to him, however, even if his ambition lies in the direction of higher education and a profession. A poor boy can earn his way in a more dignified and agreeable manner than the majority of poor students, who generally have to resort to all sorts of menial occupations to get along. If the cooperative student chooses to become a machinist, his general education and special mechanical instruction should fit him to fill, ultimately, the highest positions in the manufacturing world.

UNLAWFUL USES OF PATENTED MACHINES.

An interesting point in patent law was recently passed on by the Circuit Court of the United States in the Eastern District of Pennsylvania, in a suit to enjoin the further use of patented machines that had been sold for scrap. The court enjoined the use by a manufacturing concern of two crankshaft lathes sold by the complainant company to a junk man. The machines, which were nearly complete in all essential details, were bought, repaired, and put in use by a competitor. The judge of the circuit court in granting the injunction restraining the use of the machines by the defendant company, held that while the purchaser of a patented article from one who is authorized to sell, becomes possessor of an absolute property right in it (Keeler *vs.* Standard Folding Bed Co., 157 U. S. 689) which he is capable of also transmitting to others, in this case the right of use did not follow the sale, inasmuch as the complainant company sold the machine as scrap. "A sale as scrap was a sale not to use, but to destroy; and cannot be wrested into a sale of the patented machines because the different parts could be picked up and put together again. (Wortendyke *vs.* White, 2 Ban. & Ard. 25; Cotton Tie Co. *vs.* Simmons, 106 U. S. 89)." It was also alleged by the complainant company that the machines were fraudulently disposed of by a foreman who now is an officer of the defendant company.

The principal enunciated in the judge's decision is important to users of second-hand patented machinery and apparatus of whatever description, especially if the route by which they came into the user's factory is obscure. It seems doubtful that the decision is entirely sound, as such a ruling might easily be made to impose unwarranted hardship on innocent purchasers. If there were no other remedy for the unlawful use of discarded patented machines, there would be good reason for the injunction, but any concern about to dispose of machinery for scrap can separate the parts and break them up so that reconstruction is impossible. The sale of a machine in workable or nearly workable condition, and without destroying the possibility of use, appears to us to carry with it an implied right to make further use thereof for its original purpose. The decision referred to, if sustained, might have unexpected results. For example, it might cause serious interference with the sale of second-hand patented steam boilers, if the manufacturers were disposed to place an embargo on their further use. Steam boilers are commonly disposed of by power companies and others to junk dealers, when they have outlived their usefulness for high-pressure work. The junk men sometimes sell them to persons who want low-pressure boilers for steam heating and other work not so severe as power generation, and it seems unreasonable that such a boiler, sold without breaking up, should not be used by the purchaser for the designed purpose. The fact that it was sold to the junk dealer ostensibly as scrap should not entail the destruction of the boiler unless a specific agreement was made to that effect. The second-hand value of a boiler having a possible further use is greater, of course, than if it were sold to be converted into scrap; but if the fact that the construction happens to include some patented feature can be used to prevent further use beyond the original buyer, an injustice would undoubtedly be worked on unsuspecting purchasers.

The case in point is considerably complicated by the allegation that an employe of the complainant company disposed of the machines fraudulently, having sold them among other scrap when the officials of the company had no intention of disposing of the machines, which it is alleged had simply been removed from the machine-shop while awaiting repairs and further use. It is not clear from the text of the decision whether the judge took particular cognizance of this fact in granting the injunction, or whether he based his opinion entirely on the fact that the machines were sold for scrap and that such sale did not carry with it the right of use for their original purpose. A fraudulent sale, of course, would not carry with it the right of use of a patented article, or any other right or title; but as the complainant company was unable to establish a fraudulent sale, it appears that the court's decision was based simply on the assumption that a sale for scrap is not a sale for use, and that the user may be enjoined from such use.

PRESERVING RECORDS.

Some time ago we published an editorial on "Keeping Things Seven Years," in which was questioned the advisability of storing away for future use odds and ends left around the shop. There are two departments in the shop, however, where almost everything pertaining to the work should be kept, even when it apparently has passed its time of usefulness. These departments are the general office and the drafting-room. Little need be said about preserving the records in the office. Those pertaining to the mercantile end of the business are, of course, carefully preserved; but in the drafting-room, the practice is not always well defined. Regular drawings, it is true, are filed away, but a considerable part of the work in the average drafting-room consists in making small sketches, often in a hurry, for some special work in the shop. Often these are made simply in pencil and are not traced or blue-printed, the sketch itself being sent out in the shop, so that no record is left in the drafting-room. Sometimes the sketch is lost in the shop, the work perhaps being half completed, and under such circumstances it is much more difficult to make another drawing that will conform to the work partly done, than it was to make the original lay-out. The saving of time incident to this method of sending sketches and drawings into the shop is usually so small that it does not seem worth while to invite all the trouble that often comes from it; and for this reason a record of everything in the shape of a drawing, sketch, order or specification which goes into the shop from the drafting-room, should always be kept in some form so as to preserve a permanent record. While it may require a few more hours' work, at times, to systematically adhere to this policy, in the long run it will save a great deal of trouble and expense. Of course, we know that in hundreds of drafting-rooms such a system is already in force, but we also know that in a great many the haphazard methods referred to are practiced.

The faculty of memory, while one of the most wonderful qualities of the human mind, is at the same time one of the most uncertain, and it often fails at the very time when its accurate working is of the greatest importance. For this reason *anything worth remembering is worth placing on record.* The drafting-room may seem to be overcrowded with the card indexes, files or cabinets necessary to a scrupulous adherence to this principle; but there will be less time wasted searching for things mislaid or destroyed. Time is money.

* * *

GUESSWORK IN MACHINE TOOL DESIGN.

Machine tool designers and men engaged primarily in the construction of small machinery of that type, who have not had experience along other lines of mechanical achievement, are often prone to look upon calculations and formulas for the strength of materials and similar means for exact analyses as rather unnecessary, and of interest, not to practical men, but merely to the student. Engaged, as they are, in work where no great damage is done if a part proves too weak and breaks, as it can easily be repaired and replaced, the new part being sometimes made a little stronger or of the same dimensions and liable to break again under too heavy stresses, they do not seem to fully realize that in some kinds of engineering work such failures cannot be risked, for they may result in loss of life and property of appalling magnitude.

If a belt from the counter-shaft to the driving pulley should happen to be too narrow and should break under the stress of a heavy cut, the mishap may be inconvenient and cause a little trouble, but as a rule no great damage is done; while if the mast on a crane intended to lift 10,000 pounds buckles and fails when a large casting of this weight is suspended from the hook, with several men on the foundry floor near by, the danger and the loss is too serious to be lightly considered. A lever on an automatic machine subject to constant vibrations may finally break; the breakage may cause temporary difficulty, but no great harm is done, and the damage is merely a small pecuniary one; but if one of the trusses on a railway bridge is improperly calculated and designed and gives way under the weight of an express train, the damage cannot be expressed in dollars and cents.

Thus there is some reason why men engaged in the design of small machinery should leave so much to guesswork, depending largely on "snap" judgment, a condition which is not permissible in the design of machinery subjected to stresses where failure means considerable damage. This element of chance and guesswork plays an important part in the design of machine tools, too important, in fact, for the continued prestige of designers. There are many things that could be calculated to a certainty, even on machine tools, which are proportioned merely on the designer's judgment, and the outcome is left to chance in many cases where it is unnecessary. The judgment of a machine tool designer, of course, is one of his greatest assets, but he should not despise the manner in which the designer of other classes of machinery works, where it is necessary to determine exactly the dimensions and the conditions of the design. He should learn rather to adapt himself to methods of exact analysis when and where the conditions demand it. The combination of the qualities of instinctive machine design and design by mathematical analysis is most invaluable.

* * *

MACHINE TOOL BUILDING AND ECONOMICS.

The mechanical progress of the last twenty-five years has been marvelous. The new inventions which have been brought forth, and which are constantly being perfected, have placed the machine industry, and particularly the machine tool manufacture, on an extremely high plane mechanically. Our highly developed and firmly established shop systems, proper management, and general all-around intelligence, have made economical production in the shops possible in a degree which was not expected even a few years ago. But, in spite of all this, we have temporary depressions in the machinery trade, for which there seems to be no reasonable cause. The fact is, however, that our business men, as well as our mechanics, while they have developed the science of individual economics of the shop to a high perfection, invented and improved labor-saving machinery, and, in general, placed the business, industrially, on the firmest ground, have not given due attention to the outside influences, those influences which do not depend upon the individual economics of each shop, but upon the economical principles applied to the nation as a whole.

It is not the office of MACHINERY to teach political economy, but inasmuch as the machine tool industry, and all other industries in the country, for that matter, can only secure for themselves a small portion of the prosperity to which they are actually entitled, if they are hampered by adverse conditions of economics applied to the nation, we consider it proper to ask our readers to give more attention to a subject that is fully as important to the development of the trade to which they have devoted themselves, as the economical and commercial development of the individual shops.

There is but one legitimate cause for hard times and that is the failure of crops. When depressions and hard times occur without being provoked by this cause, the reason is an artificial one, which can be removed if we only give due attention to the economic problems that cause it. Wonderful as our industrial progress during the past century has been, it will prove of little value in the end, if the manufacturer as well as the mechanic do not find it easier to secure, on the one hand, a fair profit, or, on the other, continuous employment at fair wages. It is time that the men employed in industries which depend so largely on the solution of some of our economic problems, should no longer ignore giving attention to so important a subject.

Inventions alone are not the only thing necessary to the prosperity of the machine industry. It is equally important that each man, whether he be a manufacturer or an employe, receives a fair equivalent for his exertions, and that he should not need to fear depressions caused simply by artificial economic conditions. If the business men and the mechanics of this country would give more attention to economic conditions and problems of this character, they could better safeguard themselves against such difficulties.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

As the result of the agitation which has been in progress for many years, the technical schools and universities of Prussia have, by a recent decree, been opened to women. Such privileges had already been granted in some of the smaller states.

The experiments on the elevated railway lines in Chicago to eliminate noise by the use of a gravel roadbed on the structure, has recently been abandoned, as the gravel not only failed to reduce the noise, but held water, with injurious effects to the structure.

The best preventative for spontaneous ignition of coal, says *Compressed Air*, is a small cylinder containing compressed carbon dioxide, fitted with a fuse plug melting at 200 degrees F. A cylinder one foot long and 3 inches in diameter is sufficient to take care of 8 tons of coal.

Two motor shows are to be held in France the latter part of this year, one being for private and the other for commercial vehicles. Both exhibits will take place in the Grand Palais. The show for pleasure cars will be open from November 28 to December 13, and that for commercial motors from December 22 to 29.

The importance of cement in engineering work is indicated by a contract recently made by the United States Government with the Atlas Portland Cement Co. for the Panama Canal. The contract is for 4,500,000 barrels of Portland cement at a cost of $5,500,000. This, it is said, is the largest single contract ever given out in the Portland cement business. The contract calls for a minimum shipment of 2,000 barrels a day and a maximum of 10,000. The present productive capacity of the company is 40,000 barrels per day.

The Pennsylvania Railroad forestry department has just completed its forestry planting for this year. It is stated by *Railroad Men* that 625,000 trees were planted. This makes a total of 2,425,000 trees set out by the Pennsylvania Railroad up to the present time. The object is to create an adequate supply of timber for ties required in years to come. The Pennsylvania Railroad evidently is taking active steps in regard to the preservation of natural resources. The true way of preserving our forests is not necessarily not to use them, but to replant them.

Cotton gins, printing, spinning, weaving machines, and scientific instruments are being exported from Japan to China, India and the United States. The exports of machinery for 1907 is reported by Consul General H. B. Miller, of Yokohama, to have increased 61 per cent, and there is an increase over the average for five years of 250 per cent. Thus far the exported machines have been mostly copies of foreign models, but the makers of violins at Nagoya have invented labor-saving appliances, and the tea-firing machinery used in Japan is chiefly of native invention.

The twelve new torpedo boats under construction for the German Navy are to be driven by steam turbines. According to *Engineering*, it is planned to try four different types of turbines. The three boats which the Vulcan yards near Stettin are constructing are to be equipped with turbines of the Curtis type. The four boats which the Schichau yards of Elbing and Danzig have undertaken to build, will have Melms and Pfenninger turbines. Of the five torpedo boats under construction at the Germania yards at Kiel, four are equipped with Parsons, and one with Zoelly turbines.

A union railway station is now in the course of construction at Leipzig, Germany, which will be one of the largest in the world. The five terminal stations which are in Leipzig at the present time, will all be removed upon the completion of the new terminal. This latter is to have 26 parallel tracks which will accommodate the trains of 13 different lines, and between each pair of tracks is to be a walk 40 feet wide, so that the total width of the train shed will be nearly 1,000 feet. The main facade of the building will be 1,115 feet wide, or over 350 feet greater than the facade of the new Union Terminal at Washington, D. C., which is at present the largest in this country.

The Cunard steamer *Lusitania* broke all records on her western trip ending August 21. She crossed the Atlantic in 4 days and 15 hours, the total distance traversed being 2,780 knots. The best day's run was 650 knots. The best hourly speed was 25.66 knots and the average for the trip was 25.05 knots. This trip demonstrates the ability of the vessel to make the average speed required by the terms of the subvention allowed by the British Government, it being required by the terms that the vessel make one trip at the rate of 25 knots.

While the discussion of the recent disaster of the collapse of the Quebec bridge is still occupying the engineering profession, reports of a similar accident come from Germany. On July 9 a bridge under construction over the Rhine, at Cologne, fell, and at least fourteen of the men engaged on the bridge work lost their lives, and nine men were taken from the water severely injured. The traveler used in erecting the central span collapsed, and carried with it all of the steel work. While not as disastrous an occurrence in regard to the loss of life as the Quebec bridge collapse, it was perhaps, merely by chance that no more men were, at the time, engaged on the work on the bridge, and the occurrence of two accidents of so similar a character, one in America and one in Europe, indicates that the engineer has still a great deal to learn and that, particularly in structural work, too great pains can never be taken by those in charge of design or erection.

In an editorial in *Engineering News* attention is called to the practice of sending catalogues to prospective customers without price lists, even though a price list may have been specifically requested. The idea is that the customer should state in detail the particular machines he is interested in, and prices will be furnished him for these only. Sometimes, however, the lack of definite information given to the customer is the cause of loss of big contracts. In the present case, a firm in Chile had requested manufacturers of mining and smelting machinery to furnish catalogues and prices. Many American manufacturers furnished catalogues, but did not attach price lists, whereas all the European manufacturers gave definite prices and terms. As correspondence between Chile and the United States requires some six weeks or two months in each direction, and delay was not permissible in this case, the result was that an order for $75,000 worth of machinery was cabled to Europe and lost by the American trade.

The original supply of coal in the state of Pennsylvania is estimated by Mr. M. R. Campbell, of the United States Geological Survey, to amount to 21,000,000,000 short tons in the anthracite fields, and 112,574,000,000 short tons in the bituminous fields. It is interesting to note the statement that by the methods of mining anthracite coal in former years, for every ton of coal mined and marketed one and one-half ton were either wasted or left in the ground as pillars for the protection of the workers, so that the actual yield was only about 40 per cent. This percentage of waste has been greatly reduced in later years. Of the original available supply, as mentioned above, it is estimated that there is 17,000,000,000 tons of anthracite coal left, of which one ton can be mined for each ton lost. This would indicate that the Pennsylvania fields can still yield 100 times the quantity

of anthracite produced in 1907. The supply of bituminous coal at the rate of production in 1907 would not be exhausted for nearly 500 years.

Economy in the use of material is the first law in manufacturing, but there are certain economies that may be obvious when once known, but which have developed slowly and have to be seen to be appreciated. In the manufacture of twist drills it formerly was the practice to cut bar stock for drills into short lengths about six feet long. It finally was realized that "every bar has two ends," and that the proportion of waste with the six-foot bars was more than with the 12- to 14-foot bars. The Standard Tool Co., Cleveland, O., no longer cuts its stock into lengths as short as 12 or 14 feet even, but stores them in mill lengths of 24 to 28 feet, thus reducing the waste due to croppage to a minimum. The stock is stored on end in a concrete storage warehouse specially constructed for convenience in unloading from cars and supplying the needs of the factory. The stock is leaned against the side walls and a central rack. Each stock has its own stall, the sizes running from ¼ inch up. Of course, the small sizes come in shorter mill lengths, it not being feasible to handle or store these in lengths of 24 feet or more. The central rack in this storehouse has three arc lights overhead for illuminating the stock at night or during the dark days in winter. The storehouse is warmed by five hot-air discharge flues distributed in the warehouse so as to keep the steel at a comfortable temperature to handle, no matter what the outside weather may be.

AERONAUTIC RECORDS.

Leon Delagrange, president of the Aviation Club of France, established a new world's record with his aeroplane at Issy, near Paris, September 6. His machine remained in the air 29 minutes, 54 4/5 seconds, and circled the field 15 1/2 times, covering a distance of about 15 1/4 miles. On the following day Delagrange remained in the air 31 minutes, but was penalized three minutes because his machine touched the earth while making the first round of the field. On September 5 Wilbur Wright made a flight with his aeroplane at Le Mans, France, of 19 minutes 48 2/5 seconds and traveled between 14 1/3 and 15 miles. Following is a partial record of the progress of the heavier-than-air flying machines during the past year, taken from the *New York Times*:

Oct. 15, 1907—Henry Farman traveled 285 meters near Paris.

Jan. 13, 1908—Farman won the Deutsche Archdeacon Prize by sailing a kilometer in a circle near Paris.

March 20—Farman flew his aeroplane 1½ miles near Paris.

May 13—The Wrights flew 3 miles in 3 minutes near Paris.

May 18—Baldwin's aeroplane *White Wings* made a short flight near Hammondsport, and five days later traveled 183 yards and then upset.

May 27—Delagrange's aeroplane flew 6 miles before the King of Italy at Milan, and next day made a record flight of 10 miles.

June 29—Bieriot's monoplane won the Aero Club's medal by flying 100 yards.

July 4—Curtiss's aeroplane the *June Bug* flew one mile, and won the *Scientific American* Cup.

July 7—Farman won Armongaud's $2,000 prize by remaining twenty minutes and twenty seconds in the air.

Aug. 2.—Farman, at the Brighton Beach track, went 700 yards in forty seconds.

Sept. 2—Two Cornell instructors covered three miles in five minutes in an aeroplane of their own making.

Sept. 3—While Orville Wright at Washington covered two-thirds of a mile in one minute, his brother Wilbur, at Le Mans, France, covered six miles in ten minutes.

Sept. 5—At Le Mans, Wilbur Wright covered 15 miles in twenty minutes in his aeroplane.

Sept. 9—Orville Wright made two record-breaking flights near Washington with the machine under perfect control. The distance covered in the longest flight was about 40 miles, the time being 62 minutes and 15 seconds.

Sept. 11—Orville Wright again breaks his record by remaining in the air 70 minutes and 24 seconds.

SMOKELESS FUEL.

Mechanical Engineer, August 14, 1908

Mr. Sherard Cowper-Coles of Grosvenor Mansions, 82 Victoria Street, Westminster, London, has recently patented the following process for the manufacture of smokeless fuel About one-third part by weight of wet peat and two thirds part by weight of bituminous coal in a finely divided state, are placed in a retort and heated to a temperature sufficiently high (about 850 deg. F.) to drive off those hydrocarbons that produce smoke, the generation of the steam from the peat assisting in this operation. It will be understood that the temperature is not raised materially higher than is necessary to drive off the hydrocarbons, as above stated. The heat is applied for about five hours. The bituminous coal binds the peat together to a coherent mass and forms a fuel of high calorific value, which is readily ignited in a grate in the ordinary way and burns economically and without smoke. In practice the retort may be provided with relief valves and arranged so as to maintain a pressure of 10 pounds per square inch. The retort may also be fitted with a plunger which is forced to one end when the contents are in a plastic state, and it may be heated in any convenient way, such as by heat externally applied or by burning some of the gases generated after partial purification. The watery extract, containing tar of complex constitution, pyroligneous acid, and other products derived from the carbonization of peat, in addition to the gases above referred to, is advantageously condensed and utilized for the production of a pitch of superior quality, and the usual condensible products obtained from the bituminous coal in the retort may be collected and used for any desired purpose. In some cases the contents, after the above described process has been completed, may, either while still hot or after they have cooled, be discharged into a solution of calcium chloride. By this means the smokeless fuel is rendered slightly deliquescent and always retains a certain quantity of moisture. The coal or the peat, or both, may also be moistened with a solution of calcium chloride before being placed in the retort.

THE MANUFACTURE OF SLAG-CONCRETE BRICKS.

Engineering, August 14, 1908.

The amount of slag produced per ton of iron from the blast-furnace, varies in amount from ½ ton to about 1½ ton, according to the ores used; and, with the enormous output of pig iron at the present time, it is not surprising that attempts are continually made to find some satisfactory means of turning this material to account. The manufacture of concrete bricks from blast-furnace slag has become a commercial process of some value. The material, containing as it does a large amount of lime and silica, is eminently suitable for such a purpose. The granulation of the slag is first effected by running it, while still in a molten condition, into water. After granulation, the slag is passed between squeezing-rollers for the purpose of removing the excess of water and crushing any large particles. For mixing with the slag, white unslaked lime has proved most satisfactory, ground to an 8,000 mesh. The lime should not contain more than ½ per cent magnesia. The slag and unslaked lime in proportions of 95 to 93 per cent slag to 5 to 7 per cent lime, are tipped into a large hopper and passed thence to a steam jacket mixing machine; the heat, together with the moisture in the slag, starting the reaction of the lime. It is then taken to the presses, in which the pressure is exerted on the 9 x 3-inch side, thus insuring uniform thickness of all bricks, and from these presses the bricks are taken to steaming chambers. The slag must be of uniform grey quality, or variations in the color of the bricks will result. The success of the bricks depends on the care and uniformity with which the various operations are carried out. Uniformity of mixture and of pressing are most important. The moisture carried by the slag, when mixed with the unslaked lime in the mixing hopper, should not be more than 8 to 10 per cent. The resulting bricks compare very favorably with red bricks, and are of a more uniform quality than cement bricks made of zinc slag and lime, or refuse clinker. They have a crushing strength of between 2,500 pounds and 3,000 pounds per square inch, and have withstood very severe

boiling and freezing tests. The bricks are satisfactory for building purposes, and masonry built with them has fire-resisting qualities as good as, if not superior to, that built of red brick. Coloring matter can be added, if necessary, when mixing the lime and slag. The cost-sheet suggests that there may be a considerable future before this process, for the prices compare favorably with other bricks of equal quality.

BRAZING CAST IRON AND OTHER METALS.

Frank N. Blake in the *Horseless Age*, August 26, 1908.

Brazing consists in uniting metal parts by flowing melted brass, technically termed spleter, between them. It is practically identical with soldering, except that spelter is substituted for solder, and that a much greater degree of heat is necessary. In the greater degree of heat required to melt spelter lies one of the advantages which brazed work possesses over that which is soldered, the finished work enduring more heat without breaking or weakening; but the chief advantage lies in its superior strength at all temperatures and its applicability to a large variety of uses. Cast iron is a common material which is prone to break, and which can now be brazed. The production of the necessary heat is an important part of the process of brazing, and constitutes the chief difficulty and almost the only source of expense. For small work, a plumber's hand gasoline torch can be used in what may be termed an amateur sort of way, but for common use a forge, gasoline brazer, or a jet of gas supplemented by a blast of air can be satisfactorily used. The latter constitutes the cleanest, most convenient, and effectual brazing fire.

A bed of coke or charcoal on a forge hearth is an excellent resting place for the work during the process of brazing. A backing of firebrick or of asbestos is of considerable assistance in confining and reflecting the heat, though, of course, these do not contribute to the heating process in the way that inflammable backings do. There is considerable opportunity for the display of judgment and discretion in the arrangement of the backing; aside from the saving of time and fuel there is, on large and difficult work, all the difference between success and failure in the way the heat is applied and utilized.

Before work is assembled for brazing it should be well cleaned by file, scraper, scratch brush or other means; rust and scale do not favor the ready flowing of the fused spelter, though it will sometimes take hold of even such unfavorable surfaces. Cast iron may be cleaned by first heating to a bright red, and, after cooling, brushing the fracture and adjacent parts with a scratch brush. After thoroughly cleaning the work and securing good bright surfaces, the parts must be fastened together in the exact position they are to occupy when the job is completed. Usually the pieces are secured by pinning, but sometimes screws, bolts, wire, clamps of various sorts, and even fire-clay can be used to hold the parts in place. Whenever practicable, the parts should be secured in such a manner that the job can be turned over during the process of brazing, without disturbing the relation of the parts to each other, thus affording a better chance to apply the flux and spelter.

Alcohol used in a common gasoline torch has been said to give a greater heat than gasoline, the reason given being that it requires less air, and consequently the flame is cooled less by it. As alcohol contains fewer heat units than gasoline, it would seem a less suitable fuel to use for this purpose, but perhaps the need of less air may explain the difference claimed for it.

A simple and good formula for cast iron brazing is as follows:

	Ounces.
Boric acid	16
Chlorate of potash, pulverized	4
Carbonate of iron	3

Mix and keep dry, as moisture or long exposure to air renders it less efficient. When used, mix with grain spelter. Heat the work to a nice brazing heat and apply flux and spelter with an iron rod, flattened and spoon shaped at the end.

Borax is much used for flux in brazing wrought iron and steel; it is not expensive, and one can be sure of getting a good article by buying of a reputable dealer. In any brazing, the work is first brought to a bright red heat, flux is applied, and then mixed flux and spelter. Sometimes considerable "coaxing" is required in order to make the melted metal flow into the joints; but with the flux applied first and allowed to find its way into the cracks and openings, the spelter will follow if carefully led and rubbed with the hot iron rod. After one side of the work has been brazed, it is turned over and the other side is treated in the same manner.

In preparing work for brazing, too close a fit may be made, for the melted brass will not find its way into the most minute recesses. One one-thousandth of an inch is about as small a space as spelter will readily flow into.

After brazing cast iron, it is a good plan to let it cool slowly, sudden chilling being regarded as injurious in some cases. Whatever process is employed it is a good rule to have the work bright and clean, and to use plenty of heat; these, together with good flux and spelter, constitute the essentials. Experience is always valuable, but that comes only with practice.

TESTING STEEL TAPES AT THE NATIONAL BUREAU OF STANDARDS.

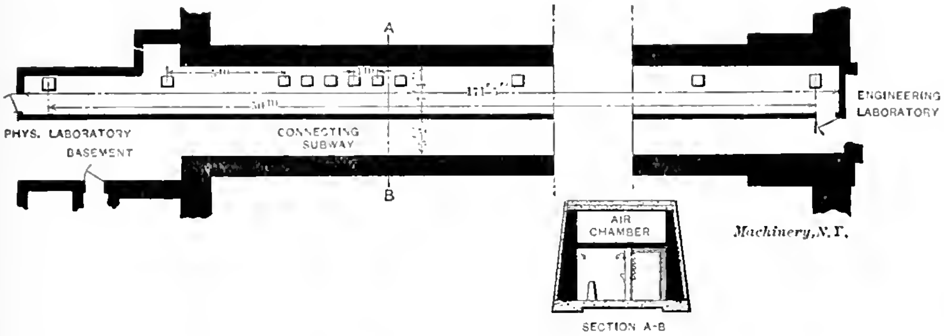
Herbert T. Wade in the *Engineering News*, August 13, 1908.

One of the most important functions of the National Bureau of Standards at Washington, D. C., is the testing and standardization of steel tapes of various lengths and forms, used in engineering work. These tests range from the minute and critical examination and study of the steel and invar tapes of the U. S. Coast and Geodetic Survey, employed in the accurate measurement of base-lines, to the inspection of the ordinary steel tapes of the surveyor and engineer. All of these tests are carried on in a specially designed laboratory, which is, without doubt, the best equipped for this kind of work of any testing bureau or physical laboratory in the world. In fact, it can be only compared with a somewhat similar room of less than half the length at the International Bureau of Weights and Measures at Sevrès, near Paris. Both of these laboratories are located underground, in order to secure a constancy of temperature, but the Washington testing room not only is better designed and equipped, but already its constants are known with a high degree of precision. The room is about 8 feet below the surface of the ground, 171 feet in length, and is about 8.2 feet in width and height. It is lined with white enamel brick, lighted by electricity, and contains steam and brine coils in addition to ventilation inlets and outlets, so that by the aid of thermostats the temperature can be controlled within narrow limits.

On one side against the wall is the United States Bench Standard of length, which consists of a steel bar mounted on rollers and supported horizontally on brackets. Opposite this standard is the comparator proper, used for the determination and standardization of steel and invar tapes for base-line measurement, and also for standardization of base bars of 5 meters in length from the national prototype meter standard. The floor of the room is of concrete, on which is laid a track for the carriage containing the ice trough in which the bar, used as a standard, is carried when measurements and comparisons are being made. There are eleven stone piers spaced 16.4 feet apart, and on these are mounted the micrometer-microscopes. Each pier is 14 × 14 inches in cross section and is set on a concrete base 16 inches square and 18 inches deep, the bases of the piers being separated from the floor by a space of 2 inches. This makes the piers and their foundations entirely independent of the floors or the structural walls of the building. At the north end of the tunnel the base of the terminal pier was built through a small vault to solid ground beneath, and is about 8 feet in height and 6 feet square. The piers at the ends carry not only the micrometers but also the marking bolts identifying the beginning and end of the standard distance. The tunnel thus arranged affords a comparator 50 meters (164 feet) in length, which is sufficient for the long tapes used in geodetic surveying. It might be said, in passing, that the development of the accurate use of tapes in the measurement of base-lines has been a striking feature of the work of the U. S. Coast and Geodetic Survey in recent years, and such precision has been attained in the use

of these tapes for measurements of base lines that they seem destined to supplant the more cumbersome base-bars.

Within a few years, invar tapes, made from an alloy of steel and nickel, discovered by M. Ch. Ed. Guillaume, of the International Bureau of Weights and Measures, have been thoroughly tested in the field after standardization in the laboratory, and the accuracy and convenience of their use has been clearly demonstrated. In using the comparator, the first step is to standardize a 5-meter steel or other bar in terms of the U. S. National Prototype Standard, which is a meter bar of platinum-iridium made at the International Bureau of Weights and Measures at Sevrès, and like the other similar national standards of length of the nations of the world, known most accurately in terms of the International Prototype Meter preserved at the Bureau. To transfer the meter to the five-meter bar, there are in the third interval of five meters between the piers, measuring from the south end of the tunnel, four similar and intermediate piers spaced a meter apart. These piers are of similar size and construction to the others, and on them the micrometer-microscopes can be placed so that the meter bar passed successively over the intervening five meter distances will give a standard distance of five meters with which the five-meter standard may be compared. The micrometer-microscopes are placed on iron brackets or arms which are attached firmly but in an adjustable manner to the tops of the stone piers, each of the latter having a hole cut through its top below the microscope arm so that light from an incandescent lamp hung back of the pier can be used for the illumination of the microscope and bar.



Horizontal and Vertical Sections of the Tape Testing Chamber.

The micrometer-microscopes used in the standardization work of the Bureau, have been tested for many years by the Division of Weights and Measures of the Bureau of Standards and, previous to its establishment, by the Office of Standard Weights and Measures of the Coast Survey, so that the constants and operation of these instruments are known thoroughly, though the usual adjustment is for one division on the head of the micrometer to correspond to one micron on the bar. The standard meter is placed in shaved ice in a trough mounted on two trucks. This trough can be raised or lowered by simple and exact adjustments, and, in fact, the bar in the trough may be adjusted under the microscopes to a micron, or one-thousandth of a millimeter. The standard meter is placed under one of the microscopes at the beginning or end of the five-meter interval, and the cross hairs are set with great precision on the fiducial line marking the limit of the standard distance. Then the second microscope and its cross hairs are set on the line at the opposite end of the bar with similar accuracy. The bar on the supporting carriage is then moved along between the second and third piers and similar adjustments are made. In this way the standard length of five meters is established, and the value of the five-meter bar which then can take the place of the standard meter in the ice trough, is obtained. The value of the meter at the temperature of melting ice, 0 degree Centigrade, is accurately known, and this temperature figures as a standard in all metric determinations. With a five-meter standard accurately determined, it is possible to measure successively the ten intervals of the 50-meter base of the tunnel, the process being precisely similar to that followed in getting the value of the five-meter bar.

Not only must the temperature of the bars in the ice trough be known and regulated, but the temperature of the tunnel itself and of the tapes under test. For this purpose there are carried on the walls of the room 14 lines of pipe, the upper twelve of which are used for circulating brine cooled to a temperature of —10 degrees Centigrade and enabling the temperature of the room to be reduced to 0 degree Centigrade with facility. The two lower lines of pipe contain steam when desired, so that not only can the coefficients of expansion of the tapes be measured, but the temperatures of ordinary field work duplicated. This, of course, does not obviate the necessity of taking exact thermometer readings at each observation and determination, and these are made as usual with carefully calibrated thermometers.

The microscopes at the ends of the 50-meter comparator, to which reference has been made, are referred to the bronze bolts in the pier foundation to insure their greater stability. Having the distance between the two terminal microscopes accurately determined with the ice bar apparatus, it is only necessary to substitute the steel or invar tapes and to apply the standard tension with spring balances which previously have been calibrated with correct weights in another laboratory of the Bureau. The tapes can be supported at such intervals as would be employed in field work, and, by the temperature regulating apparatus already described, the temperature of the vault can be varied and the coefficients of expansion can be determined with great precision.

In making the standard tests, measurements are made with the ice bar apparatus in the morning and then again at night, and the mean of the two measurements is the standard distance for the day. The tapes ordinarily are measured after they have remained all night in the laboratory comparator room and have assumed its temperature. In recent tests of invar tapes the coefficient of expansion of tapes of 50 meters in length was determined with precision to a micron, and was found to range from 0.000000374 to 0.00000044 for 1 degree Centigrade. Thus invar has a coefficient of expansion of about 1/28 that of steel, so that working under ordinary conditions where the refinements of the most precise geodetic work are not necessary, a temperature correction can be neglected. The determination of the expansion of the invar and steel tapes involved a study of the constants of the comparator room itself, and it was found that the entire tunnel shrinks about six-hundredths of an inch in passing from a temperature of 100 degrees F. to 32 degrees F.

The work in the laboratory is so arranged that there can be measurements made each day, and there is a direct comparison of the tapes with the five-meter bar on each occasion. This bar, which has been used for many years, so that its constants are known with high precision, is of steel, with the terminals of the standard distance indicated by lines on platinum-iridium plugs. In testing invar tapes the tension used is 10 kilogrammes, while ordinary steel tapes of 100 feet are stretched at a tension of 10 pounds. The chief practical advantage of the invar tape is that its small coefficient of expansion not only simplifies measurements generally, but in particular, permits of accurate measurements being made in the daytime instead of at night, as is essential in using steel tapes in base-line measurement.

On the wall opposite the comparator is the 50-meter U. S. Bench Standard for testing ordinary steel tapes. This has been formed of five cold-rolled steel bars, about 33 feet in length, welded end to end with thermite. As previous to the welding the bars were well fitted and cleaned, the result is a continuous bar 165 feet in length. Not only are the terminal distances marked by platinum-iridium plugs with fine transverse lines, but at various regular intervals similar plugs are inserted, so that the intermediate distances on a tape can be verified with accuracy. These plugs are inserted every 10 feet for the tapes with the customary divisions, and every 5 meters for the metric tapes, the distances being correct at 62 degrees F. for the customary measures, and at 0 degree Centigrade for the metric scale. Ordinarily, the tapes are laid flat on the steel bar, but if desired they can be suspended

on small pins on the outside of the bar and the conditions of support arranged to simulate those in the field. The bar itself is free to move on rollers carried on brackets fastened to the masonry wall and spaced at intervals of 40 inches, so that not only is it kept hornzontal, but it is free to expand and contract with changes in temperature.

The Bureau of Standards not only tests metal tapes for the various government departments, but also for manufacturers and engineers upon payment of nominal fees, depending on the length of the tapes and the number of divisions examined. The charges range from 75 cents for tapes not longer than 100 feet, and supported throughout the entire length, to $2.25 for tapes 400 feet in length with comparisons at the 100, 200, and 300-foot divisions. If the tape is supported at intervals, the Bureau doubles the charge, while determining the coefficient of expansion, testing under different tensions, determining the modulus of elasticity, or other tests are made for suitable and reasonable fees.

The tests can be made as elaborate as desired, but in most cases it is sufficient to compare the tapes with the U. S. Bench Standard for the total distance and some of the more important subdivisions, as the coefficient of expansion of the majority of steel tapes is practically that of the standard steel bar—0.0000063 per degree Fahrenheit or 0.0000114 Centigrade—so that a direct comparison with the latter suffices and will afford an adequate determination of its accuracy for most purposes. If the tape in construction and tests complies with the requirements of the Bureau, it will be certified, and the Bureau of Standards test number corresponding to the number of the certificate issued will be stamped or etched on the tape.

Since the Bureau has undertaken the testing of tapes there has been an increase in the accuracy of those available for engineers, and there is no reason to-day for any one to have any uncertainty about the accuracy of his measures with the Bureau of Standards ready to make final and conclusive tests on payment of a small fee. In the year ending June 30, 1907, 135 tapes were submitted for test by engineers and surveyors in all parts of the country.

THE DIRECT PRODUCTION OF COPPER TUBES, SHEETS, AND WIRE.

Paper by Mr. Sherard O. Cowper-Coles read before the British Institution of Mechanical Engineers, July, 1908.

The numerous processes involved in the production of suitable copper and its subsequent conversion into copper sheets, tubes, and wire by a series of operations, such as rolling, drawing, and annealing, would occupy too much time to be referred to even briefly; therefore the author has limited the paper to the direct production of copper tubes, sheets, and wire by electrolysis from impure copper. The methods described are all based on the work of Davy and the law of electrolysis established by Faraday in 1833, namely, that when a current of electricity is passed through a solution containing metallic salts and two or more electrodes, one of which is soluble in the solution, a known quantity of metal is transferred from one electrode to the other for a given quantity of electric current; that is to say, if the soluble electrode (the anode) is connected to the positive pole, and assuming the metal and the electrolyte employed to be pure, a weight of metal will be deposited upon the cathode connected to the negative pole, corresponding to the amount dissolved from the anode. If the anode is of impure metal many difficulties are introduced, and if the current is increased, to a sufficient density to enable the metal to be deposited at such a rate as will give commercial results, other serious difficulties arise. Electro-metallurgists have been working for thirty years or more devising methods to overcome the difficulties experienced in applying Faraday's law to the commercial production of copper tubes, sheet, and wire from comparatively impure copper having the physical properties of wrought copper, when deposited at a sufficiently rapid rate.

The refining of copper by electrolysis has now assumed vast proportions, and the annual output of electrolytic copper in the year 1907 has been estimated at 400,000 tons, equal to 56 per cent of the world's production, and the capital sunk in the industry at about £15,000,000. The whole of the copper thus produced is in the form of rough slabs or cathode plates which have to be smelted and worked to the desired forms. Electro-metallurgists have been striving for many years to devise a process which does away with the smelting of copper after it has been electrolytically refined, and to electro-deposit copper after the refining operation in such a form that it can be placed direct on the market as finished sheets, tubes, and wire.

The author, when carrying out some experiments on the production of copper tubes and sheets by electro-deposition on rotating cathodes, observed that when the speed was greatly increased, entirely new results were obtained, and that a current density of 200 amperes or more per square foot could be employed, the copper remaining smooth and having a tensile strength equal to the best rolled or drawn copper, and in some cases a tensile strength some 50 per cent higher than that obtained by the ordinary process of casting and rolling, the tensile strength increasing with the rate of rotation of the mandrel. The result of revolving a mandrel at a comparatively high speed is that every molecule, as it is deposited, is burnished or rubbed down so as to produce a tough fibrous copper, the usual order of things being reversed, the present practice being to put the mechanical work into a mass of copper by rolling or drawing instead of treating each molecule separately. This observation led to further experiments, which resulted in evolving the process now known as the centrifugal copper process for the manufacture of sheets, tubes, and wire, which will now be described in detail, together with the results obtained.

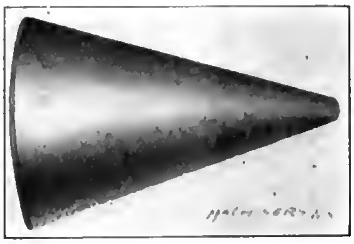


Fig. 1. Copper Cathode in the Form of a Cone to determine Critical Speed.

After a long series of experiments had been made to determine the best composition for the electrolyte and the most economical current density to employ, the critical speed was accurately determined by means of revolving cathodes in the form of cones, Fig. 1. By observing the point at which the copper remains smooth, and by measuring the circumference of the cone at that point and multiplying it by the number of rotations per minute, the critical speed is readily determined; 200 amperes per square foot is found to be the most economical current density, although a current density up to 500 amperes per square foot can be employed by increasing the rate of rotation, but the increased cost due to increased voltage renders such a current impracticable for ordinary commercial work.

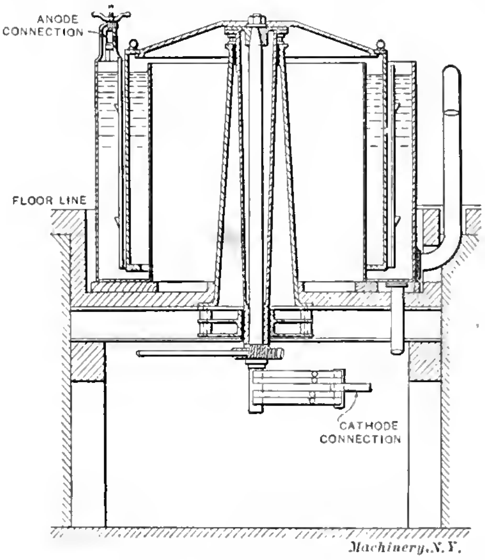


Fig. 2. Vat used for producing Copper Sheets by the Centrifugal Process.

One of the chief difficulties inherent in any electrolytic or wet process for the production of copper tubes and sheets, is having any working parts, such as bearings, in an acid copper sulphate solution, and this was one of the first troubles en-

countered when working the centrifugal process on a commercial scale. This difficulty was eventually overcome by constructing vats in the form of an annular ring, as shown in Fig. 2. It will be observed that by such an arrangement all working parts are outside the vat and do not come into contact with the electrolyte, so that the bearings can be lubricated in the ordinary way; only the actual face of the mandrel on which the copper is to be deposited is immersed in the electrolyte. The cathode consists of a steel or cast-iron cylinder closed at one end, to which is attached on the inside a steel rod projecting below the edge of the mandrel to guide it into position; the cylinder can be 5 or 6 feet in diameter or even larger, so as to produce a copper sheet of say 20 feet long by 4 or 5 feet broad. Anodes, composed of crude copper, are placed around the mandrel with intervening spaces, and are fed forward by suitable mechanical means, as the copper dissolves away, so as to keep the voltage constant.

One great advantage of the centrifugal process is that a very low voltage is required even when employing a very high current density; for instance, only 0.8 of a volt is required at the terminals of the vat when working at a current density of 200 amperes per square foot of cathode surface. The effect of revolving the cathode is five-fold; it keeps the electrolyte agitated, so that there is always a fresh supply of copper ions in proximity to the cathode; each molecule of copper as it is deposited on the cathode is burnished or rubbed down by means of the skin friction between the revolving cathode and the electrolyte; the rotation prevents any foreign matter that may be in suspension in the electrolyte settling on the cathode and becoming entangled by further copper being deposited around or over it; it brushes away any air-bubbles on the cathode, which are the cause of nodules forming; and the rotation of the cathode ensures the thickness of copper being uniform, even when a mandrel of say 8 feet in length is employed.

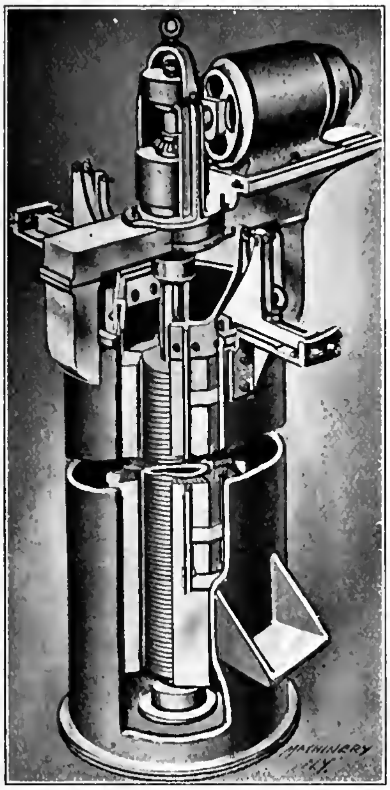


Fig. 3. Vat used when making Tubes by the Centrifugal Process.

The method of making tubes by the centrifugal process is as follows: A mandrel somewhat smaller than the finished internal diameter of the tube is prepared by coating it with an adhesive coating of copper by first depositing copper upon the surface from an alkaline solution and then thickening it up in an acid solution, the surface being highly burnished and treated chemically to ensure the easy removal of the deposited tube. The mandrel thus prepared is then placed in a vat as shown in Fig. 3. When the desired thickness has been obtained, the mandrel is removed and placed in a horizontal or vertical lathe, and a round-faced roller run over the surface so as slightly to expand the deposited copper, which can then be readily drawn off.

Copper sheets are prepared in a similar manner, the only difference being that the mandrels are of much larger diameter, and a narrow insulating strip is fitted down one side so that the sheet can be easily removed by inserting a tool under one of the edges of the deposited copper. It is no more costly by the centrifugal process to make thin sheets than thick ones; copper foil can be made in five minutes, direct from crude copper. Copper tubes produced by this process without any drawing, have given a maximum stress of 17 tons, and tubes after drawing have withstood a pressure of 3,000 pounds per square inch without showing any signs of distress. Sheets made without any rolling have given a maximum stress of 28 to 30 tons per square inch, according to the peripheral speed at which the mandrels were revolved.

The production of copper wire by electrolytic means is a more difficult problem than the production of copper tubes and sheets. Various processes have been suggested and tried from time to time, such as the electro-deposition of copper on thin wire, until it has obtained a considerable thickness, and then drawing the thickened wire down to a comparatively fine wire. Experiments have been made with such processes, but so far they have not been worked commercially.

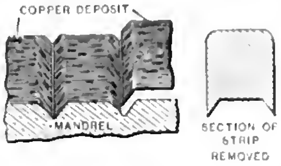


Fig. 4. Diagram showing Method of forming Weak Line of Cleavage due to Crystalline Structure

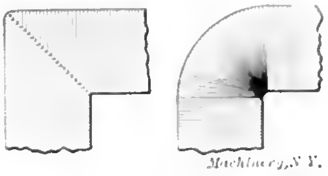


Fig 5 Diagram showing the Effect of Sharp and Rounded Corners on the Crystalline Structure of Metal deposited on Mandrel

Copper wire is made by the centrifugal process in the following manner: A mandrel similar to that used for making copper sheets is employed, around which a spiral scratch is made, the pitch being determined by the size of wire required. The effect of the spiral scratch (which need only be very light, but must be angular), is to cause the crystalline structure of the copper to form a cleavage plane, as shown in Fig. 4. It will be observed that the copper divides exactly at the apex of the scratch, that is, the copper deposited in the scratch is equally divided and forms a small V-shaped fin on two sides of the copper strip. If the scratch is not angular, but rounded at the base, the copper will not divide, as the crystals are radial, as shown in Fig. 5. After the desired thickness has been obtained, approximating the pitch of the spiral scratch, the mandrel is removed from the depositing cell and placed in a vertical position on a special lathe, and the copper strip is unwound, as illustrated in Fig. 6, at an angle of about 45 degrees to the face of the mandrel. During the process of unwinding, the small fin or burr is removed by passing the wire through a suitable die and then through a wire-drawing machine provided with three or more draw-plates to reduce the strip to the desired diameter. By employing a mandrel of 6 or 7 feet in diameter, lengths of wire 4 or 5 miles long can be made in one operation. Reference was previously made to this method of making copper wire in the November, 1905, issue of MACHINERY.

The advantages of an electrolytic process as compared to a smelting process are many, and the day is not far distant when copper will no doubt be leached direct from the ore and electrolyzed with insoluble anodes, to produce finished copper sheets and tubes in one operation direct from the ore without the intermediate process of smelting and refining. The centrifugal process is a step in this direction, as it is capable of depositing copper from its solutions by using insoluble anodes in the form of finished tubes or sheets in one operation. The centrifugal process is at least ten times faster than any existing electrolytic process, and a high current density can be employed without deteriorating the quality of the copper. The plant is simple and free from mechanical complications, and the amount of copper locked up for a given output is small compared to other processes. The process is of interest to mechanical engineers, as it conclusively proves that to get a high tensile strength in metals combined with ductility, it is not essential to put a large amount of work into the metals as hitherto has been considered necessary, by the processes of swaging, rolling or drawing, but that a very small amount of energy will suffice when applied in the manner described.

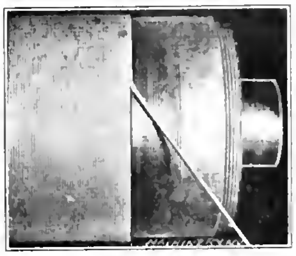


Fig. 6. Unwinding the Copper Strip from the Mandrel.

CUTTING AND KEYSEATING CHANGE GEARS ECONOMICALLY.

RAQUET

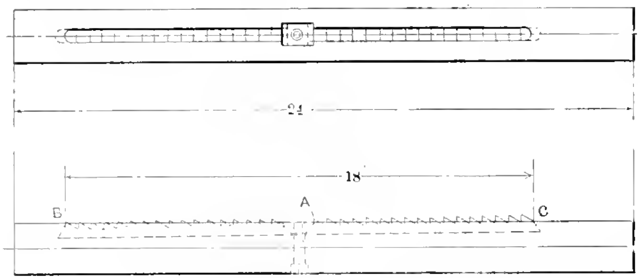
This article is a kind of appendix to the one on machining change gears which appeared in the April issue. Through information obtained later, I was rather surprised to learn that the method of broaching keyseats therein described was comparatively unknown in America. So I thought a bit more information might be acceptable.

Of course the "pull" broaching machine as made by the Lapointe Machine Tool Co. in America and Smith & Coventry in England, are well known examples of broaching machines, but I do not fancy either of them (from a casual knowledge of the machines) for keyseating change gears, because every time a gear or stack of gears has been operated on, the machine must be stopped to place another in position.

With the "push" method the machine runs continuously, it being comparatively easy to keyseat a gear at every stroke, the machine running at from 120 to 140 strokes (forward and return) per hour.

Another objection to the "pull" type when applied to this work is the difficulty of making the long slim cutters which must of necessity be made in one piece, whereas with the cutter bar, illustrated herewith, the cutters may be made in two or more parts. My previous article stated that the cutters were fixed to the bar by screws from the under side, but since that was written we have found a better way.

The objection to the first method is that the cutters must be exceptionally wide to admit of using reasonable size of screws. We have had a lot of trouble with the cutters breaking at the tapped holes, so after some study I evolved the one shown in sketch.



Bar with Inserted Cutters for Keyseating Change Gears.

It will be seen that there are no holes in the cutters, so that they, therefore, may be made the same width as the keyseat to be cut. The beveled ends and the clamping arrangement at the center ensure a solid job and also make it possible to insert new cutters with very little trouble. Of course, it will be understood that the taper of the cutting edges from *B* to *C* is not a straight line from end to end. The presence of the clamping plate at the center necessarily does away with two or three of the cutting edges so that if *BAC* were all in the same straight line the tooth *A* would have two or three times too much stock to remove.

The largest bar we have at present is 1½ inch diameter for keyseats 3/8 inch wide, 3/16 inch deep, and 18 inches of cutting edges seems to be about right. Of course, the overall length of the bar is unimportant, but I should not reduce the length of the cutting edges for 1 inch bars for keyways 1/4 inch by 1/8 inch and over.

While in my previous article I showed how we did the work on a planer, it would be far more convenient, where there is much small keyseating, to make a special machine. This machine would always be ready and it would then pay to keyseat even odd gears in this manner. A machine for this work is very simple and could be made very cheaply. All that is required is a gap lathe bed, a central screw driven by two belts (open and crossed), a reciprocating carriage driven by the screw, and a suitable bracket for the work to press against.

The cutter bars could be kept in close proximity to the machine; then if even a single gear required to be keyseated it would only be necessary to insert the correct size of bush, start the machine, mount the gear on the cutter bar, insert bar in end bracket, and the job is finished in less time than it takes to tell about it.

I think it would pay almost anyone to make a special machine in preference to rigging up a planer; but at the same time it must not be supposed that the machine would be kept constantly at work. It would take rather a big shop and a large number of gears to keep one of these machines in full employment, but an hour or two's run a day will be quite sufficient to pay a good percentage on the investment.

It should also be mentioned that the keyseats are kept up to size (depth) by putting tissue paper under the cutters.

Another point I should like to particularly emphasize is the importance of the method of indexing, christened block indexing for want of a better name, [Also known as multiple indexing—EDITOR] which was referred to in my previous article. I am firmly convinced that where the ordinary consecutive indexing method is in use on gears, say up to 6 diametral pitch, it is possible, by introducing block indexing, to increase the speed and feed so that the output is raised by fifty per cent. Not only this, but with the latter method and the increased speed and feed, the cutter and finished gear will be actually cooler than it would have been under the former conditions after doing an equal amount of work. The Brown & Sharpe Mfg. Co., in the book of instructions sent out with their gear-cutting machines, does not in my opinion attach sufficient importance to this method of indexing; they dismiss the question as follows: "The advantage claimed for omitting one or more teeth before cutting is the more even distribution of heat throughout the blank. On the other hand, however, good results can be obtained by arranging the speed and feed slow enough to avoid heating."

This was written a few years ago, before high-speed steel wakened up machine tool-makers. It was, no doubt, permissible then to "run slow enough to avoid heating," but now modern conditions demand that we should run as near the top speed and feed as we can get, finding ways and means of dissipating the heat generated.

Those mechanics who have never tried this method will be surprised to learn how the heat is dissipated by simply skipping a few teeth. At our works we would never think now of cutting change gears by the ordinary consecutive indexing method. The table (see Data Sheet Supplement) is exactly like the one we use with our B. & S. machine, but it is quite a simple matter to calculate one for any other make of machine. Suppose, for example, that the change gear table supplied with any particular machine gave the following change gears to index a certain number of teeth $\frac{20}{60}$ and $\frac{30}{50}$ (20 and 30 being drivers in both cases): then if we wish to cut say every fifth tooth (this depends on the number of teeth in the gear, it must not be a multiple) multiply the fraction $\frac{20}{60} \times \frac{30}{50}$ by 5. Then we have $\frac{20}{60} \times \frac{30}{50} \times \frac{5}{1} = \frac{1}{1}$ In this particular case equal gears would divide the blank so that every fifth space was cut.

I notice in the series of articles "Gear-Cutting Machinery," which have recently appeared in these columns, that one machine (February, 1908, engineering edition), by J. Parkinson & Son, Shipley, England, is specially arranged for block or multiple indexing, but as shown above, nearly any machine can be set up with very little trouble, though, no doubt, there would be some difficulty with the smaller pinions; but block indexing does not make as much difference when the gears to be cut have only a small number of teeth, so that it is not really a very serious difficulty after all.

* * *

The largest apartment building in the world will be built in New York City, on Broadway and Amsterdam Avenue, between 86th and 87th Streets. It will cover the entire block and will be 350 feet long, 200 feet wide and 150 feet high. It will be twelve stories in height, and will have 175 apartments, containing from nine to fourteen rooms each. The building will be constructed in the form of a hollow rectangle, the courtyard in the center being 250 x 100 feet wide. The structure will cost $3,000,000.

THE STRENGTH OF HELICAL GEARING.*

It has long been possible to produce a double helical form of cut gearing by bolting together a pair of spiral wheels of opposite hand, but this method of construction is far from satisfactory on account of the extreme difficulty of bringing, at anything like a reasonable cost, the two sides into accurate register. About five years ago Herr Wüst, of Zurich, conceived the idea of generating both sets of spiral teeth in a single-wheel blank by using two hobs of opposite hand to cut the teeth simultaneously. The difficulty was to find means whereby the teeth on each side could be cut through to the center. This difficulty was, however, solved when the teeth were staggered, so that the centers of the teeth on one side of the wheel coincided with the centers of the spaces between the teeth on the other side. Wheels and pinions of this form are now manufactured by the Power Plant Company, Limited, West Drayton, Middlesex. The result of the method adopted by this firm will be better understood on reference to Fig. 1, which is a reproduction of an actual pinion of seven teeth which was cut in this way. Not only have wheels so made proved quite satisfactory, but they have been found to possess the advantages incidental to the old stepped type of gearing, *viz.*, greater freedom from backlash and shock; and machine-cut double helical gears of this type are far stronger than straight-cut gears of equal pitch and width. The capacity of a gear-tooth to transmit power depends on the metal section available at the base to resist the maximum bending stress. In the case of ordinary straight-spur gears, the teeth are subjected to greatly varying bending stresses while in engagement, and the maximum stress on a driven tooth occurs when a driving tooth first engages it at the extreme tip. The bending stress is then proportional to the product of the driving force into the height of the tooth.

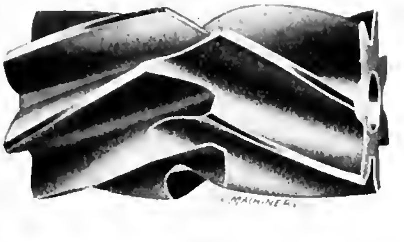


Fig. 1. A 7-tooth Herringbone Gear formed by the Wüst Process.

With double helical wheels the conditions are much less severe. What is meant will be understood on reference to Fig. 2 below, which shows in development a portion of the rim of a wheel of 50 teeth, having staggered double helical teeth cut at 23 degrees, and a width equal to five times the circular pitch. The three teeth, A, B, and C, are all in engagement at the same time, and the normal elevations of these teeth are shown. The wheel of 50 teeth is considered to be driven by a pinion of 25 teeth, and the representation is made at the moment when the center of tooth B is engaged at the pitch line. In order to make a comparison with straight spurs it is necessary to average the contact across the three teeth A, B, and C. This is shown by the horizontal lines in Fig. 3, which are obtained by averaging the ordinates of the contact lines in the upper view of Fig. 2. On comparison of Figs. 2 and 3, it will be noticed that the average contact for A is at its lowest and C at its highest, while the average for B is about the pitch-line. As the wheels roll on, these average contact lines change in position, but on any one tooth they never rise above the level shown for A in Fig. 3, nor fall below that for C in the same figure. Thus for every tooth there is a zone within which the limits of average contact must lie, as illustrated by Fig. 4. Here the shaded portion Y shows the variation of average contact for the case under consideration, while X is the working height of the tooth. For teeth cut at 23 degrees to the axis, on a wheel whose width is five times the circular pitch, Y equals about $0.44X$ for a wheel of 50 teeth driven by a pinion of 25 teeth.

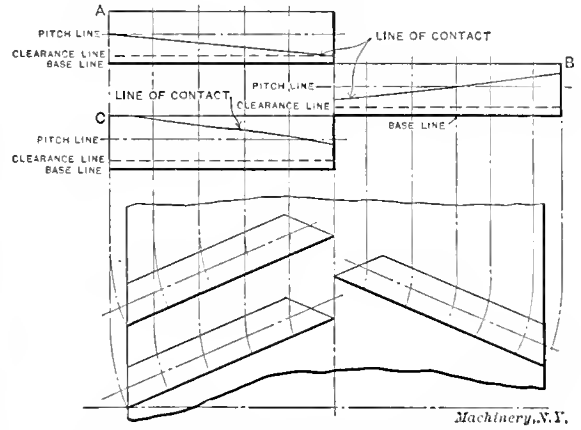


Fig. 2. The Instantaneous Lines of Contact made by Three Contiguous Teeth with their Mating Teeth.

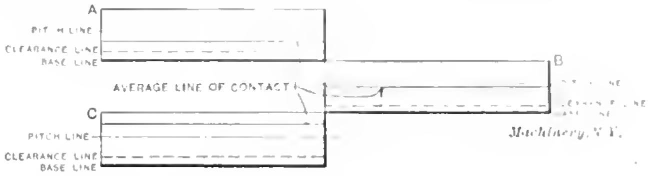


Fig. 3. The Average Lines of Contact on the Three Teeth.

Fig. 5 shows the corresponding variation of contact, and of bending stress, in a straight-cut spur-wheel under similar conditions. It will therefore be seen that the reduced variation of stress allows the employment of much finer pitches, for equal powers and speeds, than are permissible for straight-cut gears.

The particular case considered is merely given for illustration, but the same method of comparison holds good for any combination. In general, the variation of bending stress on double helical staggered teeth is less than in the case considered, because the comparatively fine pitch employed usually leads to wheels of many teeth, the number being rarely less than 100, and rising sometimes to 500. Another advantage claimed for these helical teeth is that their gradual engagement tends to eliminate shocks, and this effect is increased by the stepped form of teeth adopted. The smoothness of running, which is the direct outcome of these special features, consequently makes it possible to produce noiseless gears without having recourse to intrinsically weak pinion materials, such as raw hide, or fiber.

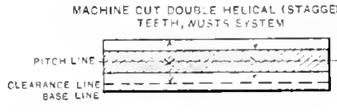


Fig. 4. Shaded Area shows Range of Average Line of Contact on Herringbone Tooth.

Fig. 5. Shaded Area shows Range of Line of Contact on Spur Gear Tooth.

[The form of gearing here shown is that produced by the Wüst machine, described in the April, 1908, installment of the series of articles on gear-cutting machinery which we have just finished. The great advantage of this form of herringbone gearing would seem to be the possibility of producing it at a reasonable cost. We do not understand the difficulty mentioned in the above article of bringing the two sides of a split gear of this style into accurate register. If the two sides are not in accurate register, the pinion will float sideways on the gear slightly until it is in engagement equally on each side. The shaft should be left free for end-wise movement for this purpose, and no collars are necessary. We are not, furthermore, inclined to believe that the staggered form of tooth is of any advantage whatsoever, except as it facilitates manufacture. The herringbone gear itself has the effect of a stepped gear of an infinite number of steps, so it is perfect in this respect, and staggering the teeth cannot make it any more perfect.

The main subject matter of this article, however, relating to the strength of helical gearing, is new so far as we know. It is evidently a fact that helical gearing is stronger than spur gearing of the corresponding size, owing to the fact that at no time is the whole breadth of any one tooth subjected to the maximum pressure, that pressure occurring only at one point. —EDITOR.]

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Don't tell what you would do if you were someone else—just show what you can do yourself.—*Speed.*

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* From an article entitled "Machine-cut Double Helical Wheels" in *Engineering*, February 21, 1908.

OXY-ACETYLENE PROCESS OF METAL CUTTING AND AUTOGENOUS WELDING.*

Within the past seven years a valuable tool, unique in its characteristics, has been developed for cutting, shaping, and welding metals, in the oxy-acetylene "torch," which now is so well advanced that it bids fair to displace other emergency cutting and welding means to a large extent. The oxy-acetylene process had its inception in France, the first experimenter being Mr. Edmund Fouche, of Paris, who began his work on it in 1901. The principle of the oxy-acetylene torch or burner is essentially the same as that of the oxy-hydrogen blow-pipe, which has been used for many years for generating intense heat. But though the oxy-hydrogen flame is intensely hot, the flame produced by the oxy-acetylene torch is so much hotter that the two are not in the same class. The temperature produced by the oxy-hydrogen flame is rated by authorities at about 4,000 degrees F., while that of the oxy-acetylene flame is estimated at about 6,300 degrees F. Not only is the flame of acetylene much hotter than hydrogen, but the number of B. T. U. per cubic foot is about five times as great, being as 330 to 1,600. Hence both the intensity and amount of heat is greatly increased in the flame of the oxy-acetylene torch. A comparison between the two instruments has been aptly put as like that of "a finely pointed-tool and a blunt instrument."

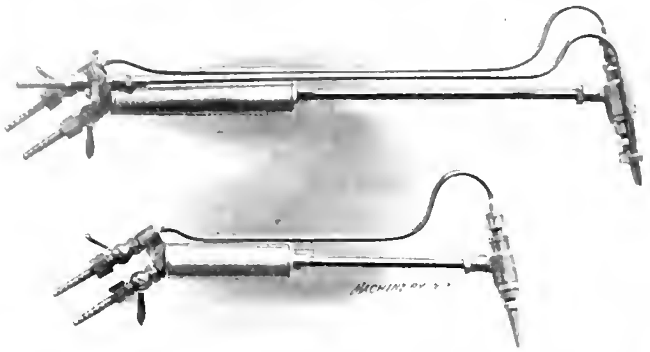

Fig. 1. Davis-Bournonville Oxy-acetylene Cutting and Welding Torches.

While the temperature of the flame of the oxy-hydrogen torch is high enough to melt and even vaporize most commercial metals, when the heat is confined, it is not high enough to fuse the edges of metals and make autogenous welding commercially profitable. At least this appears to be the case in the present development of the art. The rapid radiation and conduction of heat away from the joint prevents perfect fusion and joining, but with the vastly hotter oxy-acetylene flame, autogenous welding becomes easy and rapid. Even aluminum, which conducts heat away with great rapidity and can be locally fused with difficulty, yields to the oxy-acetylene flame and joins perfectly, the joint being entirely homogeneous. In fact, the autogenous weld thus produced is the only known method of joining aluminum that will not separate with use.

Fig 2. Samples of Steel and Cast Iron Welding, and Cutting done with Oxy-acetylene Flame.

The commercial development of metal-cutting and autogenous welding has been taken up by several concerns in the United States and Europe. The processes are essentially the same, the difference being in the construction of the torches and the manner in which the gases are generated. Great difficulties have been met in cheaply producing pure oxygen gas. The cheap production of acetylene had, to a great extent, been satisfactorily solved in the extensive development of acetylene lighting, but even this art had to be further developed to meet all the requirements of metal welding and cutting work. There are four or five commercial means of making oxygen, these being principally the oxone or barium process, the liquid air process, the epurite process, and the chlorate of potash process. The latter process is used by the Davis-Bournonville Co., New York, and the following notes relate to the development of the art of metal cutting and autogenous welding, as reached by this concern.

The chlorate of potash process of generating oxygen is well known, being perhaps the simplest method. It will be found described in elementary works on chemistry. The oxygen of chlorate of potash can be driven off by gentle heat, and, in practice, the potash is placed in a closed retort and subjected to a comparatively low temperature. The reduction is facilitated by the addition of black dioxide of manganese in the proportion of 14 pounds of manganese to 100 pounds potash. The oxygen gas is passed through scrubbers and is pumped into receivers. The pressure in the receivers is varied according to the use, it being desirable to compress from 125 to 150 pounds per square inch for metal cutting, while 15 pounds pressure suffices for autogenous welding. The acetylene gas is produced in the Davis generator which is adapted to all pressures up to 15 pounds per square inch. The machine is automatic and feeds lump carbide perfectly up to sizes that pass through 1-inch screen. The theoretical quantity of water to carbide is about ½ pound to 1 pound carbide, but to absorb the heat of the chemical transformation the generator is required to have a water capacity of 1 gallon water to 1 pound carbide. For repair shops and work outside of the shop, a portable apparatus is required, and for such purposes the oxygen and acetylene gases are stored in small cylinders. The storage of oxygen is a simple matter of pumping the gas into the cylinders until the required pressure has been reached. The storage of undiluted acetylene under pressure in tanks is impracticable, but fortunately, it was discovered in 1896 by Claude and Hesse, two French engineers, that acetone, a fluid derived from the dry distillation of wood, is a remarkable solvent for acetylene, being capable of absorbing 25 times its volume at 60 degrees F. for each atmosphere. At ten atmospheres, or 150 pounds pressure per square inch, a gallon of acetone absorbs 250 gallons of acetylene gas. When absorbed by acetone, acetylene is non-explosive under heavy pressure.

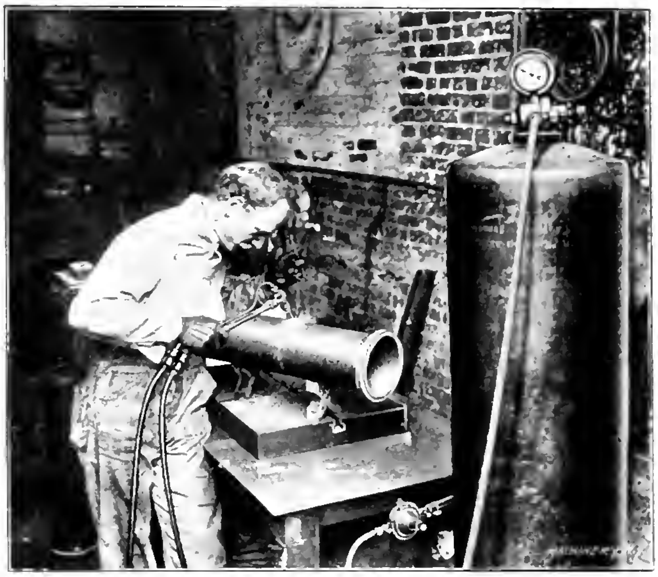

Fig. 3. Welding together the Parts of a Drawn Steel Retort. The Operator feeds the Joint with a Special Grade of Iron Wire.

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*For other articles on autogenous welding, see "Blow-pipe Metal Welding with Acetylene," March, 1904; "Acetylene Gas for Welding," September, [illegible], and "Autogenous Welding," July, 1907. For articles on storage of acetylene gas in acetone, see "Acetone as an Absorber of Acetylene Gas Under Pressure," December, 1903, and "The Acetylene Safety Storage System," August, 1904. For article on oxygen cutting, see "The Use of Oxygen for Removing Blast Furnace Obstructions," July, [illegible].

A red-hot wire might be thrust into the receiver with absolutely no effect, provided there is no free space occupied by acetylene gas. To prevent the possibility of there being free spaces for the accumulation of gas, acetylene storage tanks were designed by Mr. Edmund Fouche, which are packed with porous brick, asbestos or other neutral porous material, thus filling the entire free spaces and affording storage for the acetone and acetylene gas only in the cells of the filling.

Fig. 1 shows the Davis-Bournonville Co.'s cutting and welding torches. The upper illustration is the cutting torch and differs from the welding torch shown in the lower illustration simply in that it has an auxiliary detachable oxygen tube secured to the side. The welding torch has an acetylene gas tube and an oxygen tube which combine in a tip or nozzle from which the united gases flow and burn. The upper tube in each illustration is for oxygen, while the lower tube is for acetylene, the two gases uniting at the end of the removable tip within the body of the torch. The enlarged portion of the torch in the acetylene pipe is packed with porous material to prevent flash-backs extending beyond the torch itself.

Samples of welding and cutting are shown in Fig. 2. The pieces at the left are parts of two steel strips which were welded edge to edge. The welded piece was cut in two and the lower specimen shown was bent over on the weld through an angle of about 120 degrees. The ground parts on the left end of each piece indicate a perfectly homogeneous union. The piece in the lower right-hand space is made up of cast iron and steel welded together. The cast iron is welded to itself as indicated in the illustration, and to the steel, the union in each case being perfect. However, because of the difference in expansion and contraction, there is danger of a crack appearing in cast iron welded to steel unless it is carefully cooled off. Right here it might be said that expansion and contraction are the greatest foes of autogenous welding, and to effect satisfactory work on some pieces, it is necessary to raise the temperature by pre-heating before welding is commenced. Then the difference in temperature of the welded and unwelded parts is not so great. Moreover, this practice has the advantage of saving gas that otherwise would be required to heat adjacent parts before fusion is reached.

Fig 4. Welding the Broken Flange of a Cast Iron Base. The Operator feeds the Joint with a Cast Iron Rod.

Fig. 5. Cutting Off Steel Sheet Piling with Oxygen Cutting Torch showing Portable Apparatus.

The upper right-hand piece shown in Fig. 2 is a sample of ½-inch steel plate cut out with the cutting torch. The piece illustrated is shown reduced to about one-half the actual size, and it gives an idea of the width of kerf, the kerf being about ⅛ inch wide. Cutting steel with a torch is much more spectacular and impressive than welding, the metal being cut away rapidly and passing off in scintillating sparks. The work is done with comparative rapidity. A No. 1 tip will cut up to ½-inch steel at the rate of 60 feet per hour, with a consumption of 12 cubic feet of acetylene and 15½ cubic feet of oxygen in the heating jet and 60 cubic feet of oxygen in the cutting jet. The cost of operation with labor at 30 cents per hour is estimated at $2.68, or about 4½ cents per lineal foot. The oxygen for the heating jet is carried at 11 to 18 pounds pressure, while the pressure of the oxygen cutting jet supply is much higher, being about 125 pounds pressure. Only one oxygen cylinder is required, however, the low pressure welding flame supply being taken from the high pressure supply and regulated by a reducing valve.

Fig. 3 illustrates the welding of thin steel retorts used for generating oxygen gas. The material for the retorts is brought in drawn shape, one part being made with a collar and the other having a rounded bottom. The length of the retort is too great to permit it being drawn in one piece, hence the necessity of welding the two parts together near the center. The following is an approximate cost of welding 1/16-inch metal. The consumption of acetylene is 2.8 cubic feet per hour; of oxygen 3.6 cubic feet at a pressure of 8 to 10 pounds. The rate of welding is about 50 feet per hour, and with labor at 30 cents per hour, the total cost per hour is 43.6 cents, or less than 9/10 per cent per lineal foot. The cost of welding increases with the thickness of material, of course, reaching an estimated cost of 37 1/2 cents per lineal foot for 7/16- to ½-inch thick metal.

In Fig. 4 is illustrated the welding of a broken flange on a casting. This job, which would have been difficult and expensive by brazing, was easily accomplished. In this illustration, as in Fig. 3, the operator is shown feeding material into the weld, the same as a tinner feeds solder when soldering. For welding steel and wrought iron a special iron wire is used, and for welding cast iron, rods of cast iron.

Fig. 5 illustrates the use of the cutting torch cutting off steel sheet piling. This work, as before stated, is done with rapidity, and is a very spectacular performance. In the case of cutting, the combustion of the steel materially raises the temperature and assists in the work. This was pointed out by Chevalier C. de Schwarz in a paper read before the May, 1906, meeting of the Iron and Steel Institute, and it gives one a startling idea of the power of the oxygen cutting flame when the concentration of the heat units produced is known. Burning 1 pound of acetylene with oxygen produces from 18,250 to 21,500 B.T.U. The mean value may be taken as about 19,750 B.T.U. per pound, and the number of cubic feet at atmospheric pressure at about 14½. Now, the burning of 1 pound of steel with oxygen produces approximately 2,970 B.T.U., but at atmospheric pressure 1 pound of acetylene gas fills 6,750 times the space of 1 pound of steel. Hence, the intensity of the heat with perfect combustion of the steel in oxygen will be, theoretically, $\frac{6,750 \times 2,970}{19,750} = 1,015$ times the intensity of heat of the oxy-acetylene flame. As a matter of fact, of course, this enormous temperature is not even remotely approached, because the metal dissolves at a far lower temperature and passes off in sparks, which are speedily cooled by the atmosphere.

F. E. R.

DEVICES FOR GRINDING FLUTING CUTTERS.

ERIK OBERG *

In the January issue of MACHINERY a contributor described a simple device for grinding angular cutters. The principle embodied in this device is used in almost all devices for grinding angular cutters, or formed cutters having regular milling cutter teeth. In the case of formed cutters with regular milling cutter teeth, it is, of course, necessary that the teeth be ground around the edges instead of the teeth being only ground on the faces as is the case with eccentrically relieved teeth. In Fig. 1 are shown two types of milling cutters which may be ground with devices working on the principles indicated and described below. The cutter *A* is a regular fluting cutter for taps, and the cutter *B* is a formed fluting cutter.

In Fig. 3 is shown the device used for grinding a tap fluting cutter. The angle included between the two faces on the fluting cutter is 85 degrees, and the angle between the two faces *C* and *D* in the device for grinding the teeth of these cutters is also 85 degrees, one side making 30 and the other 55 degrees with a line at right angles to the axis of stud *A* on which the cutter is mounted while grinding.

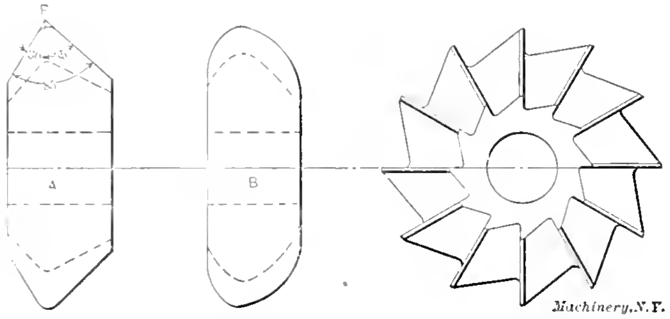

Fig. 1. Shape of Regular Tap and Formed Fluting Cutters.

The device consists of a base-plate *G*, having three feet which rest on a special table on the grinding machine, shown in Fig. 5, which will be more fully described later. On this base-plate *G* slides a cutter holding slide *H*, which has a groove in the bottom, fitting a tongue projecting from the base-plate. An oblong slot is provided in the base-plate as shown at *P*, so that the slide *H* can be clamped to the base-plate by the screw *L*, at any place within the length of the slot. The screw *K* passing through the lug *R* driven into the base-plate *G*, and acting upon the slide *H*, permits the necessary adjustment. The slide *H* holds a stud or spindle *A*, passing through a projecting standard *F* of the slide. The cutter to be ground is mounted on this stud.

It will be evident upon explanation of the action of this device in grinding the cutters, that these must be so mounted upon the stud *A* that the apex of the included angle between the two angular faces (that is, the point *P*, Fig. 1, where the angular sides would meet if extended) shall be on the same center line as the point *N* of the grinding fixture, where the two sides *C* and *D* meet (see Fig. 3). In order to obtain the fine adjustment necessary to bring these two points on the same center line, that end of stud *A* which enters in the bearing in the standard *F* is provided with threaded portions on which adjusting nuts are mounted. Collars are placed on the smaller diameter of *A*, against the shoulder *M*, so that the adjustment necessary to be made by the nuts will be comparatively small, the collars taking up the main difference in width of the various cutters to be ground. On the outside end of the stud *A* is a collar *B*, and a set-screw, having a large round slotted head, which is used for binding the collar against the cutter. It will be noted that this collar is cut off on one side to an angle. This is done in order to permit the collar to clear the emery wheel of the grinder when the side of the cutter tooth next to the collar is being ground.

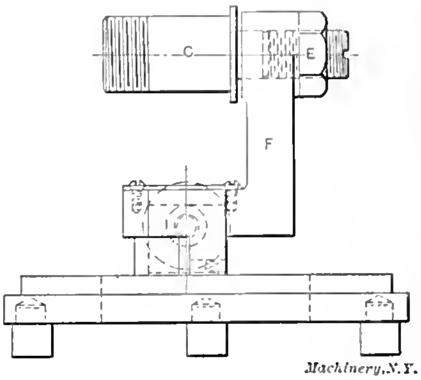

Fig. 2. End View of Formed Fluting Cutter Grinding Device.

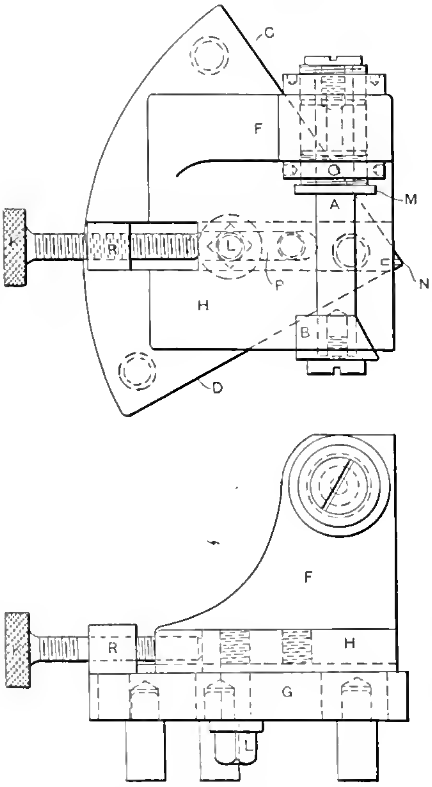

Fig. 3. Device for Grinding Tap Fluting Cutter shown et A, Fig. 1.

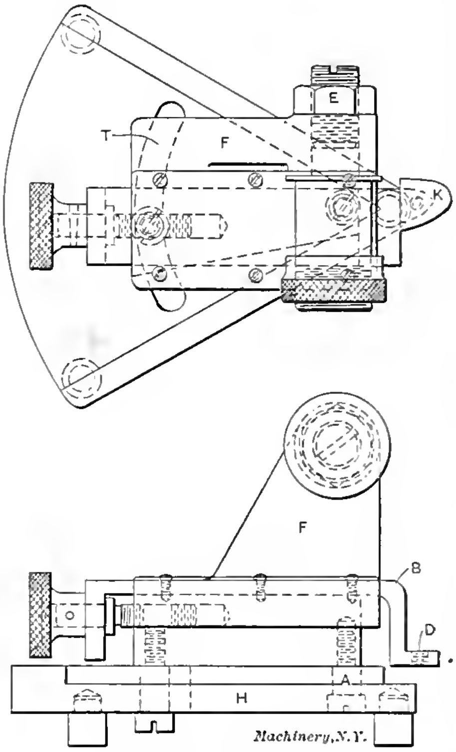

Fig. 4. Device for Grinding Formed Fluting Cutter shown at B, Fig. 1.

As shown at *A*, in Fig. 1, the cutters to be ground have their two faces connected with the small radius, different for different kinds and sizes of fluting cutters. This radius is obtained by permitting the faces of the cutter teeth to project slightly outside of the faces *C* and *D* of the base-plate *G*, Fig. 3, when the cutter is in position on the shaft *A*, the point *P* of the cutter, however, still being in line with the point *N* of the device, as mentioned above. When in use, the grinding device is placed on the table of the grinding machine, as shown in Fig. 5. This table is mounted directly on the grinding machine knee, and is provided with a guide strip *E*. The hardened shoe *N*, in Fig. 3, slides against this guide strip *E* in Fig. 5, and by swinging the device around so that first the face *C* comes along the guide strip *E*, and then turning it around the point *N* until the face *D* rests against the guide strip, the cutter is ground to the same angle as that of the base-plate *G* in Fig. 3, and a radius will be formed at the point of the cutter, its length depending upon the distance the faces of the cutter teeth project outside of the faces *C* and *D*. Different angles may be obtained by putting tapered strips along the sides *C* and *D*, the angle included between the faces of the strips being the same as the angle between the faces of the teeth of the cutter. The base-plate for this device should be made of machine steel, and the faces *C* and *D* should be case-hardened. If tapered strips are screwed onto the faces *C* and *D* to accommodate other angles than the ones referred to,

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* Associate Editor of MACHINERY.

these strips should also be made of machine steel and case-hardened. Slide *H* is made of cast iron.

The engraving, Fig. 5, shows the special table, previously mentioned, on the cutter grinding machine. This table consists of a cast iron body, provided with two tool steel plates *S* on the top, forming the table surface. These plates are hardened and ground to prevent too rapid wear as the feet of the grinding device constantly slide on their top surface. The guide strip *E* is also made of tool steel and hardened.

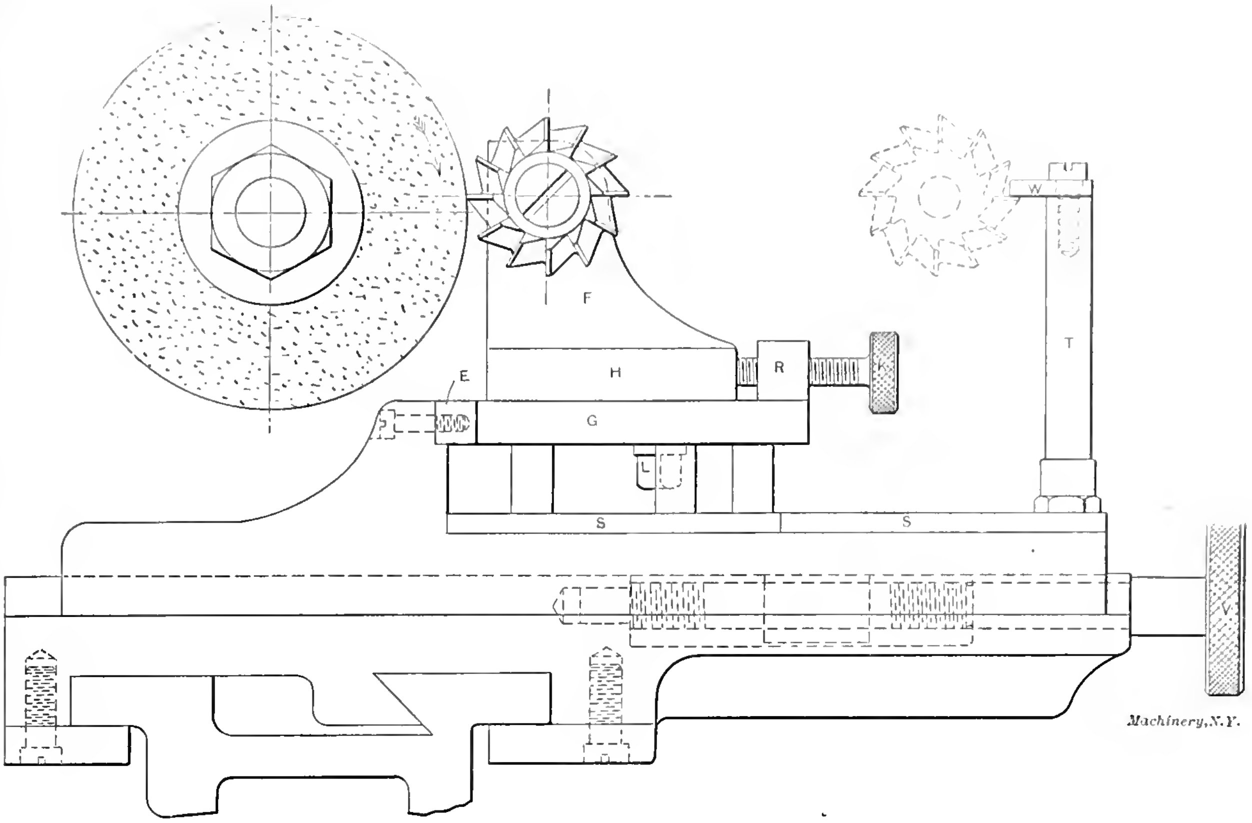

Fig. 5. Grinding Device for Cutters, on Table of Grinder.

At *T* in Fig 5 a stud is shown projecting up from the top of the table. From this stud extends an arm *W*, which is used for setting the cutter tooth, as shown, the cutter being indicated by dotted lines. It is, of course, necesssary that each tooth be exactly at the same height as the others, when ground, so that the diameter of the cutter measured over any two teeth will be exactly the same. The cutter is held simply by frictional resistance, and the indexing around is done by hand by the operator. The table can be fed out and in, by means of a feed-screw with a knurled head *V*, thereby permitting a greater or less amount to be ground off from the teeth of different cutters.

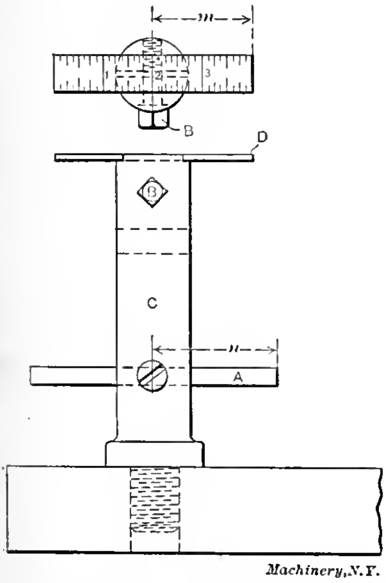

Fig. 6. Device for Setting Grinding Fixtures to grind a Certain Radius at Point of Cutter.

In Fig. 6 is shown a device which is used for setting the slide *H* in Fig. 3 to such a position that the correct radius will be ground at the apex of the angle of the cutter teeth. The stud *C* is screwed into the top of any kind of a base or surface-plate. This stud has a slot or groove cut in its top surface, and a regular 4-inch machinist's scale, preferably graduated in 100ths or 64ths of an inch, is laid in this slot at the top and held by means of the set-screw *B*, the upper part of the round stud *C* being split so that the scale can be gripped in the slot cut for it, as if placed in a split chuck.

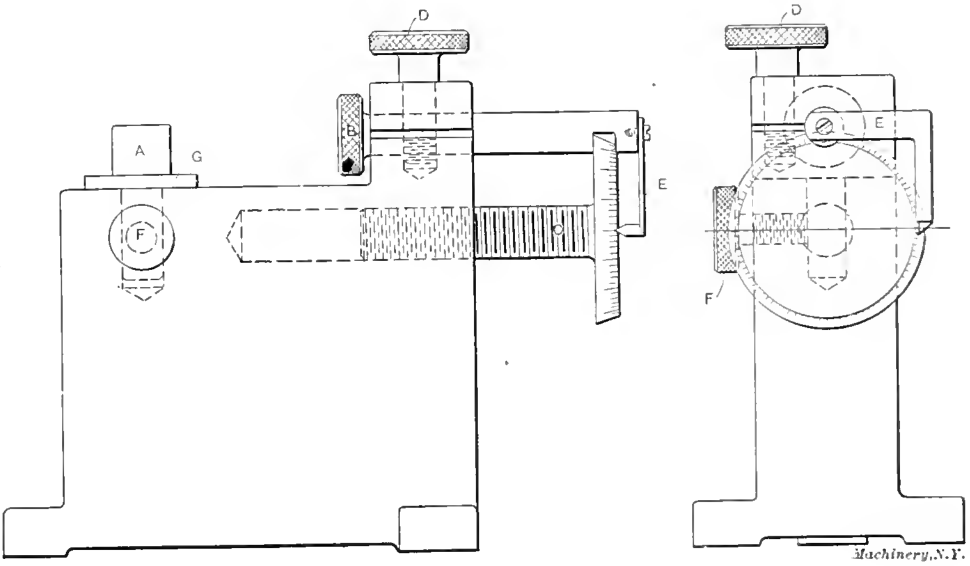

Fig. 7. Gage for Fluting Cutters.

When the device in Fig. 3 is to be set so as to grind a certain radius, the pin *A*, Fig. 6, is placed against the edge of the point *X* in the base-plate *G*, Fig. 2, and the slide *H* is adjusted so that the cutter touches the end *D* of the scale in Fig. 6. When the scale is so set that *m* equals *n*, the cutter to be ground will have no radius, but will have a sharp edge at the point. When *m* is shorter than *n*, the difference between

n and m will give a relative measure of the radius that will result between the faces of the cutter teeth; but it must be understood that this difference does not give the exact radius. This would be measured from the side D of the plate G to the side of the cutter. Of course, the arrangement in Fig. 6 may be used for measuring this length also, by placing the face D against pin A, and the angular side of the cutter tooth against the end of the scale.

The device in Fig. 7, finally, is used for inspecting the cutters when ground. The cutter is placed on the stud A, the stud entering the hole in the cutter, and the gage pin B, having a large head ground flat, is pushed up against the ends of the teeth in the cutter. This permits not only the length of the different teeth in the same cutter to be gaged, but in cases where several cutters are used in a set for fluting taps, all the cutters in the set can be gaged to find out if they are of exactly the same diameter. The gage stud B is fed in and out by means of the micrometer screw C, having a graduated head as shown. When the stud B has been set to the size of one cutter in the set of cutters, it is clamped in place by the clamp screw D. If, however, the other cutters in the set should prove to be smaller or larger than the first cutter, the clamp screw D can be loosened and the micrometer screw adjusted so as to move B in the desired direction, and the amount that the cutters are smaller or larger than the size of the other cutters in the set can be determined by reading off the number of thousandths directly on the graduated head of the micrometer screw C. This head should be graduated so that each graduation reads 0.001 inch. A pointer E is screwed to the end of the gage stud B, for enabling correct reading of the graduations. Collars may be put on stud A to accommodate smaller or larger thicknesses of cutters, or the binding screw F may be loosened and the stud A moved up enough to accommodate thinner cutters, the cutters resting on the shoulder G.

In Fig. 4 is shown a device used in conjunction with the grinding table Fig. 5 for grinding the shape of formed fluting cutters, such as shown at B in Fig. 1. The principle of this device is practically the same as that in Fig. 3. It will be noticed, however, that in order to permit the device to be swung around so as to grind the complete form of the fluting cutter, a slot T, cut on a circular arc, has been provided in the base of the device, and the top portion is swiveled around the stud A. At the front end of the slide B, a threaded hole D is provided for the screw which holds the former for the various drill fluting cutters to this slide, the slide being adjustable to take care of the different diameters of the cutters. In Fig. 2 is shown a side view of this device, which plainly shows the design of the cutter holding slide, the arbor, and its adjustment. It will be noticed that in this case, instead of adjusting the cutter arbor by means of two nuts, on each side of standard F, the stud C has the smaller end threaded directly into the upright F and the nut E simply acts as a binding or check nut. A slot is provided for a screw-driver in the end of the stud C to facilitate adjustment. It will be noticed that in the device in Fig. 4 the former is not attached directly to the base of the device, but is placed on an independent slide. On account of this, there is no need of having any sliding adjustment between the base H of the device and the standard F, all adjustment being taken care of by the slide B, having the formers attached at D, as mentioned. The general shape of the formers used is shown at K.

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The experiments undertaken by various inventors for obtaining a satisfactory solution to the problem of wireless telephony seem to be crowned with success. In a previous issue we referred to the achievements of Valdemar Poulsen, the Danish inventor. Three French naval officers have now succeeded in constructing an apparatus by means of which they have, according to the *Petit Parisien*, been able to distinctly hear talking and singing over a distance of 90 miles.

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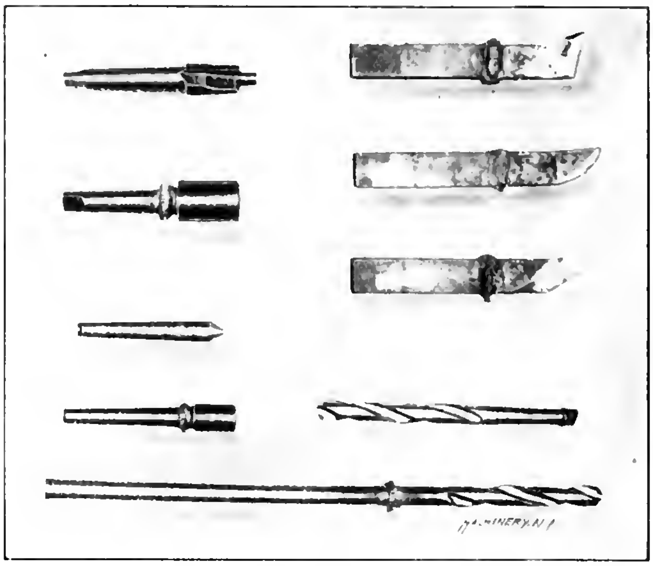
Once in a while a concern hustles so everlastingly to beat a competitor that it works itself out of business. Success is not necessarily in beating the other fellow but in serving your own trade so well that it finds you indispensable.

ELECTRIC WELDING OF TOOLS.

The accompanying illustration received from the Thomson Electric Welding Co., Lynn, Mass., shows samples of electric welding which are of special interest to machine shop managers, foremen, and others interested in economical shop practice. They illustrate the economy in the use of high-speed steel, made possible by the electric welding process. The upper left-hand figures show a counterbore made with a carbon steel shank and high-speed cutting part electrically welded thereto. Below these views are views of a lathe center with carbon steel shank and high-speed steel tip, before and after finishing. In the same illustration are shown diamond point, side and turning lathe tools of high-speed steel welded onto carbon steel or machine steel shanks.



Samples of Tools Electrically Welded for Economy of High Speed Steel and to effect Repairs.

A twist drill broken in the shank can be repaired by welding on a new piece, and with high-speed twist drills, the saving in expense is considerable. The process is also advantageous in making extension drills. The ordinary practice is to weld on a wrought iron shank or to insert a wrought iron filling piece, because of the difficulty of making welds in steel. The electric welding process makes it possible to weld on carbon steel shanks which, of course, are stiffer and stronger than wrought iron. The figure directly below the lathe tools shows a twist drill with a repaired tang, the tang having been twisted off and replaced by another tang electrically welded.

* * *

Mr. G. Scott Ram, electrical inspector of factories in Great Britain, has called attention to the danger of electric hand lamps of certain construction. In some lamps a brass tube is introduced inside of the handle as a chamber for the wire, and the flexible wire is nipped between the porcelain and the end of the brass tube at the lower end. The insulation of the wires is often scraped off far enough to bring it in contact with the brass tube, and as this latter is not always completely covered by a non-conducting handle the danger in handling the lamp is obvious. If a person holding such a lamp happens to be standing on a metal floor or on damp ground, or is otherwise in connection with the earth, he may get a severe shock, and in all probability he will be unable to release his hold of the lamp, and serious results will ensue. The two most important points to be borne in mind in the design of a lamp which can be used without danger is that there should be no metallic connection between the lamp holder and any other metal part of the fitting, and that the flexible wires in passing from the lamp holder shall not be taken through a metal tube, or otherwise in any way come in contact with any metal part of the fitting. In buying electric hand lamps, customers should carefully examine the construction and see that it agrees with the rules laid down above. Here is a case where simple common sense and no extra expense will add greatly to the safety in the industries where hand lamps are required to be used.

MACHINE SHOP PRACTICE.*

MACHINING THE HOLE FOR THE PUNCH AND FINISHING A BLANKING DIE.

In the September issue of MACHINERY, the way in which a common blanking die is planed and laid out was described. After the die has been laid out accurately the next step is to machine the hole for the blanking punch. The way in which this is done will depend somewhat upon the shape of the blank which is to be produced. As the hole through the die which we have selected as an example and which is shown on Shop Operation Sheet No. 76, has circular ends, the lathe can be used to advantage for machining these ends. A plan of the die blank after being laid out, is shown, and also a view of the blank strapped to the lathe face-plate.

First, one hole is drilled and bored to the required radius for the ends, then the blank is shifted on the face-plate and the operation repeated. In order to facilitate setting the work accurately, an indicator *M* is used. This is attached to the tool-post, and its end inserted in the center punch mark located in the center of the hole to be drilled and bored. As the work is revolved, any circular movement of the center punch mark will cause the end *G* of the indicator to move in a much larger circle. By keeping the tail-stock center close to the end *G*, the result of each attempt to shift the work on the face-plate and locate it in its correct position, will be plainly visible. When the center punch mark coincides with the axis of the lathe spindle, the end of the indicater will remain stationary.

The next step is to remove the core. This can usually be done most conveniently by drilling a row of holes just inside the line representing the outline of the master templet. If each alternate hole is first drilled and then the remaining ones, the holes can be spaced closer and drilled with less difficulty, and there will be no bridges between adjacent holes to hold the core in place. It is necessary that a die have clearance, as shown in the sectional views, Figs. 1 and 2, in order that the blanks, when sheared from the stock, may fall through the die; therefore, when drilling, if a thin strip is inserted beneath the blank and on the side farthest from the hole being drilled, so that the hole is inclined to the vertical equal to the clearance angle, considerable labor will be rendered unnecessary when finishing the die. The holes can also be drilled at right angles to the face of the die and then reamed out with a taper reamer, but the former method is more practicable.

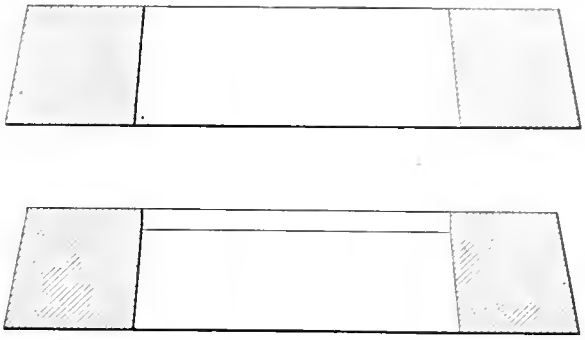
Most of the surplus metal can now be removed with a sharp chisel, but if the die is large it can be conveniently machined on the planer or shaper by strapping it to an angle plate which is inclined to the vertical sufficiently to give the die the proper amount of clearance. Of course, this work may be done more easily on a regular die-slottting machine, if one is available. If chipping is resorted to, the chisel should always be driven away from the top of the die as there is danger, when chipping from the other direction, of the metal breaking away outside of the lines. At times it may be advantageous to drill a single hole large enough to insert a milling cutter, and then work out the core on a vertical milling machine or a horizontal machine with a vertical attachment. A taper cutter can then be used for giving the die clearance.

The next step is to finish the hole to conform to the shape of the master templet. This is usually done by filing. A short piece of heavy wire should be fastened to the center of the blank, and perpendicular with it, as this will be convenient for handling the templet when fitting the die to it.

The die is fastened in a vise with its top or face toward the back of the vise. The hole is then filed to the line previously scribed on the die face. The templet should be frequently tried in the hole, the bearing points being marked with a pencil, and then removed with the file; this operation is repeated until the hole fits the templet perfectly and is large enough to allow it to just pass through. When testing the hole, the surface of the templet should be kept parallel with the top of the die. As the work is nearing completion it may be necessary to remove it from the vise each time the templet is inserted, to enable one to see the minute openings. A piece of white paper held on the opposite side of the blank will, however, suffice for the earlier stages of the work.

The amount of clearance ordinarily given a die is from 1 to 2 degrees. When the hole is being filed to size the clearance angle is made correct and uniform by testing the work with a die-makers' square, which differs from other squares in that the blade is set at an angle with the stock, of 90 degrees plus the clearance angle. In the sectional views shown in the engraving, two methods of giving clearance to dies are illustrated. In the one the clearance extends to the top of the die, while in the other there is a space of about 1/8 inch, which is practically straight, a very small amount of clearance being given. For very soft metals, such as soft, thin brass, the first method is preferable, but for harder materials such as hard brass, sheet steel, etc., it is better to have the clearance end a little below the cutting edge. With a die made in this way thousands of blanks can be cut without any great variation in their size, as grinding the face of the die will not enlarge the hole to any appreciable extent.

The clearance should be filed as straight as possible, so that the blanks, when cut, can fall through the opening easily. To file a narrow surface straight is difficult and requires considerable practice, and while one only becomes proficient in work of this character through practice, still a hint as to the proper method of procedure may be useful. When the file begins its stroke, the downward pressure exerted by the left hand holding the outer end should be maximum, while a minimum pressure is given by the right hand; as the file advances, the pressure from one hand decreases while that from the other increases. After considerable practice, one is enabled, unconsciously, to regulate the pressures on each end of the file so that rocking is prevented. If the surface being filed becomes rounded this can usually be removed by using a sharp scraper which will cut the metal quite rapidly.


Machinery,N.Y.

Sectional Views of Blanking Die Illustrating Two Methods of Giving Clearance.

After the die is finished, the punch is laid out from it. If a die-makers' clamp, such as was illustrated in the Shop Operation Sheet accompanying the September issue, is available, it will be convenient for holding the punch against the die when laying it out. The amount of clearance between the punch and die is varied with the thickness of the stock; for thin material, as for example, tin, the punch should be a close sliding fit, but for heavy plate iron there should be a clearance equal to, at least, 1/16 the thickness of the stock. The pressure required to force the punch through the stock is less when there is clearance between the punch and die, but if this clearance be too great, a tapering hole will be the result. A slight taper is not, however, objectionable on some classes of work.

* * *

It is well known that brass becomes brittle at a temperature of about 550 to 900 degrees F. This is caused by the presence of lead or oxides of lead, or both. This brittleness, it is stated in the *Mining Journal* (London) can be prevented by mixing a certain amount of phosphorus with ordinary brass when heated above 550 degrees F. The proportion of phosphorus varies from 0.03 to 0.10 per cent. In some cases, when brass objects are subjected to high temperatures, and the metal generally does not give satisfactory service, phosphor brass gives excellent results, as for example, in the case of brass tubes for superheated steam.

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* With Shop Operation Sheet Supplement.

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

WRITING CAM.

One of the manifold uses to which cam motion may be applied, is illustrated in the accompanying engraving of an arrangement called a writing cam. It consists of two cams of such outlines that a complete turn will make the pencil at the end of the upper follower *A* trace the letters U, W, make the short dashes in place of periods behind each letter, and return to the starting point. A closer inspection shows, that while the upper follower carrying the pencil, makes up and down movements, the lower one *B*, by means of a spring which keeps it in contact with the lower cam face, advances the paper at the proper rate in accordance with the movements of the pencil.

In designing the cams, the first step is to construct the chart shown in the lower right corner. For this purpose the letters or words are carefully drawn out and framed up as shown in the smaller rectangle, which is then divided into a sufficiently large number of equal parts, which are denoted by the letters of the alphabet, reading from right to left. To get the chart proper, a larger rectangle is drawn of any convenient length. The lower part of this figure is of the same height as the letters, and contains the curves of the upper cam *C*, while the height from the base to the top line is equal to the length of the smaller rectangle, as can be seen by the letters on the vertical line, and contains the curves for the lower cam.

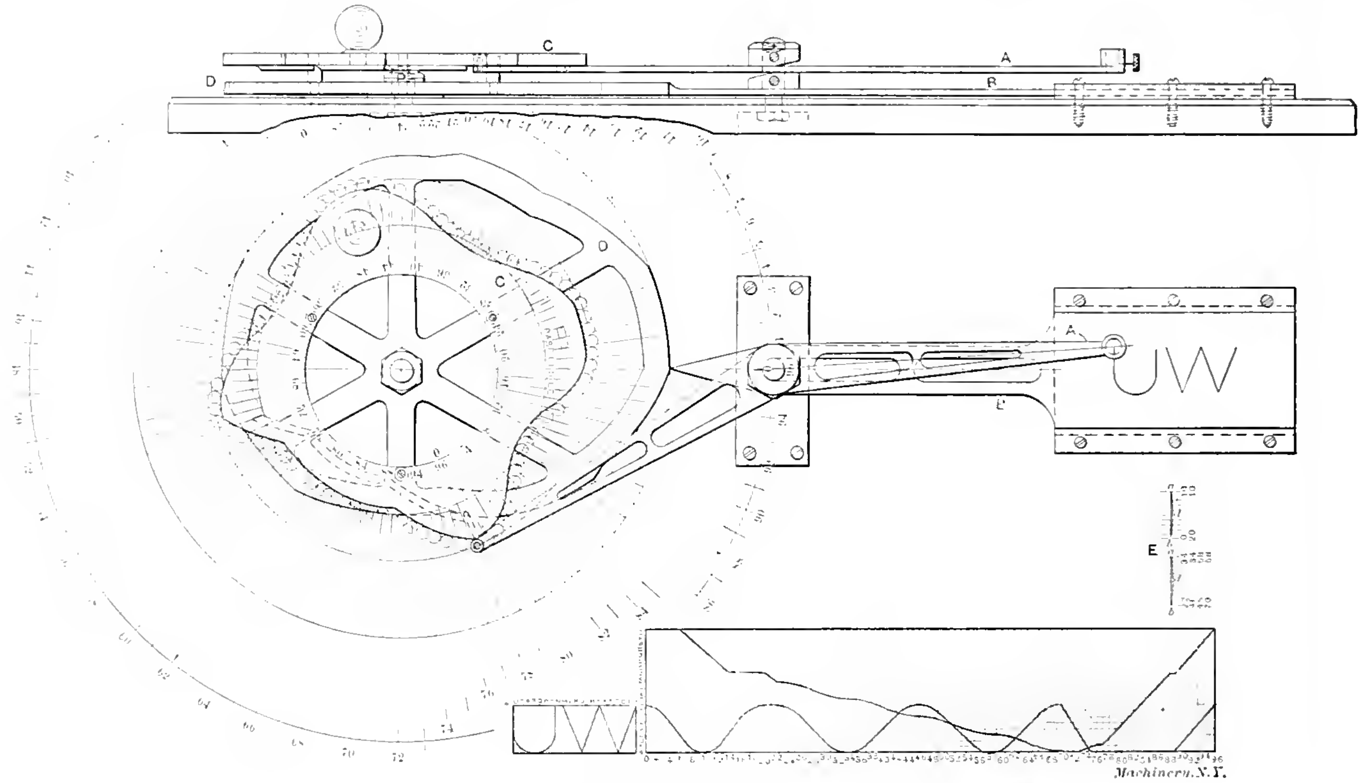


Fig. 1. Method of Laying Out the Curves for the Two Cams which Control the Movements of the Pencil and Paper.

The base line is next divided into an even number of equal parts, a multiple of four being preferable, because these lines represent as many radii, and the base circle has to be divided into the same number of parts. In the present case, 96 divisions were chosen as this permits of convenient subdivision. Having completed this step, the next is to evenly distribute or virtually stretch the letters over the lower part of the figure, leaving enough room for the home stroke, and then referring to the letters at the end of the rectangle, find the curve for the lower cam *D*. For instance, referring to the chart, while the pencil forms the straight line of the U which extends over radius 1-6, the paper does not move, therefore, that part of the curve for the lower cam is a horizontal straight line. The curved part of the same letter covers radius 6-14, and as the motion is uniform, the other curve drops uniformly to the intersection of radius 14 and a line drawn from between *ON*. The curve then stays at this height for the other straight part of the U to radius 20, then drops from *N* to *M* and radius 22, for the break between the two letters. In forming the W, the curve drops successively from *M* 22, to *J* 34, to *G* 46, to *D* 58, to *A* 70, each of these drops corresponding to one straight part of the letter W.

If the uniform law of motion had been followed, the curves would have been straight lines for the straight parts of the letters. In the present case this would, however, result in sharp corners at the joints of the W, which again would result into abrupt changes in the cam outline. To avoid this, the harmonic law of motion has been used, which insures continuous and smooth curves and cam outlines. The lines from 70 to 96 are for the return stroke, and being of minor importance no special law of motion has been employed.

To lay out the cams, the base circle and the large circle which passes through the fulcrum of the upper lever follower, are drawn and divided into the same number of equal parts as the chart. In numbering these radii, care must be taken in locating the zero point for each cam, which lies at the respective point of contact of cam and follower. Going out from the base circle, the distances of the chart are stepped off on the corresponding radii. As, however, the upper follower moves in circular arcs, it is evident that the distances must be laid off on arcs drawn from the various division points of the fulcrum circle with a radius equal to the lengths of the follower from fulcrum to point of contact. Connecting then the various points so found by a continuous line, the theoretical cam curve is obtained.

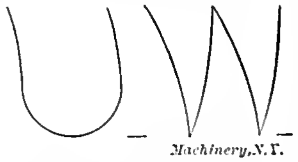


Fig. 2. The Letters as they would appear, owing to the Circular Movement of the Pencil, if the Cam controlling the Movement of the Paper were not corrected to prevent it.

If roller followers are used, the working curve is found by the usual process of reducing the contour an amount equal to the radius of the roller. In this case this applies to the upper cam only.

The working curve of the lower cam is identical with the theoretical, except for a correction due to the circular movement of the pencil, which would give the letters a distorted appearance, as shown in Fig. 2. It is therefore evident that,

if a straight line is to be drawn, the paper must be moved back and forth just enough to take up the arc formed by the pencil. The way to find the proper distance to be added is shown at *E*, where *a-b* is the height of the letters and arc *a-d-b* the path of the pencil. The divisions are the numbers of the radii over which the part of the letter extends. The chart shows that each stroke of the U, covers 10 radii, from 0 to 10 and 10 to 20, while the W requires 12 for each stroke, from 22 to 34, from 34 to 46, from 46 to 58 and from 58 to 70. Two constructions are therefore necessary. Adding now the distance between line *a-b* and arc *a-d-b* to the corresponding radius to the previously found curve, the rectified working outline of the cam is obtained.

To produce the break between the letters, a little metal strip at the bottom of the upper cam, presses the upper follower down at the proper moment and thus lifts the pencil off the paper. The same principle is applied for the return stroke. As soon as the last part of the W is formed, at radius 70, as the chart shows, the pencil is lifted and goes to the bottom line from radius 70 to 75. At radius 75 the metal strip is interrupted and the pencil drops down and forms the dash behind the W from radius 75 to 76, where the lower cam dwells from 76 to 77 to give the pencil time to rise and thus insure a sharp line to the finish. The same process is repeated for the dash behind the U, where the dwell extends from 88 to 89.

As a suggestion, it might be said that it is advantageous to use a fairly large construction and also to avoid letters where straight lines appear, as far as possible, as this would facilitate the work considerably by permitting the use of uniform motion curves throughout and thus doing away with the correction mentioned before. This correction might also be avoided by the introduction of some mechanical device for converting the arc formed by the pencil into a straight line, as for instance Watts straight line motion, or other contrivances.
A. E. SCHULZ.

Chicago, Ill.

TO HARDEN HACK-SAW BLADES IN QUANTITIES.

In the How and Why page of the August issue, H. G. asks for information concerning the way in which hack-saw blades are hardened in large quantities. Blades may be hardened in quantities by using cast iron boxes of the style shown in Fig. 1, in which to heat them. The boxes should be large enough to accommodate about three dozen blades placed on edge with the back down. A little charcoal should be used at the sides to keep the teeth of the outside blades from coming in contact with the sides of the box. The blades are then placed in the muffle of a furnace and allowed to remain until they have reached the proper temperature for hardening. They can then be removed with a pair of tongs made to fit the shanks on the ends of the boxes. The blades should then be carefully dumped on the inclined chute of a linseed oil bath which is shown in Fig. 2. The tank containing the oil is placed inside a wooden tank which is filled with water which keeps the oil from getting overheated. Water is supplied through pipe *A*, and strikes directly on the lower side of the chute down which the blades slide on their way to the bottom where they collect in a wire or perforated sheet metal basket *B*. An overflow pipe *C* is placed at one end of the water tank to carry off the warm water which rises to the top. The oil tank should rest upon legs several inches long, so as to raise it above the bottom of water tank to allow a free circulation of the water. When the blades are fairly cooled off, the basket containing them can be removed from the oil and allowed to drip over the tank until most of the oil has left the blades; they can then be thoroughly cleaned by being immersed in a soda kettle or by placing them in clean sawdust. Flexible blades are treated differently, they being hardened on the teeth only. A fixture of the style shown in Fig. 3 is used for this method of hardening. The blades are placed, back down, between two power-driven rolls *A* which rotate in different directions, and which feed the blades, by friction, between two guides *B* and past the flame from a gas torch which heats the teeth sufficiently for hardening. A compressed air jet strikes the hot teeth immediately after they pass the torch. The temper does not have to be drawn on blades hardened by either process, except at the ends, which is usually done with a torch.

Plainfield, N. J. JAMES CRAN.

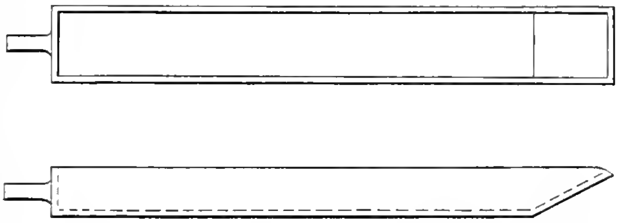


Fig. 1. Cast Iron Box in which Blades are Packed and Heated.

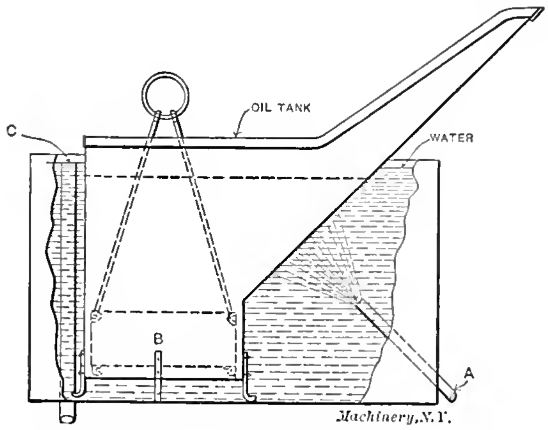


Fig. 2. Oil Tank for Hardening Hack-saw Blades.

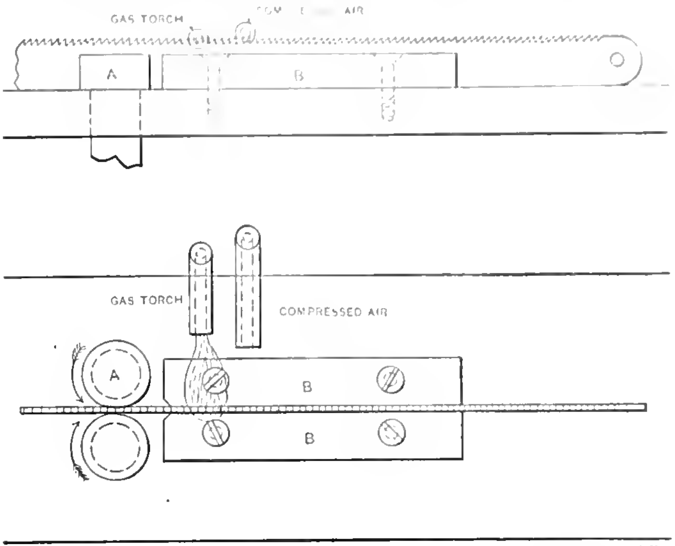


Fig. 3. Method of Hardening Flexible Hack-saw Blades

RACK CUTTING ON THE SHAPER.

We recently had occasion to cut a rack for a mandrel press which was in process of construction in our shops for our own use. As we desired to complete the machine with the facilities at hand, it was somewhat of a question as to what method would be used for spacing the teeth of the rack, which was to be cut in the shaper, a Lodge & Davis machine about twenty years old but still in good repair. The first suggestion was to clamp a finished rack, of the same pitch, in the vise with the rack to be cut, and set the tool for each cut by see-sawing the table back and forth until the tool dropped easily into the finished rack, which would give the proper spacing. The plan was abandoned for several reasons, among which was the fact that we did not have an 8-pitch finished rack to use in this way. Furthermore, the rack was to be cut in a round piece, about three inches in diameter, which had been shaped down flat for a part of its length, as shown in Fig. 1. In addition to this, its shape rendered clamping a finished rack with it somewhat difficult, and as the piece was in position to cut the teeth after shaping, it would have to be reset. The following plan was then adopted:

The diametral pitch of the rack being 8, its circular pitch is $\frac{\pi}{8} = 0.3927$ inch, and this is the amount the table has to be moved for each cut. The number of threads per inch of feed-screw was found to be 4, therefore its pitch is 1/4 inch = 0.25

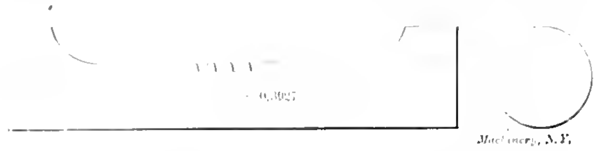


Fig. 1. Mandrel Press Rack to be Cut in the Shaper.

inch, or for one turn of the feed-screw the table is moved 0.25 inch. To move the table a distance equal to the pitch will require $\frac{0.3927}{0.25} = 1.5708$ turns of the feed-screw. The decimal part of this number, or 0.5708 is almost equal to 4/7, so that 1 4/7 turns of the feed-screw moves the table a distance equal to 1 4/7 × 0.25 inch = 0.3927 inch, approximately, which is the proper spacing.

In the practical operation of this scheme, in order to get the fractional part of a turn desired, the index plate and worm-crank from the milling machine were brought into use and placed as shown in Fig. 2. The pawl and ratchet feed of the shaper were removed, and the index plate *A*, with a 49-hole circle, was clamped in its place, a shouldered bushing being used to make the fit and keep the index plate concentric with the feed-screw. The worm-crank *B* was then fastened to the rod *C* with a screw, and this rod clamped to the saddle by a thumb-screw, not shown. The fraction 4/7 = 28/49, and for spacing the 28 holes, a piece of wire *D*, of a proper diameter to fit loosely in the holes of the index plate, was bent at the ends to such a length as to span 26 spaces on the 49-hole circle, leaving the other two holes of the 28 open to receive the pin of the worm-crank, one hole at each end of the wire. The work was then spaced just as the teeth are spaced in the milling machine, and was found accurate. When the feed-screw shaft is too large for the hole in the index plate, the latter may be mounted on the back end of the screw where the nut is placed to take up lost motion.

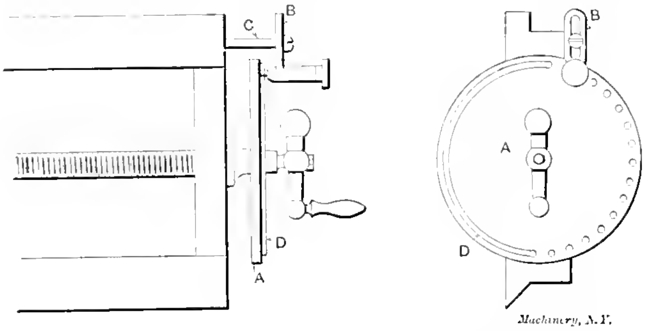


Fig. 2. The Index Plate attached to the Shaper.

TABLE GIVING NUMBER OF TURNS OF FEED-SCREW FOR INDEXING A GIVEN PITCH.

Pitch of Rack.		Pitch of Thread on Feed-screw.									
		1/3"		1/4"		1/5"		1/6"		1/8"	
Diametral.	Circular.	Turns.	Error.	Turns.	Error.	Turns.	Error.	Turns.	Error.	Turns.	Error
3	1.0472	$3\frac{7}{49}$	+4	$4\frac{7}{37}$	+1	$5\frac{4}{17}$	−2	$6\frac{11}{39}$	−2	$8\frac{14}{37}$	+1
4	0.7854	$2\frac{11}{31}$	−4	$3\frac{7}{49}$	+3	$3\frac{38}{41}$	0	$4\frac{35}{49}$	+3	$6\frac{11}{39}$	−1
5	0.6283	$1\frac{38}{43}$	−4	$2\frac{20}{39}$	−1	$3\frac{7}{49}$	+3	$3\frac{30}{39}$	−1	$5\frac{1}{37}$	+1
6	0.5236	$1\frac{28}{49}$	+2	$2\frac{2}{21}$	+2	$2\frac{29}{47}$	−2	$3\frac{7}{49}$	+2	$4\frac{7}{37}$	0
7	0.4488	$1\frac{17}{49}$	+3	$1\frac{31}{39}$	−1	$2\frac{10}{41}$	0	$2\frac{27}{39}$	−1	$3\frac{23}{39}$	−1
8	0.3927	$1\frac{7}{39}$	+5	$1\frac{28}{49}$	+2	$1\frac{26}{27}$	−1	$2\frac{11}{31}$	−2	$3\frac{7}{49}$	+1
9	0.3491	$1\frac{1}{21}$	+1	$1\frac{17}{43}$	−3	$1\frac{35}{47}$	−2	$2\frac{2}{21}$	+1	$2\frac{23}{29}$	0
10	0.3142	$\frac{16}{17}$	−5	$1\frac{10}{39}$	−1	$1\frac{28}{49}$	+1	$1\frac{38}{43}$	−2	$2\frac{19}{37}$	0
11	0.2856	$\frac{42}{49}$	+1	$1\frac{7}{49}$	+1	$1\frac{21}{49}$	+1	$1\frac{35}{49}$	+1	$2\frac{14}{49}$	+1
12	0.2618	$\frac{29}{37}$	−5	$1\frac{1}{21}$	+1	$1\frac{12}{39}$	−3	$1\frac{28}{49}$	+1	$2\frac{2}{21}$	+1
14	0.2244	$\frac{33}{49}$	+1	$\frac{44}{49}$	+1	$1\frac{5}{41}$	0	$1\frac{17}{49}$	+1	$1\frac{31}{39}$	0
16	0.1964	$\frac{23}{39}$	+2	$\frac{37}{47}$	+4	$\frac{48}{49}$	−5	$1\frac{7}{39}$	+2	$1\frac{28}{49}$	0
18	0.1745	$\frac{11}{21}$	+1	$\frac{30}{43}$	−1	$\frac{41}{47}$	0	$1\frac{1}{21}$	+1	$1\frac{17}{43}$	−1
20	0.1571	$\frac{8}{17}$	−2	$\frac{27}{43}$	−1	$\frac{37}{47}$	+3	$\frac{16}{17}$	−2	$1\frac{10}{39}$	0

As the method has a wide application for spacing equal divisions, the accompanying table was prepared to apply to racks up to 20 diametral pitch, and for a number of different pitches of feed-screw.

Thus, to space a 9-pitch rack on a shaper having a feed-screw with 6 threads per inch, we find from the table that it requires 2 2/21 turns, which will be accomplished with the index plate having a 21-hole circle, taking two full turns + 2 holes on the 21-hole circle. The errors tabulated in the table are in ten-thousandths of an inch for each space, the sign showing whether the space thus given is too great or too small. Thus, an error −1 shows each space to be 0.0001 inch too short. The total error in a rack of 100 teeth would then be but 1/100 inch, which is negligible for most work. However, the errors are all tabulated, that none may fall into error by using the approximations here given. If it is desired to use this method to cut a rack to work with a gear, the pitch of which is given in *circular* measure, the spacing may be done as follows. Suppose the pitch of pinion to be 13/16 inch, and the feed-screw has 5 threads per inch: 13/16 inch = 0.8125 inch, and one turn of the screw moves the table 1/5 inch = 0.2 inch. The turns required are therefore $\frac{0.8125}{0.2} = 4.0625$ = 4 1/16 turns, which will be made by using the circle with 16 holes.

W. L. BENITZ.

Notre Dame, Ind.

GRAPHICAL DETERMINATION OF THE CROSS-ROLL CURVE.

In the December, 1907, issue of MACHINERY was given a mathematical derivation of the cross-roll curve. In the July, 1908, issue was given a graphical method which, however, seems rather awkward and cumbersome. The following graphical methods will be found far more convenient. Lay out in two views the axis of the cross roll and the center line of the pipe, as shown in Fig. 1. Intersect both projections by several parallel planes, all perpendicular to the axis of the roll. The sections of the pipe will all be ellipses; the corresponding sections of the roll must be circles tangent to these ellipses. The radii of these circles may be set off from the axis of the cross-roll in their respective planes, and the form of the cross-roll curve thereby determined.

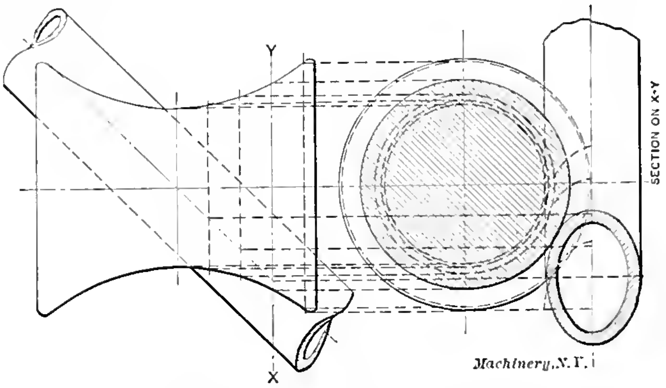


Fig. 1. Graphical Method of Laying Out Cross-roll Curve.

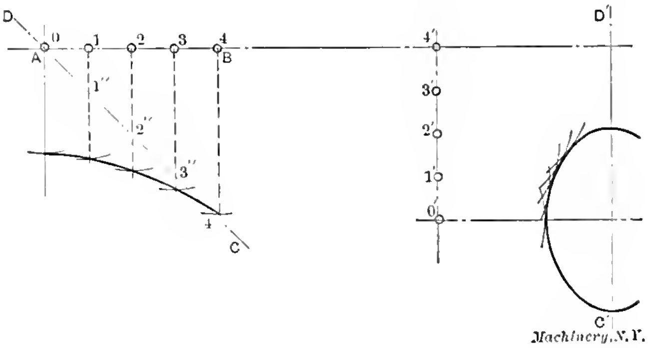


Fig. 2. Method in Fig. 1 Simplified.

The amount of work required for this construction may be reduced, and the accuracy of the construction increased, by arranging the sections so that all the sections of the pipe coincide, noting, of course, the corresponding change in position of the axis of the roll in each case. Such a construction is shown in Fig. 2. When this method is used the ellipse need be drawn but once. The line *AB* represents the axis of the cross-roll, and the line *CD* the center line of the pipe. The ellipse is the section of the pipe intersected by a plane perpendicular to the axis of the roll at 4.

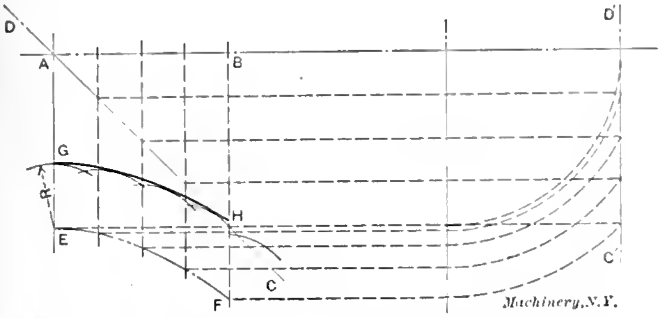


Fig. 3. Another Graphical Method for Laying Out the Cross-roll Curve.

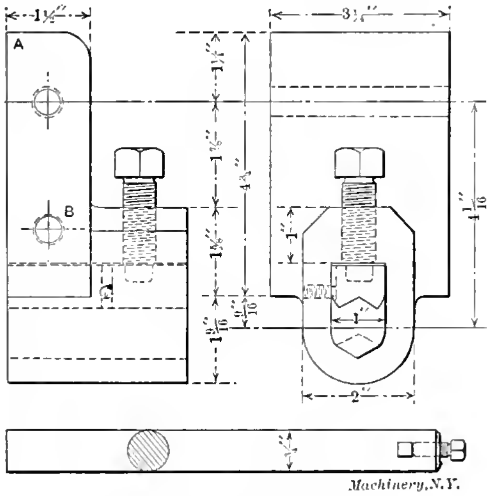
Radii of arcs tangent to the ellipse having centers at 0', 1', 2', 3', and 4' are laid off from 0, 1, 2, 3, 4 upon lines at right angles to *AB*. These radii determine the shape of the curve. The points 0', 1', 2', 3', 4' are so located that the distance 0'1' = 1''1, 0'2' = 2''2, etc.

The construction shown in Fig. 3 is based on the fact that if the pipe were of zero diameter, the cross-roll would be in hyperboloid of revolution generated by the revolution of the center line *CD* about the axis *AB*. The curve *EF* for this hyperboloid is determined as shown. For a pipe of given diameter the form of the cross-roll is a curve parallel to the curve of this hyperboloid, and at a distance inside of it equal to the radius *R* of the pipe. The curve *GH* is therefore the required cross-roll curve. E. H. WOOD.

Ithaca, N. Y.

EXTENSION TOOL HOLDER.

The extension tool holder for the shaper, which is shown in the engraving, is extremely convenient and useful, and can be made at small cost. The one shown is for a 16-inch shaper, and will hold cutter bars from 1 inch down to ⅜ inch in diameter. The holder is fitted into the clapper box, and takes the place of the clapper. When putting it in, it is necessary to drive out the taper pin and remove the clapper, then when the holder is in place and the pin driven in again, the upper square corner at *A* prevents its turning and makes a solid fixture of it. The opening for holding the cutter bar is low enough so that the bar can be extended backward under the tool head, which enables the length of the working part of the bar to be changed to any length desired. With this arrangement there is no "blocking down" of the tool, no tool-post to interfere, and the bar can be rotated so as to bring the cutter into any position. I have found it to be an advantage in doing work with an extension tool of this kind to reverse the position of the cutter, so that it will take a draw cut. If used in this way, there should be an additional taper pin put through in some such position as *B*, so as to make it more rigid for the draw cut. As the ordinary shaper head is not very strong for draw cutting, great care must be exercised when using it this way. The tool cuts smoother, however, and is not nearly so likely to "hog in"; the lines on the work are in front, and it is altogether a more satisfactory way to work. W. A. KNIGHT.



Extension Tool Holder for the Shaper.

Columbus, O.

GAS ENGINE VALVES.

The accompanying engravings illustrate the method used by one of the most progressive automobile concerns in the East, of making gas engine valves. The stock is first taken in bar form and blocked down under a trip hammer; then it is reheated and finished, as shown in Fig. 1, with one heat between dies *A* and *B*, Fig. 2. These dies produce a finished head and stem, to forging dimensions, also a screw-driver slot and center impression. *A* is the body of the top die; *C* is the inserted center die which contains the centering plug *F* and blades *E*, and the screw *D* which forms a backing for the plug *F*; hole *O* in *A* is to facilitate easy removal of *C* for renewal of center plug *F* and blades *E*. These blades form the screw-driver slot *G* in the valve head, as shown in Fig. 1. The dies were designed with the idea of doing away with two operations; milling the screw-driver slot, and center punching the head end of the valve, also for making it an easy matter to center the head end for turning in the lathe. The slot is used to drive or rotate the valve when grinding in the seat after cylinder and valve have been machined.

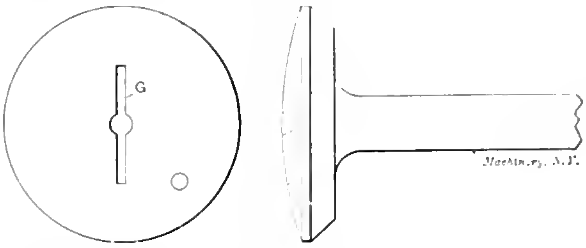


Fig. 1. Gas Engine Valve which is formed by the Dies shown in Fig. 2.

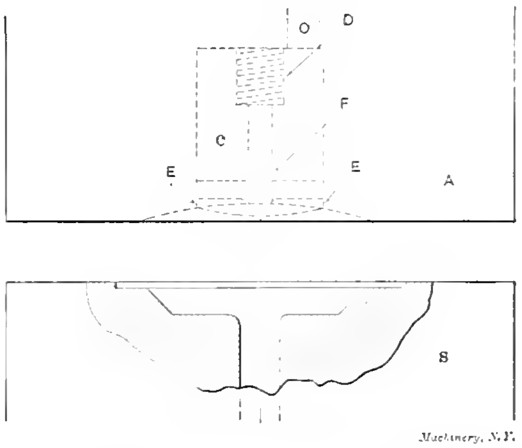


Fig. 2. The Upper and Lower Dies for Forming the Valve Head and Stem.

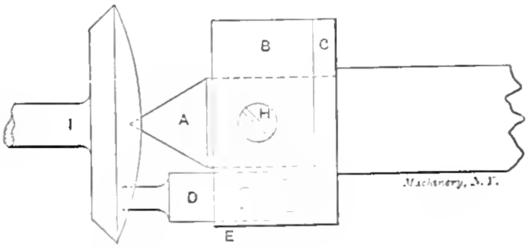


Fig. 3. Method of Driving the Valve when Turning.

In Fig. 3 is shown the driving head for turning. *A* is the center which fits the lathe spindle and *B* and *C* are two rings or collars which are an easy fit on the straight portion of *A*.

D is the driver which fits into a part round and part elongated hole in *B*, and is kept in place by pin *E*. The large diameter of *D* is a little smaller than the elongated hole in *B*, so that it will have a radial motion to allow for any variation between the center and the driving hole in the valve. There is some variation in the distances of these holes owing to the oval surface of the valve which causes the drill to crawl a little. The screw *H* holds the rig firmly in place, a flat being milled on *A* which it seats against. In Fig. 4 are shown elevations of the jig used for drilling the driving hole. *A* is the body of jig, *C* the bushed drill hole, and *B* the clamping screw with a 60 degree point which locates and clamps the valve in position while the drive hole is being drilled.

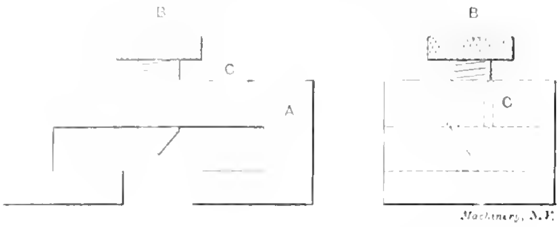
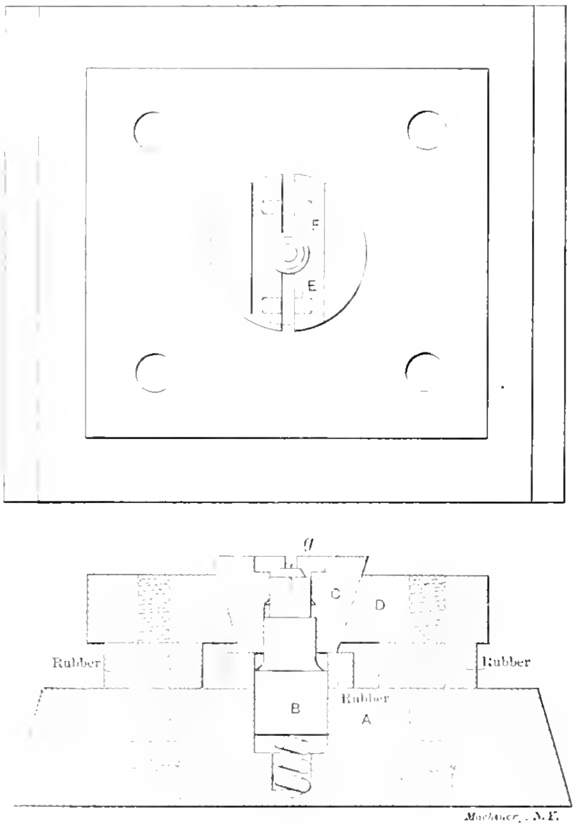


Fig. 4. Jig used for Drilling Holes for Driver.

E. S. Wheeler.

DIE FOR COUNTER-SINKING HOLES IN CORNER IRONS.

In the engraving is shown a die used for counter-sinking holes, previously pierced, in corner irons of five different sizes: 5/8, 3/4, 7/8, 1, and 1 1/8 inch inside, and 3/32 and 1/8 inch thickness. The work is done by this device much quicker than it can be done in a drill press. The work is placed in the groove in the part *C*, shown in the sectional view, and the plunger *B*, which has a sliding fit in the base-plate *A*, counter-sinks the metal around the holes in the work, by being pressed into it. The bevel on the point of this plunger *B* is made the same as the angle of the screw-head to be used for the corner irons, but the distance *g* is somewhat less than the thickness of the stock, so that the point will not project through the stock and strike the punch. The punch used is simply a flat-bottomed plunger, 2 inches square, having a perfectly smooth bottom surface, and hardened.



Die for Counter-sinking Holes in Corner Irons.

The sleeve *C* is made in five different sizes, one for each size of corner iron, and is turned tapered on the outside to fit into the holder *D*. The sleeve *C* is split, and after being split is drawn to a purple and hardened. There are two holes in each of the halves of the sleeve *C*, at *E* and *F*, as shown in the plan view. These holes contain springs which hold the two parts of the sleeve apart, so as to admit the stock. When the stock is placed in the groove in sleeve *C*, it is located by the point of the counter-sink *B*, and, as the punch descends, it first forces the sleeve *C* into the holder *D*, thus clamping the stock and preventing it from bending. The annular rings, shown under both *D* and *C*, are rubber pads, permitting a springing action, as soon as the stock is firmly held in sleeve *C*.

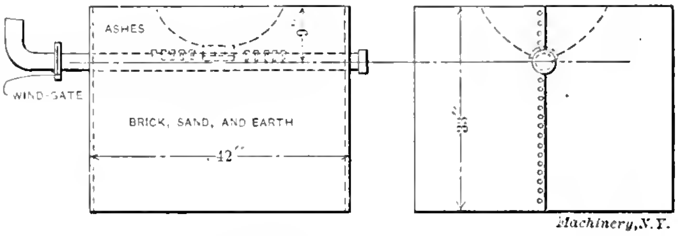
The spring under the plunger *B* holds it up against the work, and makes it possible for the point to locate the hole in the work before the punch has descended far enough to force it into the work, forming a counter-sunk hole. Plunger *B* should be left as hard as possible, because it is subject to considerable wear.

S. S. Hart.

Aurora, Ill.

A CHEAP HOME-MADE FORGE.

To make a cheap forge, a cylinder is first made about 3 feet 6 inches in diameter and about 2 feet 9 inches high, from 1/8-inch sheet steel, as shown in the engraving. Then two holes are cut in this cylinder opposite each other about 9 inches from the top edge. These holes should be large enough to allow a 2½ or 3-inch common steam pipe to pass through freely. For a forge intended for heavy forging, a 3-inch pipe is to be preferred. The pipe should be long enough to pass through the cylinder and extend about 2 inches outside on one side, and 6 or 8 inches on the other side of the cylinder. The end of the pipe that extends out about 2 inches should be threaded, and a cap should be screwed on this end in such a way that it can be removed or put on by hand. A wind gate is now put on the other end of the pipe, and this is then attached to the blast pipe. After having laid the pipe in place temporarily, a 1¾-inch hole is drilled into the pipe on one side, and on each side of this hole three ¾-inch holes, followed by two ⅝-inch holes, about 3 inches apart, are drilled. A piece of steel, one inch thick, about 4 or 5 inches wide, and long enough so that it will go at least one-third around the pipe, is now made. In the center of this piece a 1¾-inch hole is drilled, and the piece is bent so that it will fit the outside of the pipe. This piece is placed directly over the 1¾-inch hole in the pipe, being attached with some fire clay. It serves the purpose of prolonging the life of the pipe, and keeps the pipe from burning out at the hole. After the forge constructed in this manner is leveled up, broken brick, sand, dirt and cinders are dumped in and packed firmly up to the lower side of the pipe. One-half inch bolts or rivets, about 1½ inch long, are put in the small holes, and then the remaining part of the cylinder is filled up with cinders and packed firmly, space being left to form a pit for the fire. The forge is now ready for use.



Serviceable and Inexpensive Forge.

The advantages of this forge are: It is possible to make a large or small fire, according to the requirements; if a long fire is required one can pick out enough of the cinders and take out the bolts or rivets mentioned; the length of the fire can be adjusted to the requirements by taking out more or less bolts; there is no brick or fire clay lining to be set before the forge can be used. The writer has built several of these forges in various shops, and they give the best of satisfaction. The forge will work well until the pipe rusts

out, and then another pipe is made and put in place at very small expense, and very little loss of time.

When the fire gets dirty, use the poker and poke the dirt down through the hole. Take off the cap at the end of the pipe and open the wind gate and blow out the cinders inside of the pipe. It takes no more than two minutes to clean a fire in one of these forges. The writer prefers this forge to any other as the most serviceable and inexpensive one to use on any class of work. It is adapted to a great variety of forging. The writer has made big blanking dies, welded 8-inch diameter shafts, and put ¼-inch links in chains, on the same forge. **Geo. T. Coles.**

Decatur, Ill.

ON OBTAINING APPROXIMATE FRACTIONS.

Referring to the article contributed by me on the subject "How to Obtain Approximate Fractions by the Method of Continued Fractions," which was published in the August issue of Machinery, I would say that before trying to obtain the approximate fractions of a fraction, one should first attempt to factor said fraction. In the selection of 729/1,000, as shown in the article, it was resolved into approximate fractions to serve as an illustration of how the work was done, yet it might have been factored thus: 729/1,000 = 81/100 × 9/10. Retaining the 81/100 and raising the 9/10, for instance, to 36/40, we should then have 81/100 and 36/40 as fractions indicating gears that might be used, and which would give the required lead exactly.

Providence, R. I. **Mitchell Dawes.**

SPECIAL BORING-BAR.

A special boring-bar for use in either lathes or horizontal boring mills is illustrated in Fig. 1. This bar is adapted for boring taper holes or cutting grooves in bearings, as well as for other classes of work that it is profitable to do with a single-ended cutter. The bar is made of ordinary machine steel, and has a taper shank to suit the spindle of the boring mill. Length *A* is made twice the length of the hole that is to be bored and is chased 16 threads per inch the full length. Collar *C* is made of machine steel, threaded to suit bar, and case-hardened so as not to allow it to cut where it comes into contact with the steel bevel key *E*. This key is case-hardened, and is made the exact bevel of half the difference of the diameters of the two ends of the taper hole to be bored, and is a sliding fit in a ¾-inch keyway. The key should be not less than 1 inch longer than the length of the hole which is to be bored, so as to allow for starting the ½-inch square tool, which is held in collar *F* by a slotted set-screw *G*. The tool is a sliding fit in a square hole in the collar and the collar is shrunk on the bar.

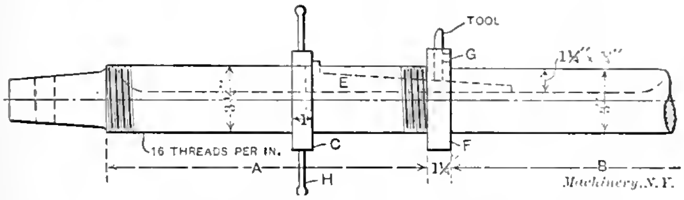


Fig. 1. Special Boring-bar for Taper Boring or Groove Cutting

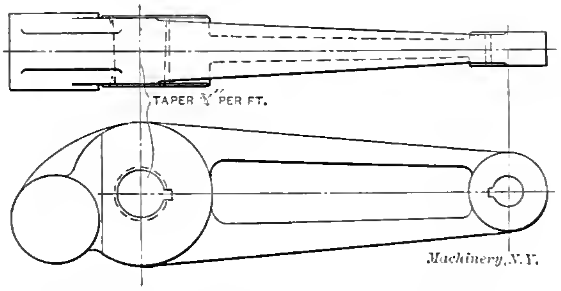


Fig. 2. Example of Taper Boring done with the Bar.

In operating the bar, the boring mill is geared to cut 16 threads per inch, and the tool set to the amount of cut desired to be taken. A parallel strip is then clamped to the table, upon which one of the four handles *H* is rested. When the machine is started the threaded collar *C* is forced to travel on the bar and as the bevel key *E* moves inward the tool is fed into the cut, the result being a taper hole the exact taper of the key. As long as the key is retained the hole can be duplicated exactly, and there need be no fear of its not fitting the same as the original, which is very often the case. The feed of 16 to the inch would leave a rather rough finish, but this is easily overcome by using a broad nose finishing tool.

When desiring to cut a groove, a tool is inserted in the collar *F* the exact shape of groove to be cut, and the bar is revolved in a stationary position. The collar *C* is then turned by the handles *H* so that the taper key forces the tool into the cut, and when the required depth is reached, set-screw *G* is slacked off and the tool drops back into the slot; the bar can then be removed. The four handles *H*, which are tapped into the threaded collar *C*, give a momentum to the collar which facilitates removing the taper key *E* after each cut, thereby saving much time. It is only necessary to make the length *B* of the bar long enough to reach the yoke of the boring mill. On the lathe, the bar is used practically the same as on the boring mill with the exception that the work moves instead of the bar. The bar is especially adapted to performing work on castings too large to swing in the lathe or vertical mill. It proved to be very economical for finishing twelve cast steel levers similar to the one shown in Fig 2, which were too long for any lathe or vertical boring mill to swing, in the shop where the bar was made. Fig. 3 shows a plan of a large thrust bearing which has thrust grooves. The bar was very useful in cutting these grooves, which were required to have a fine finish and be very accurate. This would have been a very difficult job to do with the ordinary boring-bar. This bar can be put to various other uses, and, owing to its simple construction, is quite inexpensive. It can, of course, be made in various sizes to suit very small as well as large work. **R. S. F.**

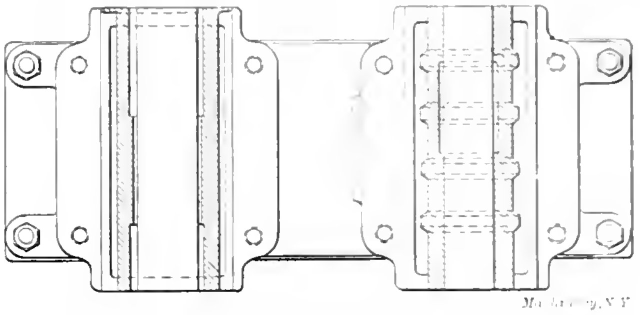


Fig. 3. Plan of Thrust Bearing showing Thrust Grooves cut by the Bar

AN ADVANTAGE OF IGNORANCE.

A variation of Billy's experience related in the May issue may be worth while telling. A farmer who needed a few repairs done on some of his implements, requested a local repair man to permit him to use a drill press, himself, in order to save time on his own work. Permission being granted, some smart Jimmy, as usual, crossed the belt, but the farmer, not being as nearsighted as poor old Bill, promptly reground the drill to suit the drill press. Needless to mention, the Jimmy figuring in this case was dumbfounded, and attended unusually well to his own business for the balance of the day, excepting, of course, that he spent some time trying to find out "how it was done." **Alfred N. Hammond.**

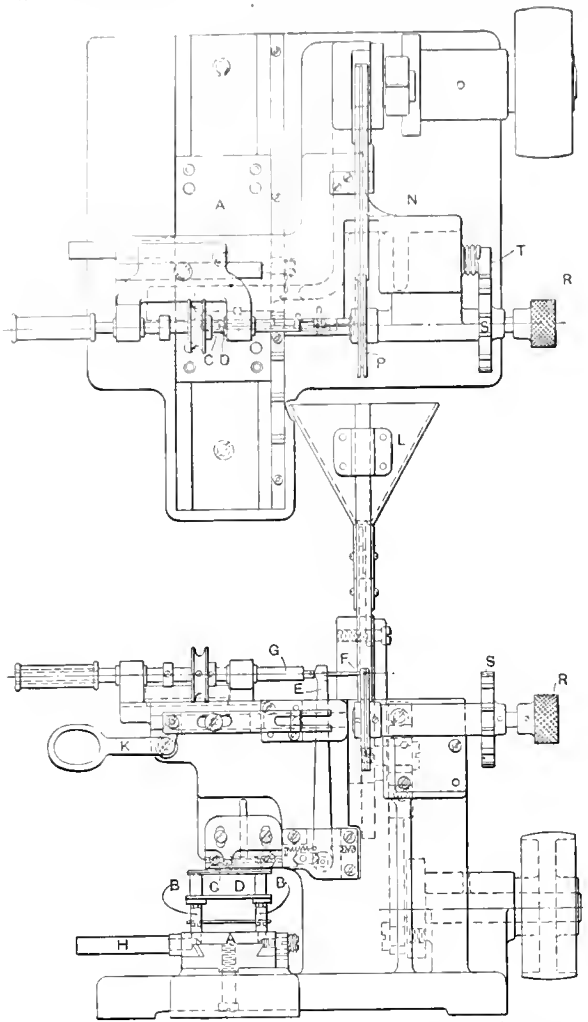
Erie, Pa.

SEMI-AUTOMATIC REAMING MACHINE.

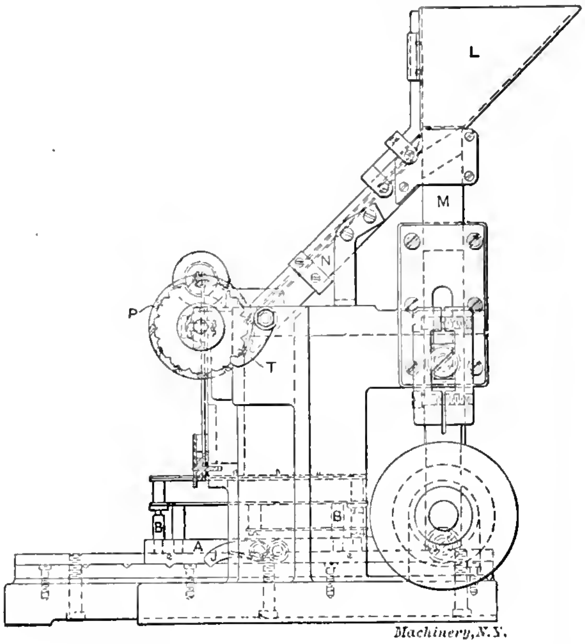
The accompanying illustration represents a small bench machine, designed for reaming holes in the pointers used on an electric meter. These holes are tapered 0.01 inch per inch, and are forced onto taper shafts after the latter are assembled in the register. The taper shafts vary in diameter so that it is necessary to ream each pointer to fit the shaft on which it is to be used. The usual method of fitting these is to use, when assembling, a hand reamer with which the pointers are reamed until they fit the shaft at the proper dis-

tance from the end. This method requires a great deal of reaming and fitting, and thus is not very satisfactory where a large production is required.

It will be observed that the device here illustrated is fitted with a slide *A* on which pins *B* are provided to hold the register, after the latter has been assembled with the pointer shafts and is ready to be fitted with the pointers. Directly above slide *A*, and in line with the pointer shafts, are located two gage points *C* and *D*, one fixed, and one movable, the latter operating a lever or indicator *E* on the same principle as a multiple gage. The upper end of the indicator *E* is split, forming a fork which straddles the taper reamer *F* thus forming a stop for spindle *G* as shown in the front elevation. Slide *A*, which carries the register, is operated by handle *H*, and the pointer shafts are stopped in alignment with the gage points by means of a pawl *J* which engages with the four notches as shown. Spindle *G* slides in its bearings, and is driven by a small grooved pulley. The back end of the spindle is provided with a spool by means of which the spindle is operated back and forth. Lever *K* operates a friction clamp, which in turn locks the indicator *E*, thus forming a positive stop for the spindle. It will be noticed that this machine is provided with a magazine feed, by means of which the pointers are automatically carried in position to be reamed. The method of accomplishing this will be readily seen. Hopper *L* forms a receptacle for the pointers. Plunger *M*, which is operated up and down through the center of the hopper, is slotted in the end so as to pick up the pointers and carry them down in the proper position to drop into the magazine *N*, from which they are conveyed to the revolving chuck *P*. The magazine and chuck are so constructed as to prevent the work from entering in any but the right way. The chuck has twelve slots to receive the work, and is indexed by means of handle *R*. The index plate *S* is fastened to the same shaft as the chuck, and locates the work in alignment with the spindle by means of the pawl *T*. A small pulley drives a crank, which in turn operates the plunger *M*.



Machinery, N.Y.



Machinery, N.Y.

Elevations and Plan of the Semi-automatic Reaming Machine.

As before stated, the size of the reamed hole is governed directly by the size of the taper shaft, the idea being to remove the pointers from the chuck as fast as they are reamed, and place them on the shaft for which they were gaged. In setting up this machine for the operator, it is necessary to adjust the taper reamer to the proper depth. The register is first placed on the slide *A*, the latter is then brought forward until pawl *J* engages the first notch as shown in the side elevation, thus bringing the first pointer shaft between the gage points *C* and *D*. This operation causes the indicator *E* to assume a vertical position, which is not very important, although it should stand about vertical. The indicator is then locked by means of the lever *K* and friction clamp, as formerly described. It is then in position to stop the spindle. The reamer has a straight shank, and is held in the spindle *G* by a small set-screw by means of which it is adjusted to the proper length. The simplest way of doing this is to set the tool out gradually, trying the pointer on the shaft each time until it fits at the proper distance from the end. When it is set for one, the rest are bound to come right for the reason that the ratio of the indicator arms is such as to correspond with the taper per inch, which in this case is one-hundredth inch.

F. H. Halstead.

Gt. Barrington, Mass.

THE EFFECT OF ROLLED BELTING ON ITS APPLICATION.

Perhaps the method adopted by the manufacturers, of rolling up leather belting, has been discussed in the columns of Machinery, but if it has not, we wish to call attention to a fault of the present practice. This fault has been forcibly brought to our attention lately while equipping our new machine shop. Obviously, belting should be rolled just opposite to the way it is now rolled if we are to apply the belting with the hair side next to the pulleys. It is the verdict of all good mechanics that belts wear best applied in this way, but belting is universally rolled with the smooth or hair side on the outside. This gives the belting a natural set or curve which is a great inducement to the mechanic to apply it to the pulley in the same way. Why do not the manufacturers roll belting the way it should go when in use?

G. R. Lang,
G. R. Lang Co.

Meadville, Pa.

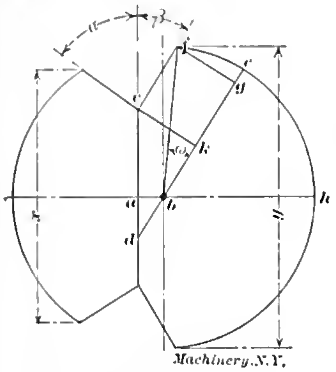
[The point made by our correspondent is important, and is one that should be taken into consideration by belting manufacturers, generally. Obviously a roll of belting looks best when made up with the smooth or hair side out, but as our correspondent says, the belting acquires a set when rolled in this direction that is hard to overcome when applied to pulleys with the hair side next to the pulleys, as it should be. Belting manufacturers who are desirous of having their belt-

ing applied so as to give the best results should give the matter their attention. Doubtless they will find that the mere matter of appearance is not nearly so important as convenience of application.—EDITOR.]

SIMPLE SOLUTION OF "A PROBLEM IN TRIGONOMETRY."

The following is a simple solution of "A Problem in Trigonometry," published in the How and Why section of the August issue of MACHINERY.

Let the given length $ac = A$; the given length $ab = B$; the given radius $= R$; and the given angles $= \alpha$ and β. Draw de parallel to cf, through the center of the circle; and ck and fg at right angles to de.



$$\text{Then } ad = \frac{B}{\tan\beta} \qquad (1)$$

$$cd = ad + A = A + \frac{B}{\tan\beta} \qquad (2)$$

$$fg = ck = cd \sin\beta = \sin\beta\left(A + \frac{B}{\tan\beta}\right) \qquad (3)$$

$$\frac{fg}{R} = \sin\omega = \frac{\sin\beta}{R}\left(A + \frac{B}{\tan\beta}\right) \qquad (4)$$

$$\text{Angle } fbh = 90^\circ - \beta + \omega \qquad (5)$$

$$y = 2\,R \sin fbh \qquad (6)$$

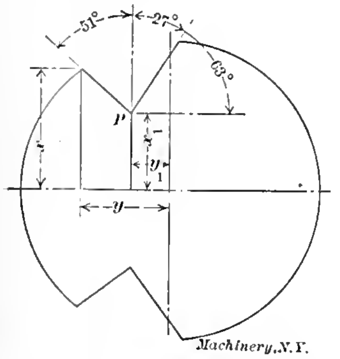
The length x is determined in the same manner. When the formula (4) has been obtained, this solution requires but three steps for finding the chord, although one step involves two divisions, one addition, and one multiplication.

Philadelphia, Pa. LOUIS J. SCHROEDER.

SOLVING "A PROBLEM IN TRIGONOMETRY" BY ANALYTICAL GEOMETRY.

The solution of S. S. Y.'s problem in the How and Why section of the August issue is an interesting practical exercise in trigonometry, but it may be solved more simply by analytical geometry. The object is to find the co-ordinates x and y of the points of intersection of the circle and the inclined lines passing through the point p.

The equation of a circle is $x^2 + y^2 = R^2$ if the origin of coordinates is at the center; and that of a line passing through a given point is $y - y_1 = a(x - x_1)$, in which $y_1 x_1$ are the coordinates of the given point, and a is the tangent of the angle the line makes with the axis of abscissas. Substituting known values in these equations, and combining them so as to eliminate y, we get the value of x, and *vice versa*. In the first of the two cases, the writer has changed the usual position of x and y, so as to get the angle 51° in the first quadrant, and thereby obtain a positive value of a.



The known values in the first case are: $R = 0.196$; $R^2 = 0.038416$; $x_1 = 0.1$; $y_1 = 0.03125$; $a = 1.2349$.

$$y - 0.03125 = 1.2349\ (x - 0.1)$$
$$y = 1.2349x - 0.09224$$
$$y^2 = 1.525x^2 - 0.2278x + 0.00851$$
$$R^2 = 2.525x^2 - 0.2278x + 0.00851$$
$$2.525x^2 - 0.2278x = 0.0299$$
$$x^2 - 0.0902x = 0.01185$$
$$x = 0.0451 + 0.1178 = 0.1629$$
$$2x = 0.3258$$

In the second case we put x and y in their usual position. We have given $a = tg\ 63^\circ = 1.9626$; $x_1 = -0.03125$; $y_1 = 0.1$.

$$y - 0.1 = 1.9626\ (x + 0.03125)$$
$$y = 1.9626x + 0.1613$$
$$x = 0.5094y - 0.0822$$
$$x^2 = 0.2595y^2 - 0.0837y + 0.0067$$
$$R^2 = 1.2595y^2 - 0.0837y + 0.0067$$
$$y^2 - 0.0665y = 0.0251$$
$$y = 0.19525$$
$$2y = 0.3905$$

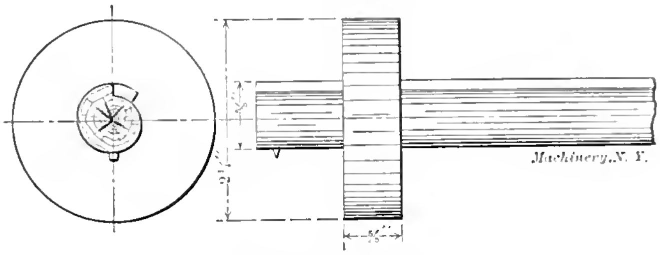
This is a good exercise for students in analytical geometry, and a test of the accuracy of their arithmetical work.

Syracuse, N. Y. WILLIAM KENT

[While the above solution may be more elegant than a trignometrical one, and seem preferable to the mathematician for that reason, it involves considerably more arithmetical work, and requires more time for working out than the trigonometrical solutions offered in the August issue and in the present number. From a practical point of view, therefore, and for practical purposes, it seems that the trigonometrical solutions are to be preferred.—EDITOR.]

PATTERNMAKERS' SCRATCH GAGE.

The illustration below shows a patternmaker's scratch gage. This scratch gage is constructed entirely of hardwood (black walnut preferred). The stick is made the full length in the shape of a cam, in a uniformly increasing involute curve. The hole in the guide is made of the same shape as the outside of the stick, but the curve is carried about 5/16 inch farther around, which makes it a little larger than the stick. Now, if the stick is slid into the guide, and then the guide revolved around the stick a quarter turn, it will clamp tightly. This makes a simple, neat, quick-adjusting tool for the patternmaker or carpenter. This gage is the invention of Mr. Ed. Therrian, of Two Harbors, Minn., and he has used it for years with great satisfaction. AUSTIN G. JOHNSON.



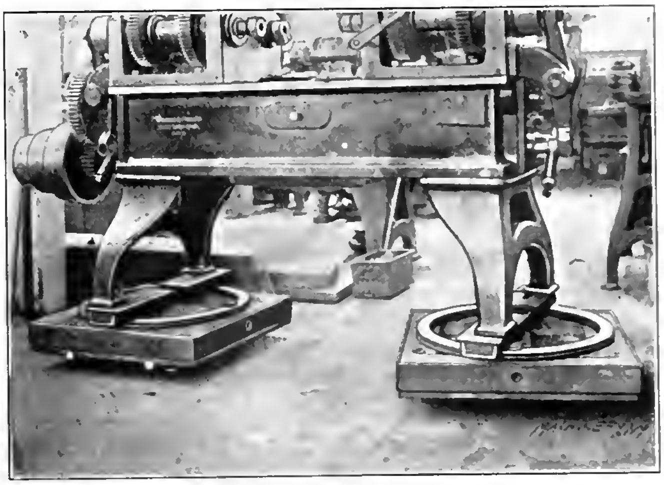
Quick-adjusting Scratch Gage.

Two Harbors, Minn.

* * *

TRUCKS FOR MOVING MACHINERY.

In the September issue of MACHINERY we published an article by Mr. Ethan Viall, under the above title, descriptive of a small truck used for moving machinery, heavy castings, etc., about the shop, together with a drawing giving its principal dimensions. The accompanying illustration gives an idea of the usefulness of a pair of these trucks in a shop. As the top of the truck platform is comparatively close to the floor, heavy tools can easily be placed upon them and moved from one place to another.



Machine Tool mounted on a Pair of Trucks.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

STAMPING TRACINGS.

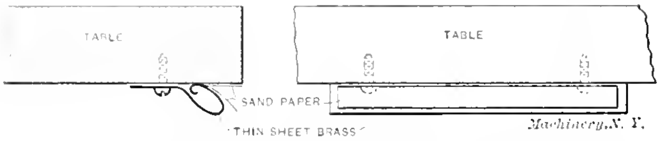
To stamp names or headings on tracing cloth, use a rubber stamp with the ordinary red, blue or green ink found in inking pads. Before the ink has a chance to dry, sprinkle lamp-black over it, using an insect powder sprayer for the purpose. When dry, brush off with a piece of chamois skin. Stamping done in this manner will be found light-proof.

Aurora, Ill. JOHN B. SPERRY.

PENCIL SHARPENER.

The accompanying engraving represents a pencil sharpener or pointer. As seen from the illustration, it consists of a piece of thin spring brass bent to the form shown and fastened under the table near the edge by two round-head wood screws. The sandpaper is held between the table and the brass spring. To sharpen the lead of the pencil, slip the point between the leaves of the sandpaper and move it back and forth. JOHN B. SPERRY.

Aurora, Ill.



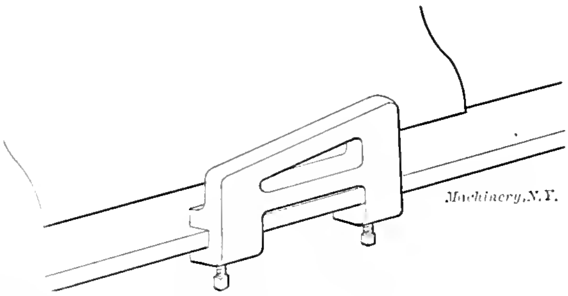
HARDENING DRILLS FOR DRILLING SPRING STEEL.

The difficulty of making a drill stand up when drilling spring steel is probably well known to all of the readers of MACHINERY who have had to do with this kind of work. The writer has been using the following method for hardening drills, with much success. A hole is drilled about ¼ inch deep in a piece of lead with the point of the drill to be hardened, care being taken that, when the drill is removed, the hole is not enlarged more than necessary to get the drill out. Then, the point of the drill is heated cherry red, and again placed in the hole and given a light blow with a hammer, and permitted to cool in the lead. It then will stand up much longer than otherwise. Turpentine is a good lubricant when drilling this kind of material. WILLIAM DAVIS.

Philadelphia, Pa.

HANDY ATTACHMENT FOR LATHES.

The accompanying illustration shows a handy attachment for lathes. The tapered slot in the casting holds the head of the set-screw in the dog when tightening it on stock. No machine work is necessary in the construction of this tool, save the drilling for two set-screws; and the device saves many steps when wrenches are scarce and hard to find.



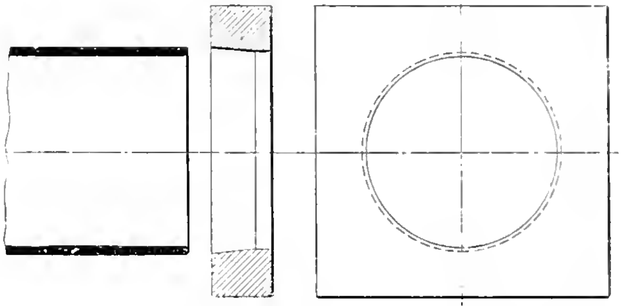
Middletown, N. Y. DONALD A. HAMPSON.

SAVING A TAP WARPED IN HARDENING.

The following method of saving a tap warped in hardening may be of special interest to those having to do with tools of this or similar description. The tap in question was of the expansion type, with a hole drilled longitudinally through its center, and reamed for a taper pin, which latter was used for expanding the tap. The total length of the tap was 20 inches, the diameter being 1¼ inch. A length of 4 inches in the center was threaded, leaving 8 inches on the one end for a guide and 8 inches on the other end for the shank. The tap was hardened, but when tried on its centers after hardening, it was found that it had warped and that there was not enough left on the shank and guide for grinding, so that the thread would run true with its guide bushings. To remedy this defect, a piece of brass was soldered onto each end of the tap, and after this was done, a piece of cast iron was chucked in the lathe and a hole bored and a thread cut to fit the tap, which was then screwed into this cast iron piece backwards, so that it would not cut its way through. The end which projected was then centered, the center being cut, of course, in the piece of brass fastened to it. When this was done the tap was screwed through the casting, the chuck was taken off and reversed, and the tap was screwed in from the back of the chuck, and the other end centered. The tap was now put on the new centers in the brass pieces and the threaded part, when tested, ran absolutely true. F. M.

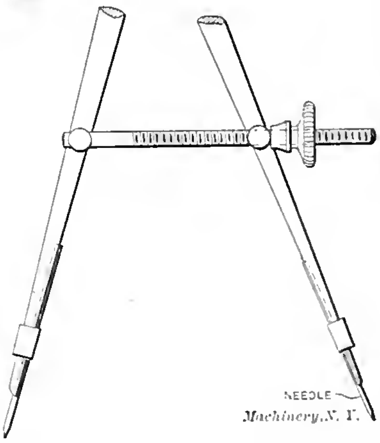
TIGHTENING A BUSHING FOR PAPER ROLLS.

To the left of the accompanying line engraving is shown the end of a brass bushing placed on rolls used in paper mills for feeding the paper through the machines. The rolls are about 2 feet in diameter and 10 feet long, and the brass bushing, which is about 3/8 inch thick, became loose on one roll. The following method of tightening it proved very satisfactory, and may be of interest to others. In order to diminish the size of the bushing so as to tighten it on the roll, a cast iron collar, shown to the right, was made, the smaller end of the taper hole bored in the collar being about 0.009 inch smaller than the outside diameter of the bushing on the roll. The brass bushing was next removed from the roll, and was forced through the collar, and then again pressed on the roll and turned true. E.



NEEDLES USED AS DIVIDER POINTS.

The engraving herewith shows the kind of divider points which I have on all my dividers and compasses. The inside of each divider leg is grooved about the depth of the diameter of an ordinary sewing needle, a needle is placed in the groove, and around the caliper leg and needle is fitted a band of brass. This band secures the needle to the leg as firmly as if they were one piece. This gives a hard, sharp, round point which can be thrown away when dull or broken. Die sinkers, tool-makers and machinists will find these the best divider points ever used. DIE MAKER.



[Sewing needles also make superior scribers for marking around templets on work requiring very exact duplication of outline and size. The points are much better than can be made by the average mechanic, being sharp, round, nicely tapered and of a fine temper. Of course, a suitable holder must be provided, but that is easy to make or buy.—EDITOR.]

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

CONSTANT-SPEED DRIVE FOR BROWN & SHARPE AUTOMATIC SCREW MACHINE.

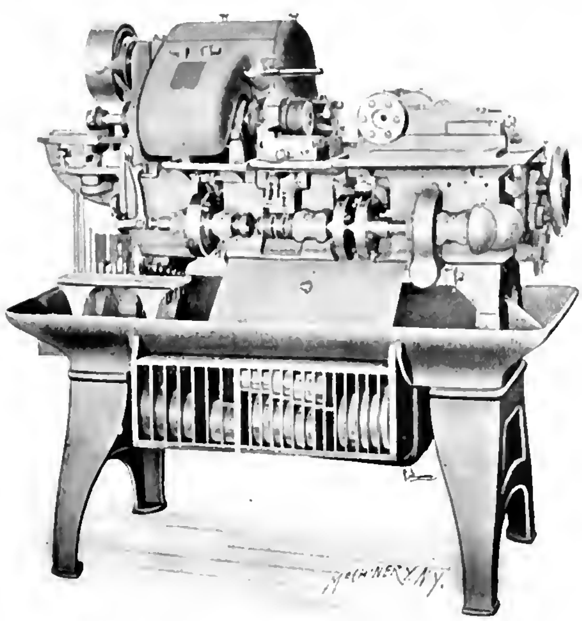


Fig. 1. Brown & Sharpe Automatic Screw Machine, Fitted with Geared Drive, Operated by a Single Conatant-speed Belt.

The automatic screw machine, of whatever design, has usually been driven from the counter-shaft by at least two belts, one for the spindle and the other for the feed mechanism, with sometimes a third for driving the oil pump. The counter-shaft also has usually been provided with two shafts, one of constant speed, receiving power from the line-shaft and driving the feed mechanism, and the other for the variable speed drive of the spindle, the two being connected by a belt over suitable cone pulleys. As a consequence of this complication, the ceiling of a screw-machine shop is completely covered with a mass of shafting, darkening the room, and causing trouble in the maintenance of the multitude of loose pulleys, hangers, clutches, etc. A large quantity of belting is also required. Besides this, the speed change, being made in the counter-shaft, is unhandy to operate, and rather difficult to keep in order, owing to the shortness of the belt on the cone pulleys.

The Brown & Sharpe Mfg. Co., of Providence, R. I., has recently designed for its automatic screw machine a constant-speed drive which does away with the various difficulties just mentioned, and gives to the screw machine, in addition, the same advantages that result in the application of the geared drive to other machine tools. The advantages include those of positive, strongly-driven feeds, self-contained mechanism, convenient manipulation, decrease in first cost and maintenance of belting and convenient provision for applying a constant-speed motor drive.

Fig. 1 shows a No. 2 automatic screw machine arranged with the constant-speed pulley drive, the construction of which is shown in Fig. 2. Flange pulley A is driven from the counter-shaft (or direct from the line-shafting, if preferred) by a constant-speed belt. This pulley, which is bronze bushed, revolves loosely on shaft G. A clutch, operated by a lever seen at the front of the machine at the rear end of the head-stock in Fig. 1, engages or disengages sleeve B and pulley A as required, to start or stop the machine. Sleeve B has formed in it pinion teeth engaging gear C, keyed to back-shaft D, which is thus driven at constant speed. Change gears E and F connect shafts D and G, giving a choice of six speeds for the latter.

On shaft D is mounted a bronzed bushed quill having a pinion formed on it at R, and a larger gear at O, and having keyed to it a sprocket P. Gear O meshes with a mating gear K of the same diameter, which is pinned to sprocket wheel L and a clutch member M, which normally revolve loosely on shaft G. Sprocket wheels P and L are thus constantly connected with each other, and revolve at the same rate of speed in opposite directions. Pinion R meshes with gear teeth on the periphery of clutch member J. A suitable clutch mechanism, operated automatically, may be made to engage either J or M, through H or I, with shaft G. When J is engaged, sprockets P and L revolve in opposite directions at a high rate of speed. When M is engaged, the sprockets receive movements in the same directions as before, but at a slower rate.

The spindle of the machine has mounted on it, on roller bearings, sprockets Q and N, which are connected by chains with corresponding sprockets P and L in the driving mechanism. To Q and N are keyed the heavy clutch members Z and X, either of which, as required, may be engaged with the spindle by the movement of clutch YY, which is automatically operated. The rims X and Z are made heavy enough to have a balance-wheel effect, as shown. This relieves the strain on the chain and the driving gearing in the very sudden spindle reversal which is a feature of this machine. The throwing of clutch YY thus serves to reverse the spindle, while the operation of clutch HH changes the speed from fast to slow, or *vice versa*. This combination of automatic reversal and speed change has a special value in threading and work of similar character, where it is an advantage to employ one speed for turning and a slower one for threading. The

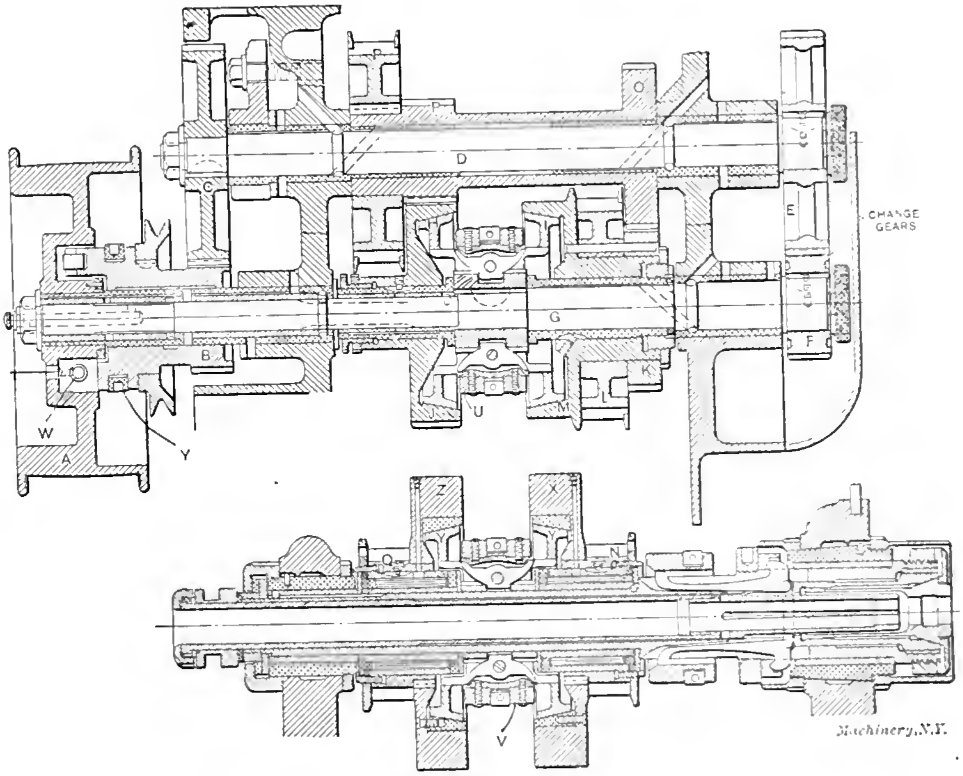


Fig. 2. Details of Construction of the Driving Mechanism, showing Provision for Automatic Reversal and Change of Spindle Speed.

speed change may also be employed in cases where the range of diameters turned, formed or drilled on a given piece is quite large, to permit all the operations to take place at suitable cutting speeds.

The feeding, operative, and idle movements of this machine, other than the revolving of the spindle, are driven by a shaft at the rear which runs at constant speed. This shaft is driven by a train of gearing, receiving motion from constant-speed gear *C* in Fig. 2. This connection includes a positive clutch thrown out by a lever at the front of the machine, so as to stop the feeding movements independently of the spindle. The power is transmitted through a shearing pin which furnishes a safety device in case of an accidental over-strain of the mechanism. On the back shaft, thus driven, is mounted a series of automatic throw-out clutches, similar in action to those used in punch presses. They operate various cams for controlling the feeding of the stock, the opening and closing of the chuck, the revolving of the turret, the reversing of the spindle and the change of speed from fast to slow or *vice versa*, the two latter movements being effected as previously described. Change gearing connects this back shaft *H*, see Fig. 3, through a worm drive, with a slow moving cam shaft *A* at the front, on which are mounted the cams for the turret and cross-slide movements, and a series of dog carriers and dogs which control the action of the various clutches on the back shaft. The change gears just mentioned determine the duration of the cycle of operations, and consequently the length of time it takes to make a given piece. The whole mechanism, as described, furnishes complete means for providing the various movements required in producing the parts for which the machine is set up.

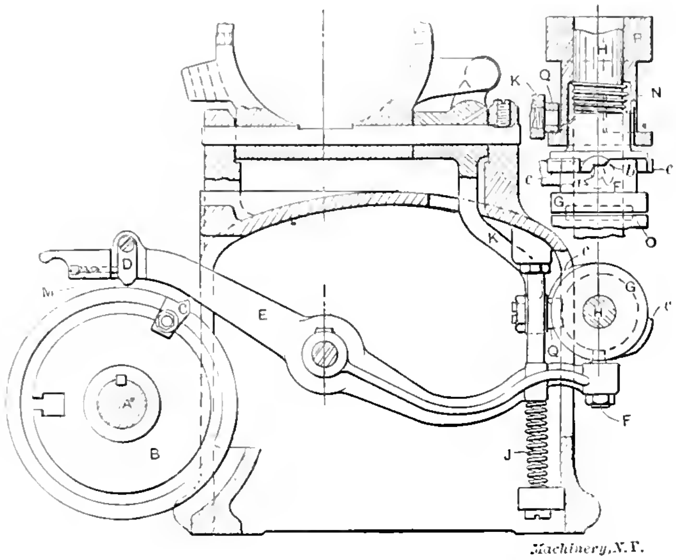


Fig 3. Cross-section through Bed, showing Reversing Mechanism.

In Fig. 3 is shown a section through the bed of the machine beneath the head-stock, which indicates the way in which the reversing movement is effected. There is a perplexing mechanical problem involved here which is solved in a very neat fashion. At *A* is shown the cam shaft at the front of the machine, to which is keyed dog carrier *B* provided with a T-slot in which are adjustably mounted dogs like the one shown at *C*. These dogs engage a tappet *D* on lever *E*, the rear end of which carries a screw *F* (locked by a nut) whose cylindrical point enters a cam groove in clutch *G*, mounted loosely on the constantly revolving back shaft *H*. A top view of the cam is shown in small detail above the position on the sectional view. The cam groove is exactly the same on the other side as on the side shown, the clutch being arranged to engage each half revolution and then automatically disengage. The normal position of the pin *F* is in the recess at *a*. When it is lowered entirely out of the groove by the action of dog *C* on tappet *D* against the pressure of spring *J*, this releases clutch *G*, which is forced forward by a spring *N* coiled about the shaft, until it engages a mating member *O*, fastened to shaft *H*, and is thus started to revolve. Meanwhile dog *C* has passed tappet *D*, allowing pin *F* to drop into the cam groove again. The clutch *G* as it revolves brings inclined face *b* of the groove (or a similar incline on the opposite side) into contact with *F*, and the continued revolution of *G*, through the action of this inclination on the pin, forces the clutch teeth out of engagement, stopping *G* again with the pin in position *a* as at the start. A cam *P*, also loose on the shaft *H*, is keyed to *G*. This cam engages a roll *Q* on the end of lever *K*, which operates a clutch fork, controlling *V* in Fig. 2. When it comes time to again reverse the spindle, another dog *C* is set in the proper position, and the clutch is again tripped, revolving for a second time a half revolution and stopping, operating lever *K* and the clutch fork to change the direction of rotation of the spindle back again.

This represents the normal procedure in cases where the time taken to make one piece is short enough so that the rotation of dog carrier *B* is reasonably rapid. For many pieces, however, this movement is so slow that dog *C* does not come out from under tappet *D* in time to allow pin *F* to drop into the cam groove before the clutch has made the required half revolution. In such cases, incline *b* having been passed without raising the clutch out, the pin can not drop in until the next recess comes along, and the next incline *b*, thus stopping the clutch at the end of one revolution instead of a half revolution. This difficulty has been very simply overcome by the following means:

Tappet *D* is pivoted to lever *E* as shown, and is forced back against a shoulder to the position indicated, by a spring *M*, located in a drilled hole, and pressing against a plunger bearing on *D*. This spring is of such strength as compared with spring *J* that the first effect of dog *C*, when it strikes *D*, is to move the latter backward without raising lever *E*. When *D* has been pressed so far back that it strikes the shoulder at the left, further movement being impossible, *E* is raised, pin *F* is withdrawn from the cam slot in the clutch *G*, and the latter is allowed to engage fixed member *O* on the shaft *H*, and starts to revolve. A cam surface *c* is provided on *G* which, immediately after the commencement of the rotation of the clutch, strikes pin *F* and depresses it still further, thus raising tappet *D* clear above the point of dog *C*, and allowing it to swing back to its normal position against the shoulder at the right under the influence of spring *M*. Lever *E* is then at once ready to drop, *D* and *C* being entirely clear of each other. As soon as the end of cam projection *e* passes, *F* drops into the groove and the rotation of the cam is arrested on the half revolution as required. When it is stated that shaft *H* revolves at 120 revolutions per minute, so that the half revolution of *G* occupies but ¼ of a second, it will be seen that the device has a difficult duty to perform. It performs it in a very satisfactory manner. Dog carrier *B* may even be arrested as soon as the clutch is tripped, but the springing back of dog *D*, affected by the mechanism just described, will bring the points of *D* and *C* clear of each other, so that the latter is allowed to drop immediately and in time to stop the clutch. A second half revolution clutch and connected cam (similar in principle though somewhat differently arranged) is provided for controlling the fast and slow movements, as determined by the position of clutch *HI* in Fig. 2. A second set of dogs and a second lever are provided on the other side of dog carrier *B* for controlling this action.

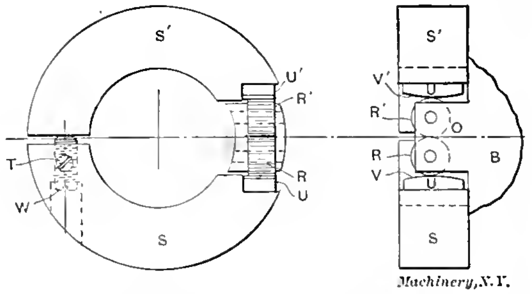


Fig. 4. Detail of Clutch Mechanism.

The friction clutch in the machine driving pulley (see Fig. 4) is entirely new in design and differs greatly from the usual type of friction employed for this purpose. The driving pulley *A* carries a split friction ring *S* and *S'*, which is

expanded by two hardened rolls *R* and *R'* on the end of the sliding pinion sleeve *B*. These rolls operate against the hardened shoes *U* and *U'*, the inner surfaces of which are arcs of circles. The sliding sleeve *B* is operated by a hand lever, conveniently located, whose fork engages the ring *Y*. To operate the friction, the rolls are forced in between the shoes a little beyond the centers of the arcs, thus expanding the ring and clamping it to the pulley. As the rolls are beyond the centers of the arcs, they remain locked in position. This rolling movement effects a powerful expansion of the ring, with but a very slight expenditure of force on the part of the operator. To compensate for wear, the friction ring is adjusted by the screw *W* and clamped by the set-screw *T*.

The grooved pulley, which is shown keyed to the hub of sleeve *B* in Fig. 2, is used for driving the various attachments with which this make of automatic screw machine may be fitted. This line of attachments includes those for automatic screw slotting, high-speed drilling in the turret, cross drilling on the cross-slide, and other similar devices. They are driven by a self-contained counter-shaft mounted as shown in Fig. 5, being attached to pads on the back of the headstock prepared to receive it. These pads are machined, drilled and tapped to accurate dimensions when the machine is sent out, so that the counter-shaft may be supplied and attached at any time by the purchaser. The various grooved pulleys shown, of different diameters, may be used as required to give the desired speed to whatever attachment may be in use at the time.

As may be seen from the details shown in Fig. 2, the whole mechanism is carefully designed to give an efficient and durable construction. The wearing surface and spindle bearings are amply proportioned to withstand the most severe service which a machine of this size and capacity should be subjected to. All the working parts are easy of access and readily adjusted, though carefully protected from chips and dirt. The driving chains are of the silent running design, operating quietly and efficiently at high speed. All the bearings in the spindle drive are bushed with phosphor bronze and, wherever considered advisable, the shafts are hardened.

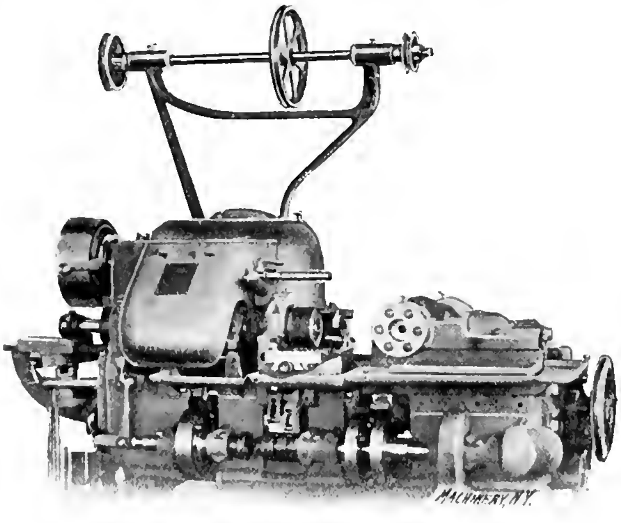


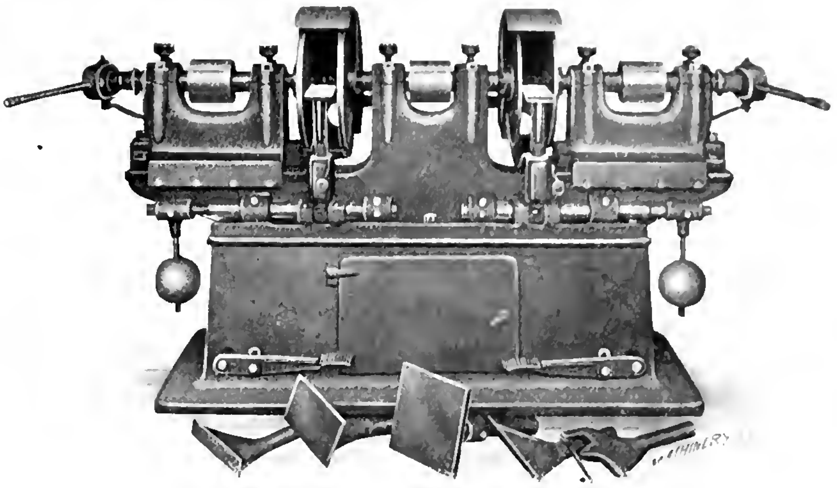
Fig. 5. Self-contained Counter-shaft for Driving Attachments.

FOUR-DISK GORTON GRINDER.

The maker of the Gorton disk grinder (The Diamond Machine Co., Providence, R. I.) has designed a form of that machine which carries four disks, and is adapted for grinding in two stages, work having parallel sides or sides at a slight angle with each other. One pair of disks does the roughing and the other pair the finishing, there being opportunity for using two operators on work of this kind.

The machine is provided with a heavy base on which the bed of the machine is mounted. Supported in bearings in the center of this bed is the main spindle, driven from the counter-shaft by a pulley between the bearings, and provided with a grinding disk at each end. The ends of the bed are machined to form ways on which slide the adjustable grinding heads, each of which carries a spindle and a grinding disk facing the corresponding one on the central spindle. These heads are adjustable on the bed to give any distance between the disks up to 12 inches. The heads are not mounted directly on the base, being clamped to saddles on which each has a swivel adjustment for any angle up to 10 degrees. This allows small angles to be ground at one setting.

The outer spindles have a longitudinal movement for feeding in against the work. This movement, which is limited by a micrometer stop, reading to 0.001 inch, may be effected either by the hand levers at the end of these spindles, or by the treadles shown on the base of the machine, the latter being connected with the hand levers by suitable link work. This foot-operated feed can be disconnected if necessary, though it does not interfere with the regular hand-operating device in any way. The work tables (which are furnished in various widths, or can be made specially to suit work difficult to hold otherwise) are adjustably mounted on counter-weighted rocking bars, as is usual in disk grinders, and may be swung in and out between the faces of the disks by hand levers projecting toward the front. The adjustable heads may be removed entirely if desired, and swiveled tables provided for the work, in which case the machine has all the adjustments of the standard machine.



A Four-disk Grinder especially adapted to Two-operation Work.

While this machine was originally designed and is here shown as a regular disk grinder, the disks may be replaced with chucks for holding emery rings, so that heavy grinding can be done. It will sometimes be found convenient to use a set of emery rings on one end of the machine, for roughing work which is finished between a pair of disks at the other end.

HAMILTON VARIABLE SPEED PLANER.

The two accompanying engravings show an improved form of planer drive built by the Hamilton Machine Tool Co., Hamilton, Ohio, which gives four changes of forward or cutting speed with a constant return, thus giving the machine the advantage of a variable cutting speed the same as has always been provided for other machine tools, such as lathes and milling machines. The changes are made entirely in the machine itself, and require no complication in the construction of the counter-shaft. Fig. 1 shows the general appearance of a planer so equipped.

The driving shaft has mounted on it four pulleys, only one of which, that for the return movement, is keyed to it. The others are: the loose pulley for the return motion, the loose pulley for the forward motion, and the forward driving pulley. The latter, as may be seen at the left of Fig. 2, is connected by gearing on the outside of the frame with a

secondary driving shaft parallel with and close to the main driving shaft. Inside the bed the main driving shaft has keyed to it a series of four gears of different diameters. The secondary driving shaft carries two sets of double mating gears, controlled by forks pinned to sliding rods. These rods may be manipulated by two handles shown on the outside of the bed at the left, so as to bring any one of the four into engagement with the mating gear on the driving shaft. The handles are so interlocked that it is impossible to engage more than one gear at a time.

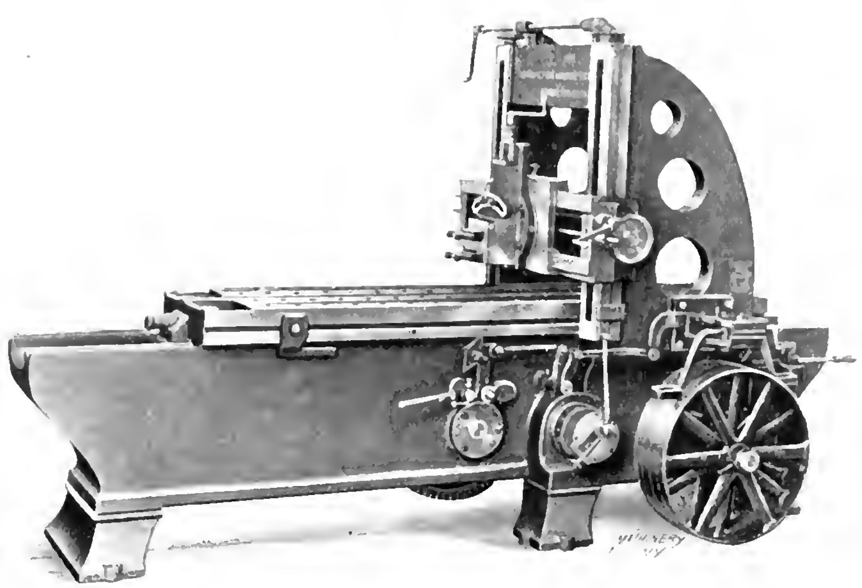


Fig. 1. 24-inch Hamilton Variable Speed Planer.

With any one of the four combinations of gearing in action, the drive is from the loose driving pulley through the outside gearing to the secondary driving shaft, and thence to the main driving shaft, through whichever one of the four pairs of gears happens to be engaged. From here the gearing connection is of standard form found on planers of the usual construction. On the reverse drive the movement is transmitted directly to the main driving shaft, to which the reverse pulley is keyed, the driving pulley running idly, meanwhile, from its connection through the change gearing and the outside gearing. One of the pair of outside gears is raw-hide, making a quiet running mechanism. The driving gears are of wide face and coarse pitch, running at comparatively slow speeds, and since only two of them are engaged at any one time, the action is smooth and durable.

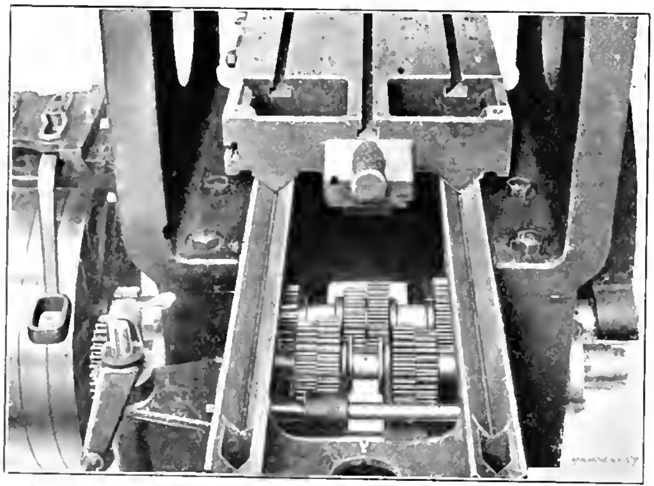


Fig. 2. Table run out to show Driving Change Gears in the Base

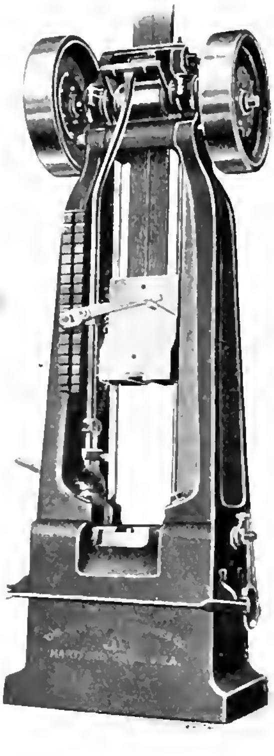
The placing of the gearing in the bed instead of on the housings overcomes any tendency to vibration, and locates it in a position which is out of the way and thoroughly protected, and yet easily accessible at any time. It is not intended that a speed change shall be made while the planer is running. While this is an advantage on some kinds of machinery, it is unnecessary on a planer, which has to be stopped to remove the work, rechuck it, or reset the tools prior to changing the cutting speed. For this reason the simple arrangement here provided can be used, giving, the builders believe, a much more satisfactory service than the complicated friction or tooth clutches sometimes used for such devices.

For the 24-inch machine, which is here shown, the forward cutting speeds usually provided are 20, 25½, 32, and 40 feet per minute, respectively, with a constant return of 80 feet per minute. Any reasonable variation may be obtained from these speeds by increasing or decreasing the speed of the countershaft, or by special modifications in the speed changing gears themselves made at the time the machine is built. By providing a two-speed countershaft, the number of cutting speeds may be increased to eight, though the four regularly furnished should be sufficient for the usual run of work. An index plate is attached to each machine, showing the different speeds provided and the proper location of the levers for each speed.

This variable speed drive, for which patents are pending, will be applied by the makers to any size of their line of planers of both the regular and widened patterns. It may be used for motor drive as well as for belt drive.

BILLINGS & SPENCER MODEL C DROP HAMMER.

The Billings & Spencer Co. of Hartford, Conn., has been making drop forgings for a period of about forty years. The firm has in that time used practically all the various forms of drop hammers on the market. The experience with these various hammers has, from time to time, given the company an opportunity to note their defects, and has suggested improvements. This led some twenty years ago to the building of hammers for use within the factory, and in this the firm has continued to the present time, bringing out successively the original Model A, a later design, Model B, and, finally, the machine here shown, Model C, which incorporates all the improvements suggested by the experience of the company in building drop hammers and using them. The new machine is intended to meet the demand for the much heavier work met with in the modern forging plant, where larger parts and harder materials are constantly being called for. This machine is not only much stronger than the old one for a given weight, but it also incorporates a number of distinctive features which will be mentioned in the description.


Billings & Spencer Model C Drop Hammer.

As shown in the accompanying half-tone, this hammer is of the board drop type, in which the weight is hung from a board which is raised by being clamped between revolving rollers. An improved board clamp catch is employed which

does away with the latch and connections at the side for holding the ram aloft. This clamp is located at the extreme top of the machine, above the friction rolls, where it is impossible for the oil to get between the gripping surface and the board, thus avoiding a most serious difficulty hitherto met with in some devices. This clamp, which is positive in its action, is controlled by clamps or eccentrics connected to a foot lever attached to the base of the machine. Another important feature of the tool lies in the adjustment provided for the rear friction roll. This adjustment is effected by means of an eccentric duplicating that used for the front friction roll. These two rolls, with their eccentrics, are therefore interchangeable. Owing to this construction, a true alignment between the lifting board and the rolls may always be preserved. A new form of bronze bushing is provided for these eccentric bearings, which may be easily and quickly removed and replaced. The attachment of the rear friction roll and the rear board clamp, which is also effected by an eccentric, are controlled by bars attached to the eccentrics and running down parallel with the uprights within easy reach of the operator on the floor. These bars are on the back of the machine and do not appear in the engraving.

The uprights used on the new model are of special design and greatly reduce the possibility of breakage, the distribution of metal being such as to afford a maximum of strength for the weight. The cross-section is that of the letter V, the apex, which is machined, forming the guide for the ram. A longitudinal rib running the entire length adds to the strength of the uprights. A feature of their construction is the fact that they are solid throughout their length, no weakening perforations being made for the fastening of attachments. The uprights are adjusted longitudinally on the base by a new and improved method, affording easy means of setting the dies. The releasing arrangement is attached to the front of the left-hand upright as shown. This may be placed in any one of a number of vertical positions at intervals of $1\frac{1}{2}$ inch, allowing the ram to be released at any desired height.

COCHRANE-BLY AUTOMATIC SAW SHARPENER.

The metal-sawing machines made by the Cochrane-Bly Co., of Rochester, N. Y., employ a saw blade having teeth ground in the manner shown in Fig. 2. As may be seen, they differ from ordinary milling saws in that every alternate tooth is beveled on each side to make a narrow cutting edge slightly higher than the other teeth. This high and narrow tooth takes a chip from the center of the cut while the following wide tooth takes two, one from each side. The chips drop freely from the slot, reducing the heat and friction of cutting and permitting greater feeds and increased production. While this form of tooth is thus a very efficient one, it is rather difficult to grind properly without special fixtures, and, to obtain the best results, the grinding should be performed automatically, so as to give uniform spacing and height to the teeth. The interesting tool shown in Fig. 1 has been designed by the builders to effect this conveniently and accurately.

Fig. 1. A Machine for Automatically Sharpening and Beveling Metal-cutting Saws.

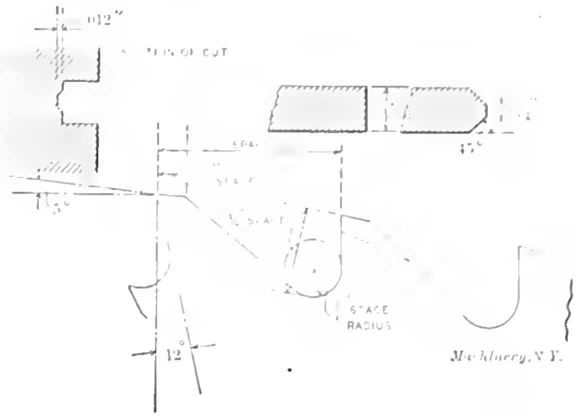


Fig. 2. Shape of Tooth produced by the Machine shown in Fig. 1

The saw blade is mounted on a spindle, with an index plate of the same number of teeth as the saw. The main emery wheel spindle is carried by a swinging frame, operated by cams and levers which give it two movements, one of which feeds the emery wheel toward the center of the saw, grinding the face of the teeth, after which the wheel is backed out and fed across the top of the teeth to grind the land. The frame is, of course, set to give the proper angle of tooth for each of these faces, and as the feeding movement starts at the point, it leaves the cutting edge sharp and free from burrs. This action takes places on every tooth with identically the same movement, except that each alternate tooth is ground about 0.012 inch lower, the high teeth being the ones that are subsequently beveled.

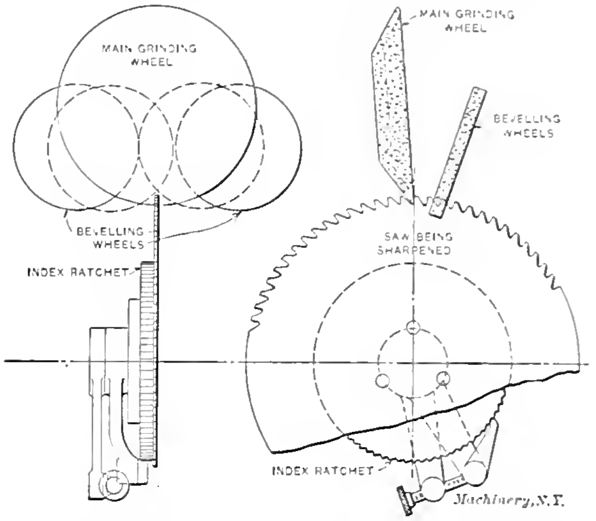


Fig. 3. Arrangement of the Grinding Wheels and the Saw to be Sharpened

The beveling is done by a pair of wheels mounted on a standard at the back of the work spindle support. They are attached to a slide which is reciprocated vertically on the standard by a cam, so as to alternately grind the upper and lower beveled corners of the alternate teeth. This is done while the main grinding wheel is working on the preceding tooth. The beveling wheels are raised from the work on each alternate low tooth. After each tooth has been ground, the saw is indexed by means of a cam-operated index lever engaging the ratchet wheel indicated in Fig. 3, and shown in Fig. 1, each tooth being thus brought to a certain fixed point, insuring even spacing. Fig. 3 shows plainly the relative positions of the wheels and the saw.

The spindle carrying the saw and index plate is set in a slide mounted on a bracket attached to the frame of the ma-

chine. This slide is adjusted by the hand screw on the bracket to accommodate the saws of different diameters. An adjustable automatic movement is provided for feeding the blade toward the emery wheels after each revolution of the saw, until enough stock has been removed to sharpen all the teeth properly. A special saucer shape is used for the main grinding wheel, which keeps its outward shape as it is worn down, and does not require constant dressing to produce the proper form of teeth. The cam movement of the machine governs the shape of the teeth.

The design of the machine shows evidences of having been carefully worked out. All the working parts are well protected from dust and dirt, the bearings being provided with covers and felt washers. The spindles are hardened and ground and the fitting is carefully attended to throughout the machine. There is but one adjustment, that which governs the depth of the teeth. This should vary according to the pitch and diameter of the blade. The capacity of the machine is for saws from 10 inches to 24 inches in diameter. The main emery wheel is 8 inches in diameter, while the beveling wheels are 5 inches in diameter. The net weight of the tool is 388 pounds.

HACKETT TWISTED DRILL.

Twist Drill made from a Flat Bar of Stock throughout its Entire Length

The drill shown in the accompanying engraving is made from a twisted flat bar of stock throughout its entire length, and may be held in a socket or machine spindle finished to the regular Morse taper standards. This, as shown, is accomplished by increasing the twist at the shank of the drill so as to form a good bearing, and grinding the spiral which is thus formed to fit accurately a Morse taper hole. The extreme end of the twisted bar is left straight and serves as a tang entering the slot in the socket, thus driving the tool in the same way as is done with a drill of the usual construction.

The construction of the tool is so obvious and so simple that little more need to be said about it. It can be made very inexpensively and of any suitable grade of steel, carbon or high-speed. It is lighter, and therefore easier to handle, and less expensive for stock than drills as commonly made, milled as they are from the solid bar. It will be noted that there is a tendency on the part of the tool to grip firmly into its taper seat under the pressure of the cut, as this causes the spiral to unwind somewhat, thereby increasing its diameter and causing it to expand tightly in the hole. These drills are sold by George E. Hackett, 90 West Street, New York City.

CORBIN-CHURCH HIGH-SPEED DRILLING MACHINE.

The Corbin-Church Co., New Britain, Conn., has designed a 13-inch high speed drill which is built in two different styles to suit the requirements of the purchaser. These two styles are shown in the accompanying half-tones, Fig. 1 showing the machine as a sensitive drill, and Fig. 2 the same machine with power feed applied. These drills are designed especially for the use of high speed tools.

The column is a solid casting with supports for the spindle and the various shafts required for the drive. The counter-shaft is contained in the machine and is provided with 8-inch tight and loose pulleys for 2-inch belt. A 3-step cone in the counter-shaft is connected by a belt with an idler cone, which in turn drives the spindle pulley by a quarter-turn belt running over suitably placed idlers. The strain of the belt on the driving pulley is taken by the sleeve on which it is mounted, leaving the movement of the spindle sensitive to the slightest touch. The large diameter of the pulleys used permits running the belt at a low tension while still furnishing sufficient driving power, thus prolonging the life of the belt greatly.

The spindle is balanced and is provided with a micrometer adjustment stop-collar on the sleeve for drilling to suitable depths. This stop-collar may be adjusted without stopping the machine. A special index is provided for measuring the depths of holes. The spindle is of tool steel and provided with a ball thrust bearing. The table is balanced by a weight inside the column. An index line is provided on the column for bringing the center of the table in line with the center of the spindle.

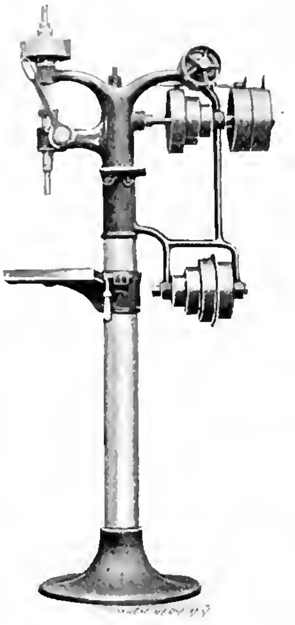


Fig. 1. Corbin-Church High-speed Sensitive Drill.

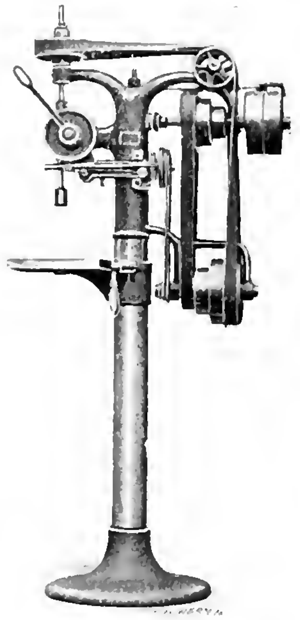


Fig. 2. High-speed Drill with Power Feed Attachment.

The power-feed attachment, shown applied in Fig. 2, is driven by a round belt from the idler cone-shaft, over a pair of 3-step cones which give a corresponding number of changes of feed. A drop worm and worm-wheel delivers the power to the feed pinion-shaft and furnishes means for providing an automatic stop. A special feature of the power-feed machine is the overbalancing of the spindle, and the automatic release of the feed, which allows the spindle to fly back to its starting position again at the conclusion of each cut. This leaves the operator nothing to do but put in and remove the work, and start the feed. This attachment is particularly useful on the multiple spindle type of this tool.

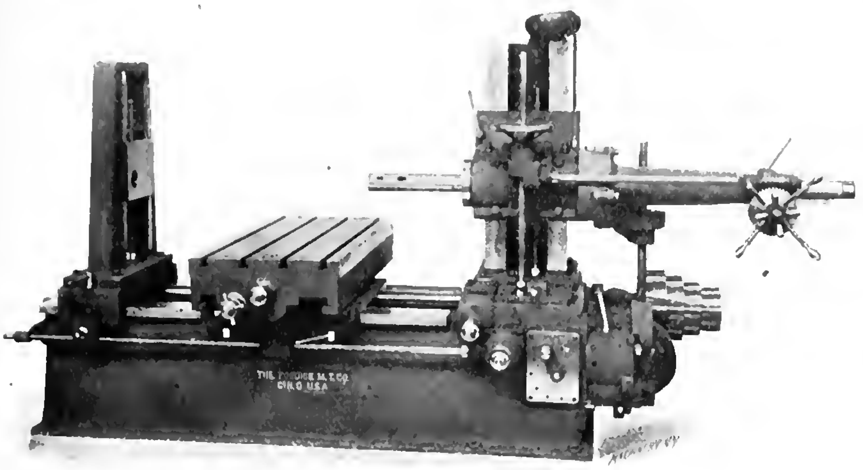
This machine gives the maximum range of 33 inches from the end of the spindle to the table, and a distance of 6⅝ inches from the center of the spindle to the column. As a single spindle machine it weighs about 325 pounds. It will be furnished with any number of spindles up to six. The makers invite comparison in design and workmanship with any other similar drills made.

FOSDICK HORIZONTAL BORING, DRILLING, AND MILLING MACHINE.

The accompanying illustration shows a horizontal boring, drilling, and milling machine brought out by the Fosdick Machine Tool Co., Cincinnati, Ohio. The illustration shows very plainly the general features of the design of this machine. The builders have particularly endeavored to make the machine convenient to operate, as this factor governs the output of any machine to the very largest extent. All levers and hand-wheels have consequently been placed on the operator's side, and within easy reach. The safety feature of operation

has also been given due attention, and all gearing and moving parts have been thoroughly encased. All the gears are made of steel, and provisions made for adjustment for wear of the spindle and alignment of the spindle with the outer support bearing. The outer support can be entirely removed if required, and independent adjustment provided for alignment if the operator should change the position of the head while the support is removed from the machine.

The spindle travel and the cross-feed of the table are actuated by power in either direction, and are equipped with graduated dials for micrometer adjustments. The diameter of the spindle is 3 inches in the driving sleeve, and 1½ inch in the rear sleeve, the end thrust being taken by ball bearings. The spindle is provided with a No. 5 Morse taper socket. There are eight spindle speeds, ranging from 12½ to 155 revolutions per minute, all being reversible. The feed changes are eight in number, varying from 0.007 to 0.250 inch per revolution of spindle. The spindle travel is 22 inches, and the vertical head travel, 21 inches. The lateral travel of the table is 36 inches, and the cross-feed, 28 inches. The working surface of the table is 50½ by 23½ inches. The table is provided with four T-slots and six stop holes.



Fosdick No. 0 Horizontal Boring, Drilling, and Milling Machine.

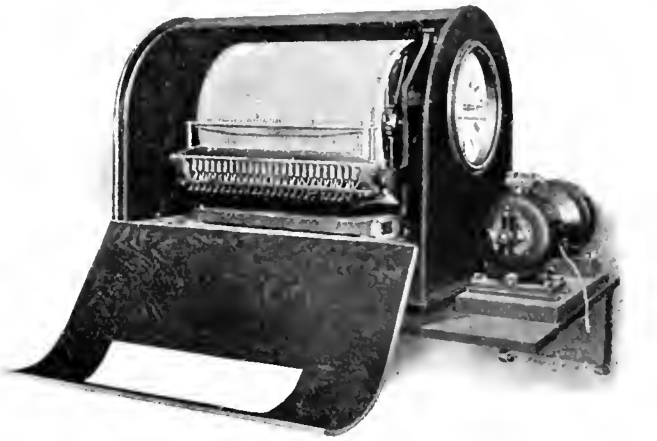
The drive is positive throughout and two mechanical changes are made with positive clutches. A 3-inch double belt is used on the cone pulley or on the constant-speed driving pulley. The counter-shaft has friction pulleys for forward and reverse, and is run at 400 revolutions per minute. When motor-driven, a 5-horse-power motor is recommended, and the motor can be direct connected to the machine through spur gearing. A constant speed motor can be applied to the machine in connection with the regular gear box for speed changes, or a 3 to 1 variable speed motor can be applied. The machine illustrated in the accompanying half-tone is termed by the makers as style No. 0. This machine requires a floor space of 13 feet in line with the spindle by 7 feet 8 inches traverse width, this latter dimension permitting the table to travel to its extreme limits. The net weight of the machine is 7,500 pounds. In addition to the No. 0 machine, two larger size machines, Nos. 1 and 2, are also built.

NATIONAL MACHINE RECORDER.

The instrument shown herewith, made by the National Machine Recorder Co., Marquette Building, Chicago, Ill., will automatically indicate and record the length of time that each of fifty machines is actually running, and the length of the corresponding idle periods. It consists of a revolving drum to which is attached a record sheet about 16 inches wide and 45 inches long, which is rotated evenly by clockwork and furnishes a complete record for twelve hours. Mounted in front of this rotating drum is a series of 50 metallic points or markers, each of which is controlled by an electromagnet connected in circuit with a switch attached to the counter-shaft of the machine whose working it is desired to record. When the belt shifter or clutch lever is thrown to start the machine, the circuit is connected, and the corresponding magnet, through the recording mechanism pushes the metallic point down until it presses on the paper, where it traces a line on the revolving surface as long as the machine is in operation. When the machine is stopped, the circuit is broken, and the metallic point drops back from the paper, breaking the line on the recorder. The fifty record lines are 5/16-inch apart, and the sheet is graduated horizontally in lines 1/16 inch apart, one for each minute, so that very accurate and easily read records are kept, it being possible to estimate the time as closely as within one-half minute. The device may be set up in the superintendent's office or that of any other official, without reference to the location of the machines to be recorded, except for the requirements of making the necessary wiring as short as possible.

The uses of such an instrument from the standpoint of the works manager are obvious. One of these is the matter of estimating the efficiency of the individual workman as far as concerns the wasting of time. A glance at the recorder will, in many cases, serve to show that a machine has been idle very much more than it should have been. Upon investigation, it can then be determined whether the difficulty lies with the machine or with the workman, and remedial measures applied.

The apparatus will also prove to be of the greatest value to the cost department in showing the length of time actually spent on work. In the case where the workman keeps his own record, the divisions of the time difference between jobs is notoriously inaccurate, the inaccuracies being due sometimes to carelessness and occasionally to design. The plan sometimes adopted of having men report to a time-keeper at the commencement and conclusion of each job is wasteful of time, and is not necessarily much more accurate than in the previous method. By the use of this instrument, however, in connection with the record of the work given out to the operator, it is possible to determine the time for commencement and completion of each job with the utmost accuracy, with the added advantage of knowing how much was spent in the changing from one operation to another. Having this accurate record on even the shortest jobs, it is possible to compare the time of the same operation in different lots, and by different workmen, and thus arrive by course of comparison and analysis at an estimate of the proper cost for given operations and given parts.



Instrument for Recording, Automatically, the Length of Time Machine Tools are Idle or in Operation.

This leads to the consideration of what would undoubtedly be the most useful function of the device in shops where the piece-work system is in vogue, namely, the setting of suitable rates for piece-work. In some plants, tests are made to determine what time should be required for each operation, and so establish piece rates. In most plants, however, owing to the complication of operations and the impossibility of properly forecasting the time without special training, this is done in a more or less haphazard manner. In such plants

there exist what are known among the piece-workers as "good" and "bad" jobs, evidencing the fact that the piece rates in force are either too high or too low. The common method followed in such places is to determine the length of time consumed in producing a certain output by day work, increase this output 10 or 15 per cent, and divide the quantity into the amount earned, the result being the piece-rate. This might be accurate if some workmen in the modern factory did not anticipate a piece rate on operations which are now being performed by day work, and did not use their ingenuity to curtail production, and keep the manager in ignorance as to what the actual output should be, so that when the piece rate is established it would be one at which it would be easy to make regular day wages.

With this machine, however, the actual length of time the machine has been producing, the duration and time of day of each producing period, and their idle moments are recorded. As the speeds and feeds are always subject to the foreman's supervision and the record shows whether or not a machine has been kept in operation for a suitable length of time, it is possible from the start to set an equitable rate of production for any given operation, and piece rates may be established with a reasonable degree of confidence.

The device should also prove a spur to the works manager himself. When the records are examined, the idle periods will doubtless seem unnecessarily long and it will be his place to investigate the reason for the delays in getting started on new work, in changing work in the machine, sharpening tools, and performing the other operations that detract from the cutting time of the machine. Such an investigation would naturally lead to a better system of shop management down to the smallest details. Since the record is made while the operation is in progress, it is possible to stop leaks of this kind at their inception. Without such a record most of the irregularities would never be discovered, while those that would be found out would come so late that investigation would be practically fruitless. This device was originally designed for the use of engineers interested in increasing production, and has proved a most valuable adjunct to that work.

STURTEVANT TYPE H ELECTRIC MOTORS.

The B. F. Sturtevant Co., Hyde Park, Mass., has designed a line of motors especially adapted for direct connection to the blowers and exhausters built by the same firm. They are of the 4-pole type, simple and compact in design and pleasing in appearance, as may be seen by reference to Fig. 1, which shows one of them connected to the blower.

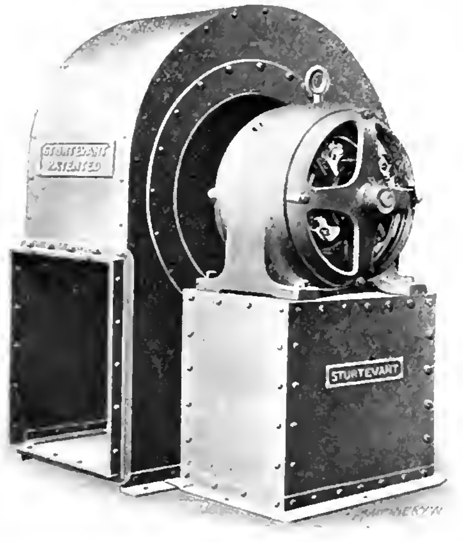


Fig. 1. Sturtevant Type H Electric Motor, connected to Blower.

The magnet frame is of cast iron with pole pieces bolted to the frame and located off center to permit the use of duplicate bearing brackets on each end. By taking out the through-bolts, the pole piece with its field coil may be removed without disturbing the armature or dismantling the motor. The pole pieces are built up of soft steel punchings secured between end plates while under pressure. They are of such shape as to afford a support to the field coil and so distribute the magnetic flux as to produce sparkless commutation under wide variations of load. Cast iron horns are provided to eliminate the disagreeable humming noise otherwise consequent to the use of laminated pole pieces. The field coils are machine wound, carefully insulated, and protected in the most improved manner against moisture or mechanical injury. The view of the machine dismantled in Fig. 2 will show the construction of these parts very plainly.

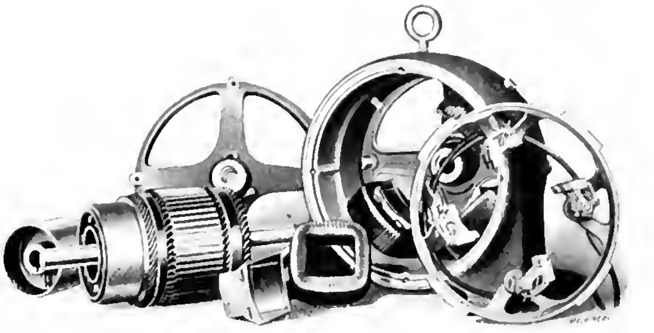


Fig. 2. View of Dismantled Motor, showing Construction.

The armature is of the iron-clad, slotted-drum type built up of soft annealed steel punchings, each insulated by a coating of japan. The punchings are assembled on a cast iron sleeve provided with openings for the full circulation of air. This is shown better in Fig. 3, where the direction of the current is indicated by arrows. The whole arrangement forms a fan exhauster between the armature and the commutator, taking in air at both ends. As may be seen in Fig. 3, the sleeve has an extended hub for the reception of the commutator shell, thus making the armature and the commutator a self-contained unit: The coils are of double cotton-covered copper wire or strap held in the slots by fiber wedges, thus preventing the stripping of the bands. The commutator is built of bars of hard drawn copper held in a cast iron shell of spider construction. Great care is exercised in selecting the mica, to have it of the same hardness as the copper, so that the wear of the two substances will be uniform. The whole commutator is assembled while hot under great pressure; thus each bar is held firmly in place, and the liability of its working loose reduced. The brushes are of carbon, and are held in holders of the sliding socket type provided with a braided copper pigtail, which relieves the brush holder body and springs of the necessity of carrying the current. The holder is supported by a ring seated in the machined recess in the magnet frame and clamped in position by the front bearing bracket. There is thus no danger of the brushes being thrown out of position or tilted, as is the case when the brush rigging is clamped by set-screws.

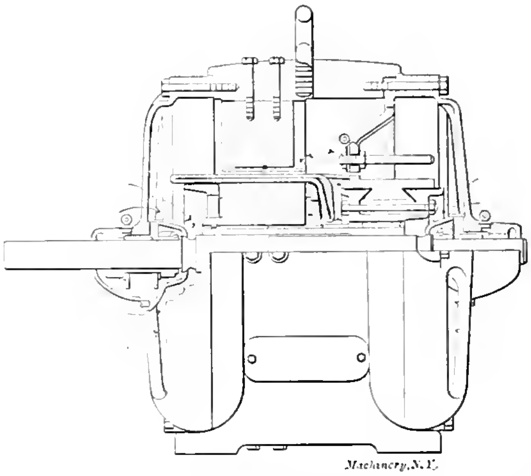


Fig. 3. Half-section illustrating the way in which a Free Circulation of Air is obtained.

These motors are designed to be as efficient as any motors built of the same size and speed, but have capacity for great

over-load. They will carry 50 per cent over-load for an hour without destructive sparking or heating, and will carry 100 per cent over-load for 5 minutes. These characteristics show their great adaptability for driving fans, particularly in factory service, when the fans are often over-loaded. Special pains have been taken to keep the heat-rise low. Tests made in clean dry places have shown the heat-rise for open and semi-enclosed motors less than 72 degrees F. at normal speed and output. These motors are made in a complete line from 1 to 100 horse-power in order to meet the requirements of all installations. Though primarily fan motors, they are applicable to the regular work of driving machine tools, etc.

THE NUTTER & BARNES AUTOMATIC SAW AND CUTTER SHARPENING MACHINES.

We show herewith in Figs. 1 and 2, illustrations of two machines made by Nutter & Barnes Co., 326 A St., Boston, Mass., for automatically sharpening gear and milling cutters, and for sharpening and beveling saw teeth. In these machines the cutter or saw is clamped in place, and automatically indexed, the machine spacing the teeth past the grinding wheel and feeding the latter back and forth across the face of the saw, or cutter. At the completion of each revolution of the latter, the wheel is fed in by hand until all the teeth are sharpened.

The saw and milling cutter sharpener, shown in Fig. 1, is an inexpensive machine intended for general shop and factory use wherever milling saws and cutters of various kinds within the range of the machine have to be sharpened. Saws from 2½ to 6 inches in diameter, and of any ordinary thickness, may be ground. Those which are badly worn may have a new set of teeth ground in them at very little expense, as the machine does not require close attention after being started. Old milling cutters of any diameter ranging from 2½ up to 6 inches, and for straight faces as wide as ⅝ inch, may also have their teeth renewed. An attachment at the rear of the machine is provided, by means of which the teeth may be easily backed off.

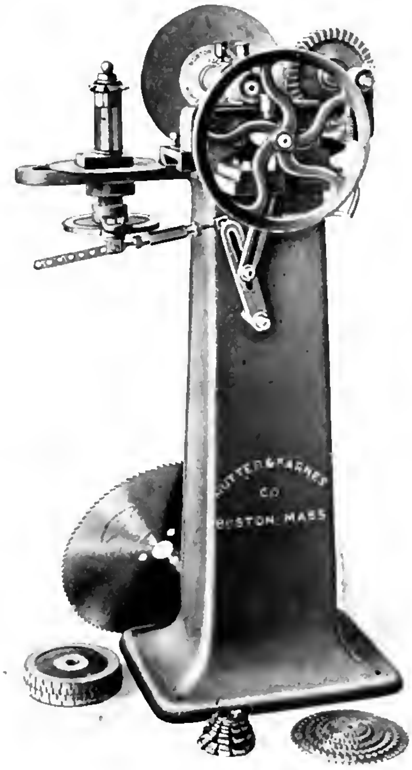


Fig. 1. Automatic Saw and Milling Cutter Sharpening Machine.

A feature of the machine is the indexing of the work by accurate index plates 6 inches in diameter. The use of these insures accurate spacing in the grinding, and permits the reshaping of teeth as described. They are also particularly useful in sharpening gear-cutters. This may be done with absolute correctness, so that the teeth will be spaced regularly and radially from the center line. This it is difficult to do in the ordinary manner without an index and means of holding the cutter central with the grinding wheel. Two index plates cut with any desired number of teeth are furnished with the machine. All the change necessary in going from one cutter to another is to change the arbor bushing and the index plate and this is a small matter, but very few minutes being required. The machine should be particularly profitable in the matter of reshaping old saws and cutters which have been abandoned on account of the teeth having become too shallow. These can have new teeth ground at much less expense than would be required for annealing, re-milling and re-hardening them.

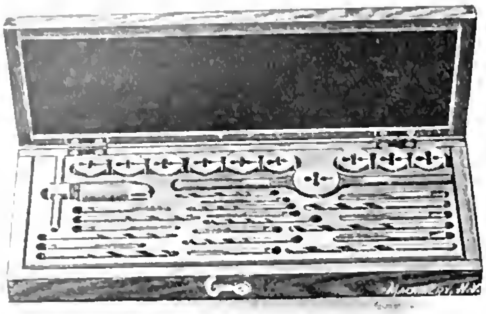
Fig. 2. Automatic Saw Sharpener and Tooth Beveling Machine.

In Fig. 2 is shown an automatic saw sharpener and tooth beveling machine of somewhat similar construction. In this case, also, the spindle is indexed from a ratchet wheel cut accurately to a number of spaces corresponding with the number of teeth in the saw. The reciprocation of the grinding wheel and the indexing are automatic. The feeding of the wheel to depth, however, is done by hand. Two index plates, one for sharpening and one for beveling, are furnished with the machine, covering the saws provided with the builder's cutting-off machine. For special index plates an extra charge will be made. At the rear of the saw-sharpening arrangement is placed the tooth beveling device, by means of which every other tooth may be beveled on opposite sides, thus relieving them of half of their thickness, while the cutting face remains the full thickness of the blade. This form of tooth breaks up the chip and allows the saw to run much more freely, practically eliminating the liability of its sticking when cutting soft stock. In no tooth, when so ground, is the full width presented to the surface of the cut. The saw is indexed in this operation the same as for sharpening, except that the index plate is set for half the number of teeth in the saw, skipping every other one. After the bevel has been completed on one side of the saw, it is turned over and treated the same as on the other side, for the alternate teeth.

REECE SCREW PLATES.

The illustration shows a screw plate set brought out by E. F. Reece Co., Greenfield, Mass., which is supplied in six assortments. The principal feature of novelty of the new screw plate set is that a Morse twist drill is provided for each size of tap, the drill, of course, being the correct size for drilling the tap hole. This feature makes a screw plate set complete, it containing all tools required for threading screws, nuts or tap holes.

Another feature of interest is a T tap wrench for holding the taps. These tap wrenches are made with spring-tempered tool steel centers in two sizes, having a range from 1/16 to 1/2 inch. These screw plate sets are made in machine screw and

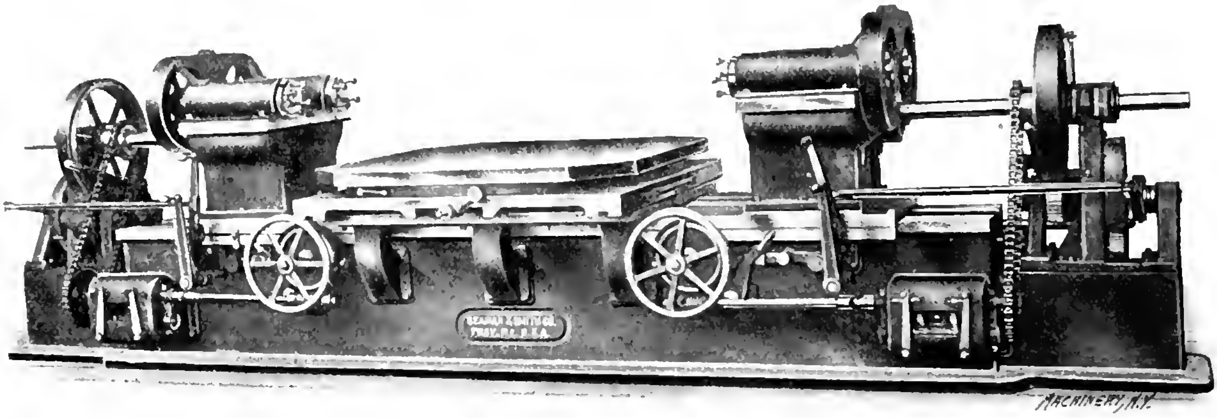


Reece Screw Plate Set, with Tap Drills.

fractional sizes. The machine screw assortment No. R. D. 3 cuts No. 2 to No. 16, inclusive, and the fractional sizes cut from 7/64 to 1/4 inch, inclusive.

BEAMAN & SMITH DUPLEX BORING MACHINE FOR AUTOMOBILE CYLINDERS.

The special boring machine shown herewith, built by the Beaman & Smith Co., Providence, R. I., combines a number of interesting features of design. It is of the type which has been called in England the "snout" boring machine, in which an overhanging rotary cutter head is fed in to the bottom of a blind cylinder bore. The operation corresponds to that of boring in the lathe, to the extent that the members of the machine are subject to a constant deflection, the tool having constantly the same over-hang from the beginning to the end of the cut. This is not the case with a boring-bar supported front and back, and fed through supporting bushings. By making the heads very strong and rigid, it is possible also to use multiple cutters, four being commonly used for roughing and six for finishing. This method of boring was described in an editorial in the May, 1906, issue of MACHINERY.



An Automobile Cylinder Boring Machine provided with a Rotating Table, permitting the Setting of Work while the Machine is in Operation.

The general construction of the machine designed by the Beaman & Smith Co. for employing this method of boring automobile cylinders, is plainly evident from the engraving. A work table is provided, pivoted so as to be swung around a cross-slide carriage, which is supported on the center of the bed. Sliding on ways on the bed on each side of this revolvable work table are two boring heads, each provided with two heavy spindles fixed in position, so far as center distance is concerned. The work is clamped to the revolving table opposite these spindles, and the heads in which they are mounted are fed forward on the bed until the boring tools have reached the bottom of the bore, when the feed is thrown out by an automatic stop. The heads are then quickly returned by power, allowing the table to be revolved and new parts to come in place to be machined.

The revolving table permits the clamping of work in place at the sides of the machine, while those presented to the spindles are being bored. At the completion of the operation, after the heads are withdrawn, the table may be indexed to bring the new pieces in position to be bored, leaving the completed parts ready to be taken off and replaced with unfinished work. This permits the machine to be in operation continuously, it being necessary to stop the boring only long enough to return the heads and index the work table. Another method of employing the revolving table, involves the use of roughing cutters on one head-stock and finishing cutters on the other; in this case, the work is indexed step by step. At the conclusion of each operation it is carried from the roughing head to the intermediate position at the rear of the machine, and then to the finishing head at the next move, finally returning to the intermediate position at the front of the machine, where it is removed and new work inserted.

Another important point in the design of the machine relates to the construction of the bearing surface on which the boring heads slide on the bed. As will be seen from an examination of the engraving, the support for the central table is raised above the bed, being mounted on three brackets attached to it on each side. The boring heads are bolted to carriages which extend for a considerable distance forward of the cutting tools, thus bringing the line of direct pressure within the bearing surface which supports the heads. This provision does away with the excessive wear at the front of the bearing surface which would otherwise take place and result in a pitching forward of the heads and a consequent disalignment of the machine.

The work table is clamped in its four positions by a lock bolt entering corresponding slots in hardened blocks, held in recesses on the under side of the table. These blocks are adjustable in their positions by screws on the upper surface of the table, so that the dividing can be done accurately at any time after the completion of the machine to make each indexing exactly 90 degrees. The carriage rotates on a ring of balls, making it very easy to swing around from one position to another. The table and the carriage are clamped together by a split reverse V-ring which brings these two parts down together firmly all around their whole periphery, and makes the table practically solid with the carriage. The short weighted lever seen just at the front of the cross slide is used to withdraw or insert the locking bolt for indexing the work table.

The carriage itself is adjustable crosswise of the machine on the base by which it is supported. This adjustment is guided by another bearing at the center to keep the movement accurately at right angles to the line of travel of the spindle. The movement is not a sliding one, there being no vertical pressure on this central bearing, and the vertical pressure at the edges being taken by a train of rollers on each side. Suitable clamps are provided for binding the carriage firmly to the base when the adjustment has been made. Instead of using fixed stops to locate the successive cross positions of the carriage required in boring multiple cylinders (or a series of single cylinders mounted side by side) a contact point and multiplying pointer are used to indicate the reaching of any desired position. Distance pieces of the required length are inserted between this contact point and the finger of the

pointer, thus providing for an accurate setting at the various cross distances desired. This is much more satisfactory than the using of stops, which probably could not be set in line with the thrust of the screw, and which would, for other reasons as well, give varying results in accordance with the degree of pressure applied to them.

The two ends of the machine are driven entirely independently. A driving shaft extends the length of the bed at the rear of the machine. This is connected by suitable gearing, as shown, with the splined shafts which lead to each of the heads. The connection with each of these splined driving shafts is through a friction clutch controlled by levers at the side of the bed in convenient position for inspecting the work, so that either may be stopped independently of the other. Each member is also provided with an automatic power feed driven by a sprocket-wheel and chain, as shown, from the driving shaft, and connected through a change gear box which gives four rates of feed. A drop worm and automatic stop are provided, so that the feed is arrested when the proper depth of boring has been reached. For the rapid handling of the head, a power traverse is provided, controlled by the lever seen just in front of the clutch lever on each end of the machine. Each head thus has independent controlling mechanism throughout.

LAPOINTE BROACHING MACHINE ARRANGED FOR BROACHING TAPERS.

The broaching machine built by the LaPointe Machine Tool Co. of Hudson, Mass., has recently been adapted by its builders to the broaching of taper holes. The machine thus arranged is shown in Fig. 1, while Figs. 2 and 3 show, respectively, the shape of the hole broached and the construction of the cutting tool by which the operation is performed. It is evidently impossible (except in the case of holes as large as in the job described in the July, 1908, issue of MACHINERY) to complete the forming of a square taper in one operation. This would require, as in the case there described, that the broach be made in sections, which must be guided in such a way as to travel in paths at the proper angle with each other to give the required taper. In the case of small work like that here shown, the plan is followed of cutting one corner of the taper at a time, and then indexing the work to four successive positions until each corner has been cut, which thus finishes the entire hole.

Fig. 1. Arrangement of Head and Cutter-bar for Broaching Tapers in the Lapointe Machine.

The work performed is indicated in Fig. 2. As shown, the hole to be broached is first finished with a taper reamer slightly larger at the large and small diameters than the width across the flat sides of the finished taper hole at the large and small ends. This gives a little clearance space for the broach to run out into on each of the operations. This round tapered hole also serves as a seat for the taper bushing on which the work is supported during the cutting operation, and as the broaching does not entirely clean out this hole, the bearing remains to the completion of the final operation. The work bushing and head may be seen in Figs 1 and 3. The work bushing, turned on its outside to the taper of the hole in the blank, is mounted at the head of the machine on a base which is inclined to the angle of the corner of the internal taper to be cut. In a groove formed on the under side of this tapered work bushing, slides the broach or cutter bar, having teeth formed in it after the usual fashion of such tools, smaller at the inner end and gradually increasing in height to the outer end until they conform to the full depth of the cut to be made. The work, of which several pieces are shown at the base of the machine in Fig. 1, has clamped to it a dog, as shown, with a slotted tail, adapted to engage any one of the four pins disposed equi-distantly about the edge of the disk which forms the base of the taper work bushing.

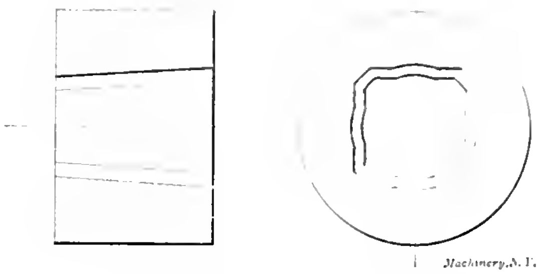


Fig. 2. The Taper Hole to be Broached.

In operation, the broach having been run out to the extreme of its travel, the work is inserted over the broach and pushed on to the taper work-holding bushing, and is located as to angular position by the engaging of the dog with one of the four pins as described. The machine is then started up and the broach is drawn back through the work, cutting out one of the corners. Then the blade is again run out, the work is drawn off by the taper bushing far enough to permit rotating it until the dog engages a second pin, when the operation is repeated, cutting out a second corner. The other two corners are successively finished in the same way, thus completing the machining of the hole to the form shown in Fig. 2.

It may be noted that while the hole shown has flatted corners, these are not required, as the broach can be made with a sharp corner if necessary. In all cases, however, it is necessary to leave a portion of the taper hole in the flat of the square, as shown in Fig. 2, so as to center the work with the bushing. Less of the circle, however, can be left than is shown in the engraving. For instance, at the large end the round taper hole need be only about 0.010 inch deeper than the square to be cut.

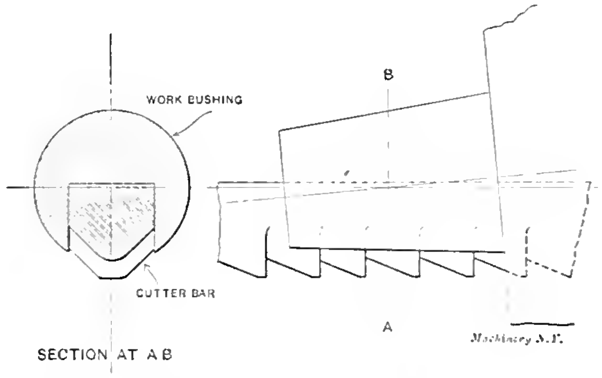
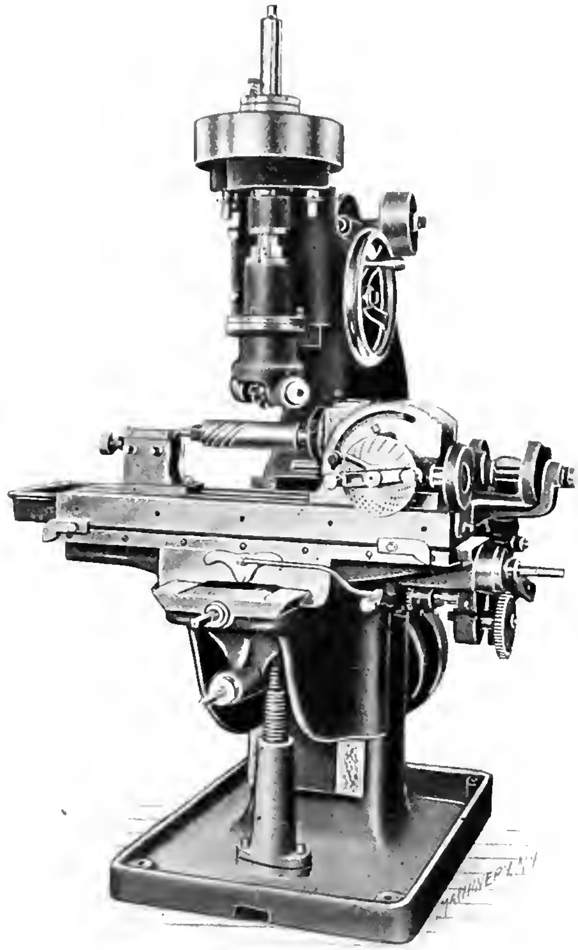


Fig. 3. Detail of Work-holding Bushing and Broach.

SPIRAL CUTTING ATTACHMENTS FOR THE BECKER VERTICAL MILLING MACHINE.

In the May, 1908 issue of MACHINERY, in the department of "New Machinery and Tools," we illustrated a horizontal attachment for the vertical miller built by the Becker Milling Machine Co. of Hyde Park, Mass. This horizontal attachment, it will be remembered, bears the same relation to the vertical milling machine, that the vertical attachment often furnished by horizontal milling machine builders bears to their product. It is adjustable at any angle about the axis of the spindle, the movement taking place in a horizontal plane instead of in a vertical plane, as in the case of the regular column and knee type machine. The builders of this attachment have recently designed the arrangement herewith shown, for providing a universal spiral and dividing head and connecting it with the table feed-screw. This device permits the cutting of spirals and doing other work which is strictly within the province of the universal milling machine.



Spiral Cutting Attachment applied to Becker Vertical Milling Machine.

The accompanying engraving shows the horizontal attachment and the spiral cutting arrangement mounted on the vertical milling machine, using a regular spiral head as provided with the builders' line of horizontal millers. The connection with the feed is made by means somewhat similar to that employed in the case of the circular milling attachment, with which this type of machine is often provided, except that both the table feed and the feed for the head are used simultaneously, while the ratio between them is varied by change gears to give a suitable range of spirals adapted to the general run of work of this kind. When set to the proper ratio, the operation of the table feed revolves the work spindle of the index head through the indexing mechanism, in the same way as in the universal miller.

The cutter, of course, for spiral work, has to be set at the helix angle of the groove to be cut. In the universal milling machine this is effected by swinging the table about a vertical axis. With the arrangement here shown, a corresponding effect is produced by swinging the spindle of the horizontal attachment about the axis of the spindle of the machine. This can be done with the same facility as in the universal miller, it being possible to center the cutter while the spindle is at right angles to the axis of the work and adjust it afterwards to the helix angle without altering the center adjustment. This makes the arrangement much superior to the devices oftentimes used on horizontal machines for somewhat similar purposes, where the cutter is usually mounted off the center of angular adjustment so that it cannot be centered with the work conveniently. Another advantage over the attachment for the horizontal machine, is in the simpler motion obtained, it being necessary to change the axis of the revolving spindle through but one right angle turn instead of two.

The machine is also, when thus arranged, more adaptable in some respects than the universal milling machine without attachments, since it is unlimited in the matter of angular settings, it being possible to bring the cutter spindle to positions between 45 degrees and a line parallel with the work—an adjustment impossible in the universal miller, where the table usually has 45 degrees of adjustment on each side of the center. The arrangement gives the same facility for cutting spiral tapers, etc., that the universal miller does, and would seem to cover its field quite effectively. The machine to which the attachments are shown applied in the engraving is of an older style, which is soon to be replaced with a new line, which the builders are now preparing for the market.

AUTOMATIC TRIMMING MACHINE FOR BOLT HEADS.

When ordinary machine bolts with square or hexagon heads are produced by the cold-forging process, the heads are first forged circular, and special trimming machines are employed for producing the square or hexagon heads by trimming off the superfluous metal by a trimming process. In the following, a machine for automatically trimming bolt heads, placed on the market by the E. J. Manville Machine Co., of Waterbury, Conn., is illustrated and described.

In order to make the principles of the machine clearer, a few words may be said on the subject of cold-forging of bolts. The bolt blank with its circular head is produced in a heading machine, in a manner as indicated by the three illustrations in Fig. 1. In the heading machine the wire is taken from the coil, straightened, and fed a predetermined distance until a cutting mechanism cuts it off to the required length. A die then receives and protects that portion of the blank which is to form the body of the bolt, and a punch compresses the projecting end of the blank into a preparatory cone shape, as shown in the central view, Fig. 1. Finally, a finishing punch forms the head to a circular shape.

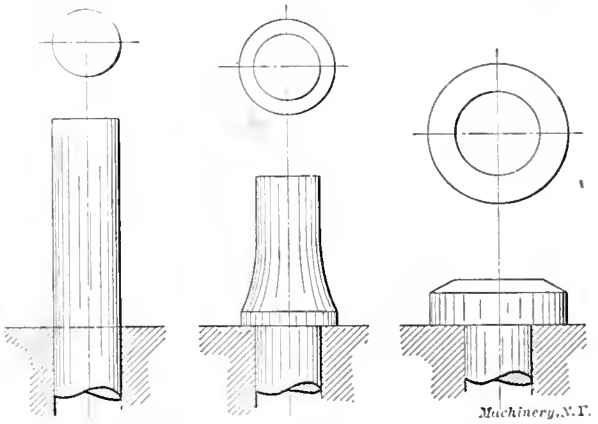


Fig. 1. Successive Steps in Cold Forging Bolts.

When the bolt blank is thus finished it passes to a trimming machine. Ordinarily the trimming operation is performed on a vertical power press, each bolt being placed by hand so that its body or shank is pushed up into a hollow punch, while the head is trimmed to the required shape. This process, however, is neither rapid nor safe, and the automatic bolt and head trimmer illustrated in Figs. 2 and 3 has been designed for rapidly carrying out the trimming operation.

The most important feature of this machine is the feeding device which must handle automatically several different sizes of work. The feeding device consists principally of a feed hopper, provided in its center with an oscillating slotted blade. This blade raises the blanks, holding them by their heads, and is pivoted at a point outside of the hopper. This lifter or blade is made of two plates of steel, riveted to a separating piece, the lower end of which is acted upon by a crank-pin and roller projecting from the face of a plate gear. This gear, in turn, is rotated by a pinion on the end of a short shaft driven by a belt on a 2-step pulley, the power being thus transmitted from the main crank-shaft, as clearly illustrated in Fig. 2. As the slotted blade passes upward through a quantity of headed blanks, several blanks will be lifted by their heads at each stroke. Owing to the incline of the blade when in its upper position, the tendency of the suspended blanks is to slide toward the lower end. A continuation of this sliding way is constructed of two stationary plates, as may be seen most clearly in Fig. 3, in which may also be seen the heads of several blanks automatically placed in proper position by the feeding device. At the junction of the stationary tracks and the lifting blade of the hopper, a device is introduced which stops the progress of every blank not properly delivered to the fixed track; this device returns such blanks to the hopper, and thereby insures a continuous action at the lower end of the race-way. A mechanically-actuated device holds back the descending column of blanks, and, at the proper moment, the lowest blank is separated from those behind it and forced outward into the spring jaws of a special carrier or transferring device as shown.

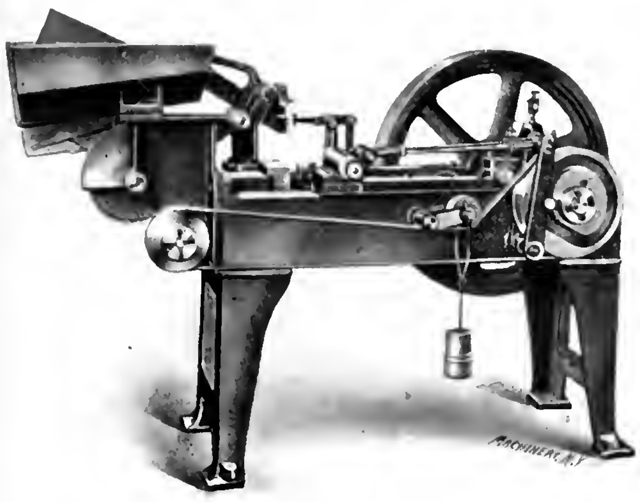


Fig. 2. Manville Machine Co.'s Automatic Bolt Head Trimmer.

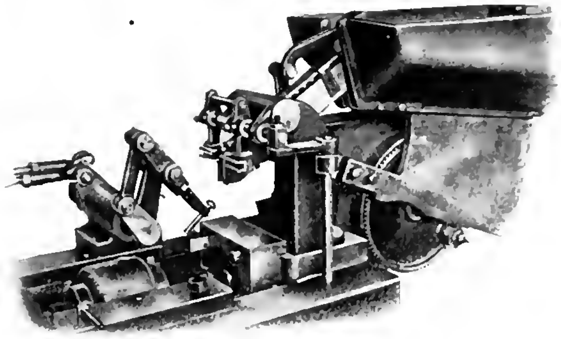


Fig. 3. Feeding Mechanism of Bolt Head Trimmer.

The blank is now transferred from the vertical position which it has had at the outlet point of the feeding device to a horizontal position in line with the punch and die for trimming the head. The mechanism by means of which this is accomplished consists of two rocking shafts working on the same center, each being moved through an arc of about 90 degrees by two cams on the crank-shaft of the machine. On the inner ends of these two rocking shafts are arms, to one of which is pivoted the finger lever holding the spring fingers which receive the blank from the feeding device and deliver it to the dies. A link joins the end opposite the spring finger and connects it with the second rocking shaft thus forming, as will be seen in Fig. 3, a parallelogram or linkage by which it is possible, with properly shaped cams, to cause a bolt held by the fingers to move in a predetermined path and place it in a horizontal position. When the bolt has reached the proper horizontal position, it comes to a rest until the hollow end of a square- or hexagon-ended punch advances a sufficient distance onto the end of the blank, at which moment the fingers move up to clear the punch.

The swinging fingers and their holders are easily removed from the finger lever and replaced by other fingers when a different diameter of bolt is to be handled. Means are provided for adjustment, so that the bolt will be placed in perfect line with the trimming tools at all times. When trimming the head, the punch advances on the shank or body of the blank until it reaches the under side of the head, when its further advance pushes the bolt head against the die and finally into it, thus shearing the head to the required shape. The punch then recedes, leaving the bolt in the die until, at the backward stroke, the bolt head is pushed out of the die by a knock-out pin.

EMMERT FACE GRINDING MACHINE.

The accompanying illustration shows a machine designed and built by the Emmert Mfg. Co., Waynesboro, Pa., intended for the grinding of lathe and planer tools, for squaring up ends of work, and for miscellaneous grinding in the toolroom or machine shop. As will be noticed from the illustration, the machine embodies several features in which its design differs from the common design of this kind of machine. One of the novel features is the provision for the use of a diamond for truing up both the side and the periphery of the wheel. This was made because the builders of this machine realized the difficulty of obtaining a true side on an emery wheel by an ordinary emery wheel dresser. A straight edge or surface on tools and a straight face on the edges of work is easier and more accurately obtained by using the side of the wheel than the periphery, provided the side is straight. To permit both the side and the periphery of the wheel to be used for grinding, the work table is located in front of the side of the wheel, and extends in front of the periphery, as shown. The table is carried by a transversely swinging arm, and in the end of the arm is a longitudinally adjusted diamond holder. When the table is in use, it may be either clamped to prevent any transverse rocking movement or adjusted to allow a certain amount of such movement, which is often of advantage when grinding wide work. When truing up the wheel, an adjustable stop below the table is moved out, and the table swung backward away from the wheel. In this position, the diamond is swung across the face of the wheel for truing purposes.

Emmert Mfg. Co.'s Face Grinder.

The table is designed to slide longitudinally and is provided with a threaded hole to receive the diamond holder, which can be transferred to this hole when the edge of the wheel is to be trued. The table slide is mounted on a pivot

in the swiveling arm, and can thus be clamped at any angle, up to 45 degrees with the face of the wheel. Graduations are provided for proper setting. On the table is also provided an adjustable squaring device or protractor, which may be set from 45 to 90 degrees with the surface of the wheel. The wheel spindle of the machine is hardened, and runs in adjustable bronze boxes. A water tank of ample capacity is provided for cooling the work. The wheels used are 12 inches in diameter by $1\frac{1}{2}$ inch thick, and are recessed in the center as shown.

UNIVERSAL BORING, MILLING AND DRILLING MACHINE.

The machine shown herewith is built by the Universal Boring Machine Co. of Hudson, Mass. As may be seen from Fig. 1, it is of the type in which the work table is provided with longitudinal and cross movements on a stationary bed, and in which the spindle is mounted on a saddle in such a way as to give it longitudinal movement in its bearings and a vertical movement, provided by the adjustment of the saddle on a stationary column. While the machine thus conforms to a type, the details of the design have been worked out in a very original and ingenious fashion. Some of these details are illustrated in Figs. 2, 3 and 4.

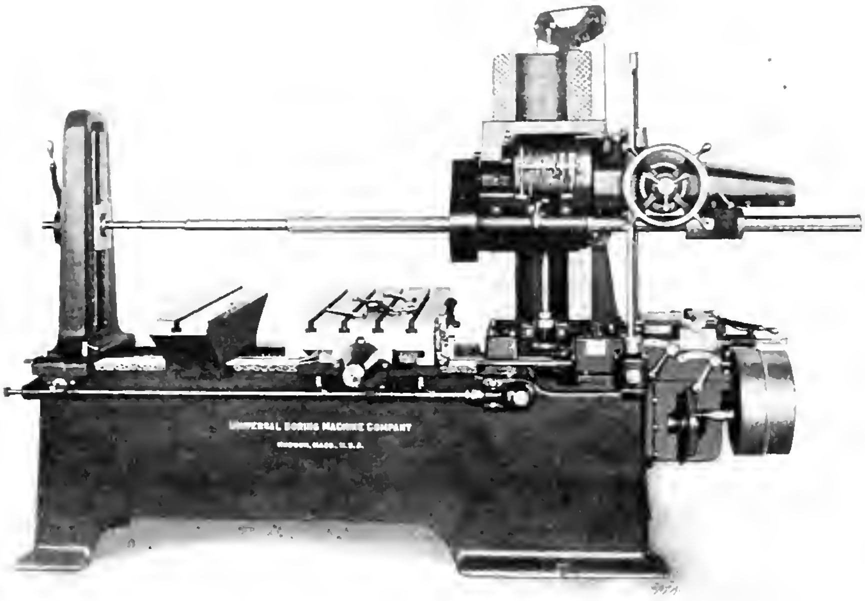


Fig. 1. The Universal Boring Machine Co.'s Universal Boring, Milling, and Drilling Machine.

In the first place, it will be noticed that the head is set at the right-hand end of the bed, contrary to previous practice in some other machines of this type. This arrangement permits running the spindle in the same direction for milling as for boring and drilling, and is convenient as well for the operator, who has the various controlling levers within easy reach of his right hand when closely examining the work. The base is of solid construction, and furnishes a suitable support for aligning the parts with sufficient accuracy to perform the high grade work for which the machine is intended. The column has guiding surfaces for the head so arranged that the latter is squared up by a comparatively long and narrow guiding surface, and at the same time it is provided with a wide area over which to distribute the wear. This guiding bearing has a length six times its width. In addition to this point, it should be noticed that the gibbing on one edge of the column is arranged with a square lock gib on the side nearest the work. One of the bearing surfaces on which the head moves is provided with a scale, which is graduated and marked in inches. The zero point indicates the position in which the center of the spindle is in a line with the top of the table.

An outboard support for boring-bars is provided, as shown, which is adjustable along the bed. The outboard bearing, which is gibbed to the internal guiding surface of this support, is raised and lowered by a screw connected by a spiral gearing and splined shafts to the elevating screw of the spindle head, so that the two move together simultaneously. A rapid raising and lowering movement is provided for the head. This may very profitably be used in connection with the vertical graduated scale just mentioned, making it possible to stop the rapid movement within $\frac{1}{8}$ inch of the desired setting of the spindle. From this point the hand adjustment is used to bring the dial on the elevating screw to a position to read the proper dimension in thousandths of an inch.

The boring-bar is driven from tight and loose pulleys operated by a belt running at constant speed. The loose pulley is provided with a method of self-oiling which does not require attention oftener than once a year or thereabouts. The design of the lubricating device is very simple, it consisting only of a hollow receptacle cast in the hub of the pulley, and filled with cotton waste which is saturated with oil, the latter being led to the bearing by a strip of wicking. Sixteen positive geared spindle speeds are provided, eight of them being obtained by a geared quick change mechanism, and this number being doubled by back gearing mounted in the head close to the spindle.

The construction of the speed box is shown in Figs. 2 and 3. To the driving shaft is keyed a cone of 4 gears *L*, fastened together, and capable of being shifted endwise by arms pinned to a rock-shaft *M*, which passes out through the front of the case. Here it has fastened to it a lever *A*, with a lock pin engaging four holes in the front of the casing, each of which corresponds to a position of the cone of four gears. On a shaft parallel to this driving shaft is mounted the tumbler gear arrangement shown in Fig. 2 and in detail in Fig. 3. This consists of a double rocker arm *N* mounted loosely on the shaft (though confined axially) and provided with pivots on each side of the shaft. On one of these pivots is mounted an idler gear *O* meshing with a small gear keyed to the shaft. On the other is mounted an idler meshing with a larger gear keyed to the shaft and pinned to a gear *P* having a position corresponding to the idler on the oppcsite pin of the rocker arm. This rocker arm has teeth cut in a segment of its periphery which mesh with a pinion operated by a crank *B* from the outside of the gear casing. This crank is provided with a pin which enters suitable holes in the casing, and thus determines the angular position of the rocker arm and the idler gears mounted on it.

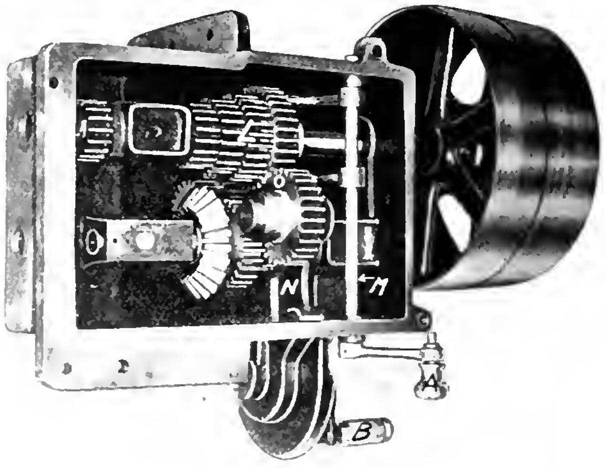


Fig. 2. The Change-gear Box which gives Eight Speeds.

The shifting of the cone of four gears and the rocking of the segment to which these idlers are pivoted, provides means for furnishing the changes of speed. In the position

shown in Fig. 2, the cone of gears is shifted so as to bring the largest one of the four in line with the pivoted idlers. In changing from one speed to another, these idlers are set in the neutral position, which allows the cone gears to be shifted freely without hitting them. When shifted to any given position, the holder carrying the idlers can be rocked to bring either the upper or the lower one into mesh with the gear presented for engagement, the position being located by the holes in which the lock pin on lever *A* is seated. The engaging of the upper or lower idler for each gear gives two speeds. This in combination with the four gears, gives eight changes of speed at this place, as previously mentioned. The bevel gear shown on the idler shaft in Figs. 2 and 3, transmits the movement through a vertical splined shaft to the head. From here (through a set of back gears operated by the handle seen at the front of the head) connection is made with a pinion driving a face-plate gear at the front end of the spindle. The sixteen speeds thus obtained range from 15 to 200 revolutions per minute, with a speed of 230 revolutions per minute given to the constant-speed driving shaft.

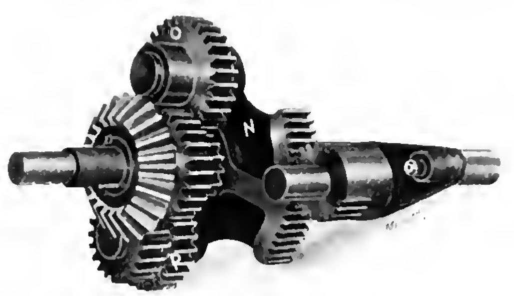


Fig. 3. Detail of the Tumbler Gear, seen in Fig. 2, which Doubles the Number of Speeds.

The spindle being thus driven by a geared face-plate on the side nearest the work, the capacity of the machine for doing heavy milling is greatly increased. Provision is made in the face of the spindle for bolting or otherwise fastening cutters, such as used in heavy milling work. The boring-bar feeds 27 inches, and can be arrested by a clamp bearing so that 55 inches of feed can be provided. A hand-wheel is set close to the work at a point convenient for operating and setting boring-bars. It allows the workman to be within easy reach of the cutting tool and of the hand-wheel and feed friction at the same time.

The machine has power feeds in all directions; that is, for the cross and longitudinal movements of the carriage, for the vertical movement of the head on the column, and for the longitudinal feed of the boring-bar. Nine feeds are provided, ranging from ¾ to 5½ inch feed per minute, taken from the constant-speed shaft. In connection with the spindle speed changes, this gives 144 different feeds in inches per revolution, ranging from 0.006 to 0.340. Of course all of these feeds per revolution cannot be obtained for each spindle speed.

The feed box is mounted above the speed change gear box at the right of the machine. It is controlled by levers *H* and *H*, each of which has three positions, permitting nine different combinations for the nine feeds with which the machine is provided. This mechanism controls all the feeds. It may be connected with the bar or table feed, as desired, by the manipulation of lever *C*. Connection with the feed elevating screw for vertical traverse in milling is made by operating lever *D*. This same lever shifted in the opposite direction gives a rapid movement of the slide on the column. These feeds, as well as all the other feeds and power traverse movements of the machine, are reversed by the operation of lever *E*. The power cross feed of the table is provided with an automatic stop operated by dogs seen at the right-hand side of the table in Fig. 1. The longitudinal feed of the carriage is obtained by connecting the splined feed shaft (transmitting the power to the table cross-feed screw) with the screw for the longitudinal feed of the carriage on the bed. This provision for power longitudinal feed of the carriage is an unusual one in boring machines, but it was so easily made that it was thought best to incorporate it in the design, as there may be cases in which it would prove useful.

All these adjustments can be operated for fine setting by hand as well, and it is interesting to note the way in which the adjustments and manipulating handles have been concentrated at the working end of the machine to make the operation as simple as possible. At *F* is shown the back gear controlling lever, the movement of which gives either a fast or slow speed to the spindle. This is located close to the spindle driving gear so that excessive torsion of long shafts is avoided. The hand-wheel for the rapid hand adjustment of the boring-bar is shown at *J*, with the feed friction mounted in its hub. The fine feed of the boring-bar, as well as the fine hand elevating adjustment, is effected by a crank on the end of squared shaft *K*. The carriage hand feed (which is out of the range of this engraving on the left) is controlled by another squared shaft. The belt shifter is seen at *Q*. A further point of convenience in the design of the tool is the segregation of the feed and speed mechanism in easily removable casings. The machine is to this extent constructed on the unit system. It is only necessary to remove six screws and pull out the feed and speed driving shafts, to permit the removal of the respective feed and speed box from the machine.

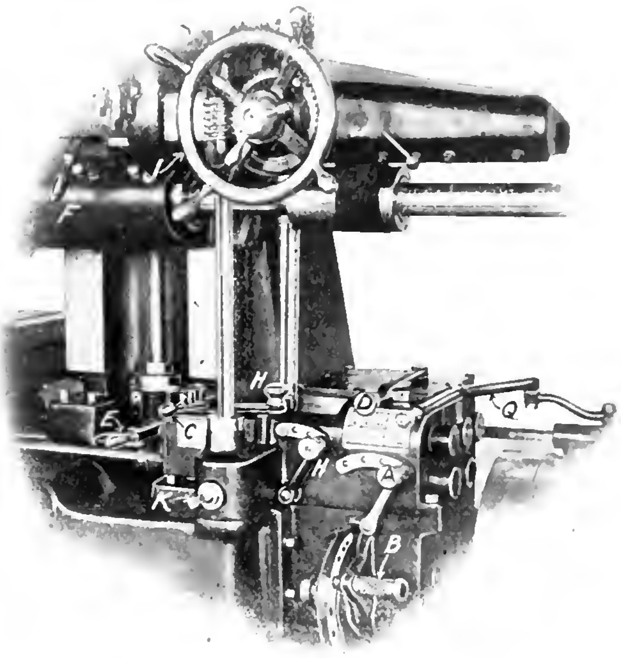


Fig. 4. View showing the Arrangement of the Controlling Handles in Locations convenient to the Operator.

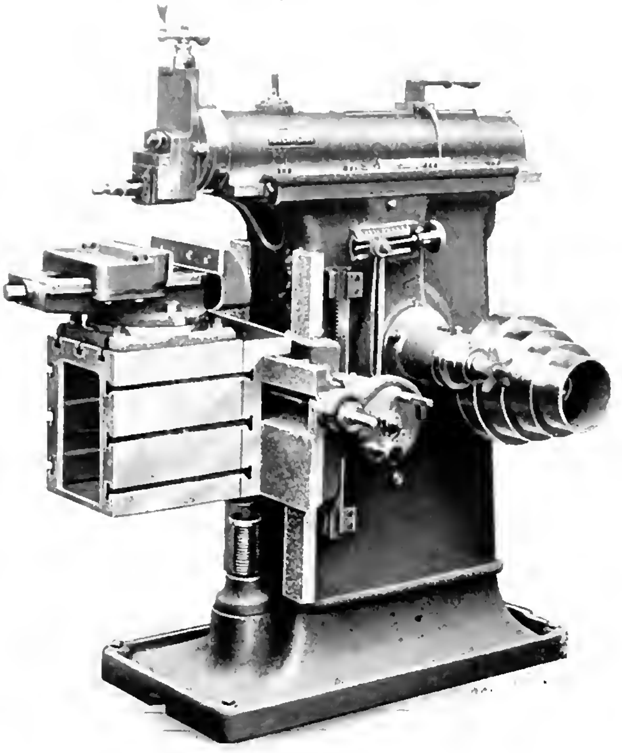
The machine is built to accurate dimensions throughout, so that the various parts are assembled without fitting in the principal dimensions. This means that a high grade of workmanship is employed, as is necessary on a machine to be used for the work for which it is designed. The weight and stiffness of the machine is also a great factor in producing accurate work. All the revolving parts such as shafts and studs are made of crucible steel and ground to size, while all bearings which have shafts running at any considerable speed are bushed with suitable bearing metal. In general, the builders have planned to make it a first-class tool in every respect, to meet the requirements for jig and fixture making, and for doing interchangeable work, as well, without the use of jigs and fixtures.

AMERICAN 15-INCH CRANK SHAPER.

Some time ago we published in MACHINERY a communication from one of our readers on the tool-room *versus* the machine-shop shaper. In this article many of the characteristic features required in each of these two classes of shapers were referred to. The distinction between a tool-room and a machine-shop shaper is becoming more and more apparent with the introduction of new machine shop methods, and it has been recognized by manufacturers of this class of tool that the ordinary shaper of the past is entirely inadequate to meet the demands of the present time. The shaper,

which in the past has often been regarded merely as a tool-room machine, has been made a manufacturing machine. In order to meet these changed conditions, the American Tool Works Co., 300-350 Culvert St., Cincinnati, Ohio, has brought out a new line of extra heavy and powerful shapers intended especially for heavy duty and designed with a view of permitting not only a high rate of production, but at the same time insuring accuracy of alignments and durability.

In order to secure the desired end, the column of the new shaper has been made wider and deeper than usual, and is strongly braced internally, thereby offering proper reinforcement along the lines of the heaviest strain. The column projects both at the front and the back in order to give a long bearing for the ram, and the base is made large, so as to give proper support to the machine. The ram is thoroughly braced by internal ribs, its bearing in the column is wide, and it is provided with a continuous taper gib, having end screw adjustment for taking up the wear. The stroke of the ram is positive, and there are four rates of speed, ranging from 20 to 65 strokes per minute. The length of the stroke can be changed without stopping the machine. A pointer on the ram, traveling along an index, as shown in the illustration, shows the length of stroke at any setting. The tool-carrying head can be set at any angle within an arc of 100 degrees, and is provided with an efficient locking device. The down-slide in the head is also fitted with a continuous taper gib, having an end-screw adjustment for taking up the wear. The feed-screw is provided with a graduated dial, reading to 0.001 inch. The tool-post is made large so as to permit using holders for inserted cutters.


Shaper of Heavy Design brought out by the American Tool Works Co.

The table is provided with three T-slots, both on the top and on the sides, and is made of a heavy box section, ribbed on the inside to insure strength. The apron has also three T-slots on its face to permit the clamping of work when the table is removed. The cross-rail is longer than usual, thereby giving the table a long horizontal range of travel. A telescopic elevating screw of large diameter is provided with ball bearings for making the elevation of the cross-rail easy. The cross-feed is of the builder's new patented design. It is variable and automatic, having a range from 0.008 inch to 0.200 inch, and can be changed while the machine is running. It is operated by the knob and screw shown on the side of the machine, by which a lever with an attached pointer is moved. The pointer indexes on a scale having 25 graduations, each graduation representing 0.008 inch feed. The construction is such that there is no necessity of change in adjustment of the feeding mechanism due to the change of position of the cross-rail. The feed gears are properly covered to prevent accidents.

The rocker arm is forked at the top, and this, together with a large opening through the column, permits a shaft of 2½ inches diameter to be passed under the ram for key-seating. Larger shafts may be key-seated by setting over the table so that the shaft passes outside of the column, the head then being set at an angle.

Throughout the design of this machine special attention has been paid to the lubrication of working parts. The ram slides are provided with felt wipers at both the front and center of the column. An oil pocket is cast integral with the column at the rear, for collecting waste oil. A large quantity of oil is stored in a pocket cast integral with the arm, and provided with suitable means of distribution for the thorough lubrication of the crank-pin and sliding block in the rocker arm. The counter-shaft has tight and loose pulleys 12 inches in diameter by 3¼ inches face, running at 180 R.P.M.

Some interesting tests have been carried out by the builders to ascertain the capacity of the machine. Cuts have been taken in cast iron ⅜ inch deep with 0.016 inch feed, 4 inches long, and ⅛ inch deep with 0.048 inch feed of the same length, with the belt on the second slow cone step. Another cut was taken in cast iron ¼ inch deep, 0.024 inch feed, 12 inches long, with the belt on the first slow cone step. In steel, a cut was taken ⅛ inch deep, 0.016 inch feed, 2½ inches long, with the belt on the second slow cone step, and the same cut 10 inches long, with the belt on the first slow step.

SCHELLENBACH 18-INCH CONE-DRIVEN LATHE.

The accompanying illustration, Fig. 1, shows an 18-inch by 8-foot cone-driven Schellenbach engine lathe, made by the John B. Morris Foundry Co., 933 Harriet St., Cincinnati, O. This machine is of the same general design as the company's geared head lathe, involving many original and ingenious features, which was illustrated in the June issue of MACHINERY. The difference between this machine and the one then described consists in the matter of the drive, the present machine being cone-driven instead of having a geared head.* It will, therefore, be necessary in this description only to call attention to the features involved in the design of the head, which is shown in section in Fig. 2. The driving cone is provided with three steps for a 3-inch double belt, the largest diameter of the cone being 12 inches. There are provisions for two sets of changes of speed through the back-gears, making in all nine changes of speed with a single speed counter-

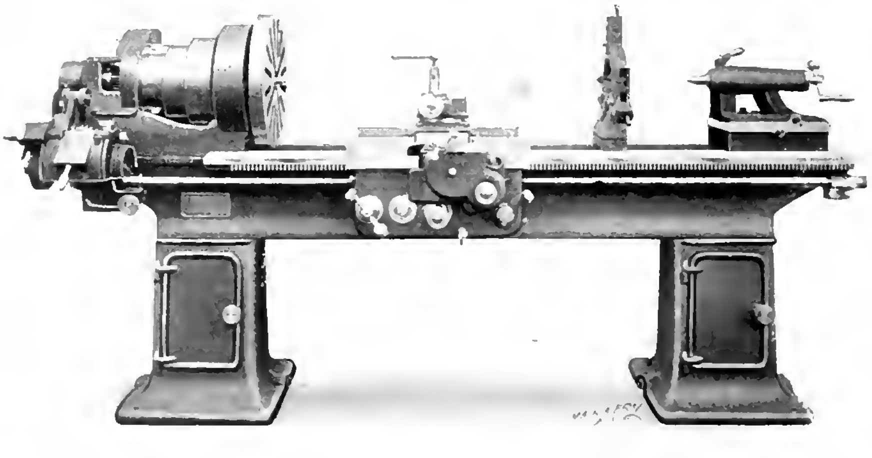


Fig. 1. Cone-driven Lathe built by John B. Morris Foundry Co.

shaft. However, the counter-shaft furnished with this machine is provided with double friction pulleys, and where a reverse motion is not required, it is possible to have a forward motion at two different speeds, thus giving 18 speed changes in all for the spindle of the machine. The back gears are operated in the usual manner. Special attention should be called to the very efficient manner in which the manufacturers have covered not only the back gears, but, in fact, all gearing on the machine. Not only has adequate covering been provided, but the covers have been made and attached to the machine in such a way as to present a very pleasing and harmonious appearance.

From the sectional view of the head, the arrangement of the drive can easily be studied. It will be seen that the spindle *A* has a flange at its right-hand end, where the gear *B* is doweled and screwed to it. This gear *B* is threaded internally in a recess, which receives the face-plates or the chuck. The chuck-plate *C* fits the counterbore of the chuck as indicated, is bored to fit on the end of the spindle, and is also threaded on the outside to screw into the gear *B*. It will be noticed that the flange of the spindle can thus be clamped tightly between the chuck-plate *C* and the gear *B*. This arrangement eliminates torsional strains within the spindle, when the drive is through the back gears. The overhang of the chuck from the face of the jaws to the front spindle bearing is not as great as with the ordinary type of lathe.

For the direct drive, the clutch teeth *D* formed upon the spindle engage with corresponding teeth in the clutch *E*, which is splined to a cone-pinion sleeve *G*. This clutch is operated at the back end of the head-stock by a spring-seated plunger, passing through the cone pulley. This plunger is provided with a knurled head having a pin to hold it out of engagement as shown.

The machine is provided with the quick change device described in connection with the geared head lathe, referred to above, giving a range of threads from 2 to 112. If required, the machine will be provided with a plain system of change gears as well as with this quick change system. While referring back to the former description for complete details, it may be of interest to mention some of the special features of this lathe, such as the double plate apron, and an arrangement for rough-chasing threads by the ordinary rack feed, in place of the lead-screw, the object being to preserve the accuracy of the lead-screw and to use it only for thread cutting where a high degree of perfection is required. This lathe is provided with cabinet legs, having hinged doors, as indicated. Another interesting feature is that a single wrench operates every adjusting screw throughout the lathe, including the tightening of the tail-stock to the shears. This lathe is also made in 14- and 16-inch sizes.

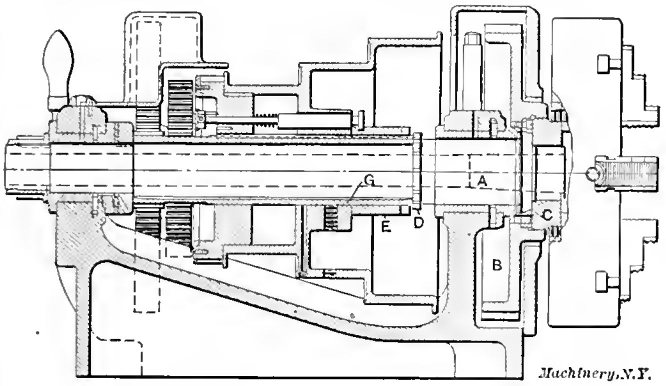


Fig. 2. Section through Head-stock of Lathe.

ACME HIGH-SPEED TWIST DRILL.

The drill and its socket illustrated herewith are manufactured by the Acme Drill Co., Sherman Ave. and Runyon St., Newark, N. J. The special feature of the combination is the strong drive obtained. As may be seen, the drill is made from a twisted bar of stock of special shape, milled accurately to dimensions. The shank is left straight and untwisted. The grooves in the sides of the shank are engaged by the rounded projections on the end of the collet, which effectively prevent the tool from rotating in its socket. The outside diameter of the shank is finished on a taper and fits a corresponding taper in the collet, being thus firmly supported and centered, as with the ordinary Morse taper drive. As may be seen, there is no tang to twist off. The drill is driven from its largest diameter, and no jaws, sleeve or wrench are necessary to tighten it. Owing to the method of manufacture, its cost is very low in comparison with other good high-speed drills.

A Twisted, Taper Shank Drill, with a Taper Drive.

The drill is made in standard sizes from ⅝ inch up to 2 inches, varying by 64ths. The collets and sockets correspond with the standard Morse taper sizes, and the collets have shanks fitting in Morse taper holes.

CINCINNATI FOUR-JAW INDEPENDENT CHUCK.

In Fig. 1 is shown an exterior view, and in Fig. 2, a cross-section of an improved independent chuck manufactured by the Cincinnati Chuck Co., Spring Grove Ave. and Sassafras St., Cincinnati, O. It might seem that there would be little possibility of improvement in an appliance so nearly standardized as the independent four-jawed chuck, but the makers have found that the tool is susceptible of improvement. In the ordinary independent chuck, the screws are mounted in semi-circular bearings, and receive the thrust on semi-circular shoulders formed in the cast-iron shell of the chuck. When these shoulders become worn in use, it is impossible to take out the play. As shown in Fig. 2, in this design, hardened bushings are provided at each end of each screw. The bearing surface and thrust surface occupy a full circle

Fig. 1. An Improved Design of Independent Chuck.

in each case, so that, in connection with the hardened materials used, the surface should wear at least three times as long. When end play becomes noticeable, it can be taken up by a machinist in a very short time, making the chuck as good as new in this respect. These bushings hold the screws absolutely in line with the jaw, preventing any tilting of the screws and consequent cutting of the thread. The screws are of the highest grade of spindle steel and have their bearings carefully ground. The shell is made from the best quality of gray iron, and the jaws are reversible.

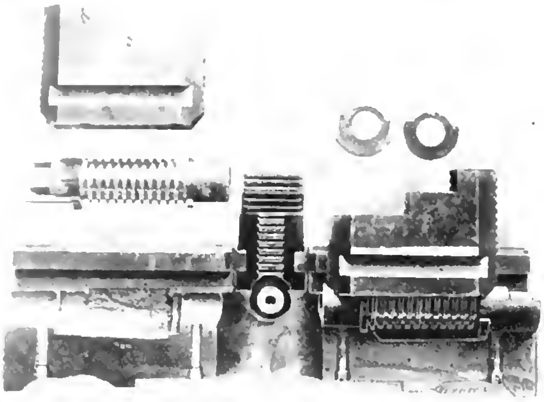


Fig. 2. Section of Cincinnati Chuck, showing Hardened Bushings for Screws.

THE VEEDER SPEED INDICATOR.

The Veeder Mfg. Co., of Hartford, Conn., has recently adapted the counting mechanism used in their well-known cyclometer and odometer to the work of the speed indicator. The device rearranged for this purpose is shown in Fig. 1, and in section in Fig. 2. As shown, it consists simply in mounting the regular registering or counting mechanism in the end of a drawn metal case, and in providing a ball bearing registering spindle and a suitable clutch for connecting it with the counter.

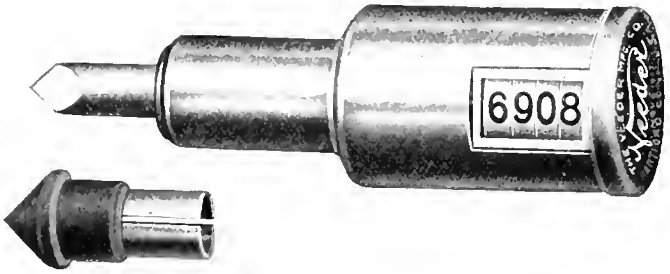


Fig. 1. The Veeder Speed Indicator or Revolution Counter.

The point of the spindle *E* is placed against the end of the shaft whose speed it is desired to measure. This spindle, which is provided with ball thrust bearings and is seated in bushing *F*, carries on its inner end the clutch member *C*. Under normal conditions, spring *D* presses bushing *F* outward so that the clutch member *C* is separated from the corresponding member *B*, attached to the spindle of the recording device. When, however, *E* is placed against the shaft whose speed it is desired to measure, spring *D* is compressed, the two clutch members come in contact, and the recording mechanism is driven from the shaft. When the reading is completed, the removal of the instrument allows the spring to expand, separating *E* and *C* and stopping the revolution of the counter.

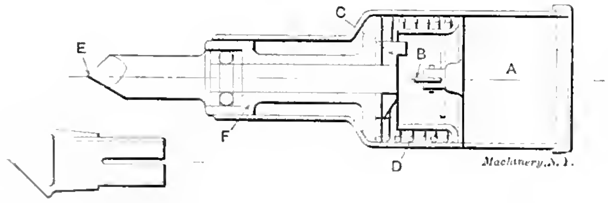


Fig. 3. Section through Indicator, showing Clutch and Ball Bearing

A feature of the device is the large number of revolutions provided for. The instrument registers up to 9,999 and repeats itself without requiring adjustment. This fact, and the ease with which the operation is automatically started and stopped, makes it possible to take readings without the use of the stop watch. Since readings may be taken for a long period of time even on high-speed shafts, it obviates the necessity for extreme accuracy in the timing of the interval. It is only necessary to watch the dial of the time-piece, the indicator itself requiring no attention. The difference between the readings of the counter at the beginning and end of the interval is the number of revolutions of the shaft in that time. It is essential to jot down the readings of the counter before beginning to count, because no arrangement is provided for setting it back to zero. Such a device would complicate the instrument, and it will be found much easier to take down the readings than to set back the counter. No matter in what direction the shaft runs, the difference between the readings will be the number of revolutions required.

The indicator is not affected by a magnetic field. This, in connection with the fact that the separate insulating tip shown is furnished with the instrument, makes it well adapted for use on generators and motors. It has frequently been used at as high as 5,000 revolutions per minute. It operates equally well in either direction, adding when running one way and subtracting when reversing.

Charles Stecher Co., 19 S. Jefferson St., Chicago, Ill. A high-speed bench drill which is built in miniature along the lines of the standard drill press, furnishing all the conveniences of the latter, including a slotted base for attaching large work. The base is cast in one piece with the countershaft frame. The drill is 10 inches swing and has a capacity for drills up to ½ inch in diameter.

Joseph Demarki, 194 Griffith St., Jersey City, N. J. Self-centering arbor which may be adjusted through a considerable range. This device is made in two sizes, one to hold from 4 to 10 inches, and the other from 10 to 20 inches. The work is gripped by a three-point bearing on each end, furnished by the sides of arms, spread outwardly by the pressure of a screw and nut.

Landis Machine Co., Waynesboro, Pa. All-steel cutter head of improved construction for holding and controlling the milled chasers used in this firm's bolt and pipe thread cutters. These chasers are made entirely of steel with the important wearing parts hardened. The head, when in closed position, is locked entirely within itself so that none of the thrust of the cutting action is taken between rubbing surfaces. Any set of chasers is adjustable for any diameter within the range of the head.

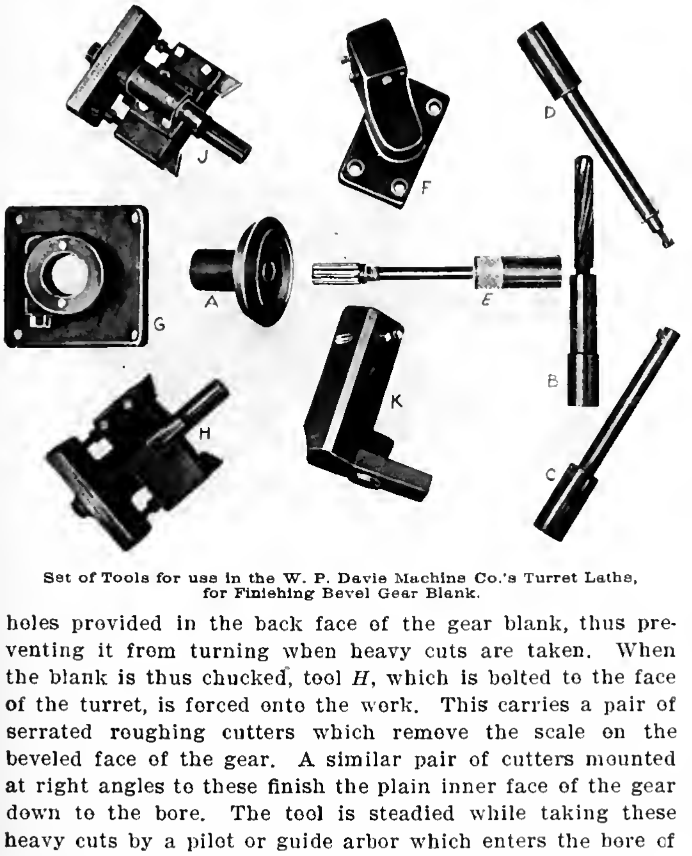
Bridgeford Machine Tool Works, Rochester, N. Y. A gap lathe intended primarily for refinishing car axle journals without removing the wheels, and for this purpose made with a very wide gap sufficient to clear car wheels of standard gage. It may also be used as a single end axle lathe. To make this possible, the head-stock is arranged so as to slide on the bed by a rack and pinion movement, to bring the wheel within the range of the carriage. It may also be equipped for refinishing engine truck axle journals, in which case an extra carriage is arranged between the wheels, leaving a short gap on each side.

Cincinnati Milling Machine Co., Cincinnati, Ohio. A new line of high-power milling machines, designed entirely from original data as to speeds, feeds, pressure of cut, etc., obtained from experiment. These machines are built on the unit system, and are so arranged that, by the interchange of various units, the machine may be arranged for constant speed or cone pulley drive (in either case with the shaft at right angles or parallel to the spindle), variable speed or a constant speed motor drive, and with the feed in inches per minute or in fractions of an inch per revolution. The same design throughout, with the exception of the spindle mechanism and the upper part of the column, is also used for the vertical spindle machine.

FINISHING BEVEL GEAR BLANKS IN THE DAVIS TURRET LATHE.

We show in the engraving a set of tools designed by the W. P. Davis Machine Co., Rochester, N. Y., for use on its turret lathe for finishing bevel gear blanks such as shown at *A*. This gear is clamped in the chuck with the hub projecting outward. The first operation consists in running the three-lipped drill *B* through the work. This roughs out the cored hole in the hub. This hole is next trued with the boring tool shown at *C*. The double-ended boring cutter at *D* is then passed through the hole, sizing it ready for the reaming. The reamer shown at *E* is mounted in a floating holder and finishes the hole to accurate size. The knee tool *F* is now brought into position and the outside of the hub is rough turned, after which it is finish turned with a similar tool *K*. All of these tools, of course, are carried by the turret. The back of the gear and the end of the hub are next faced with cross-slide tools, completing the machining of this side of the gear.

In the second operation, the turned shank of the bevel gear is held in the special chuck shown at *G*. This consists of a simple casting, bolted to the face-plate of the lathe, and having a bored hub provided with a clamp similar to that in common use for holding tool shanks in the turret of the screw machine. It is provided also, as shown, with two pins projecting from the face of the boss, which fit into corresponding holes provided in the back face of the gear blank, thus preventing it from turning when heavy cuts are taken. When the blank is thus chucked, tool *H*, which is bolted to the face of the turret, is forced onto the work. This carries a pair of serrated roughing cutters which remove the scale on the beveled face of the gear. A similar pair of cutters mounted at right angles to these finish the plain inner face of the gear down to the bore. The tool is steadied while taking these heavy cuts by a pilot or guide arbor which enters the bore of the work. The tool shown at *J*, which is very similar in construction, is next brought into operation to finish these same surfaces. The finishing of the back bevel in the blank is effected by forming tools carried in the front and back cross slides, one of them being used in the roughing operation for removing the scale, while the other finishes the surface to size.



Set of Tools for use in the W. P. Davie Machine Co.'s Turret Lathe, for Finishing Bevel Gear Blank.

This series of two complete operations requires 15 minutes for each gear, from the rough casting to the finished blank complete. The dimensions of the finished work are: diameter of hub, 2 5/16 inches; outside diameter, 6 5/32 inches; length over all, 5 inches. The builders of this outfit make a specialty of providing their turret lathes with suitable sets of tools for rapid and accurate work on cast iron parts of varied shapes and sizes.

* * *

Remember that the world does not owe you a living, but it does owe you an opportunity to earn a living.

AN AMERICAN MECHANIC IN EUROPE—7.

A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

Copenhagen, Denmark, September 14, 1908.

The business conditions in the Scandinavian countries have, although slowly, continued to improve during the month of August. Judging from the reports in the trade journals and from the opinions of a few machinery dealers who have direct connections with the large trade centers in Germany and England, the conditions in these countries have improved even in a greater degree, and hopes are expressed that the crisis of the year will soon have passed entirely. The labor troubles in Sweden, which were referred to in my letter in the September issue, have been satisfactorily settled, and a return made to normal conditions in this respect.

General Conclusions regarding the European Machine Tool Trade.

The present letter will conclude the series which the writer has contributed to Machinery regarding European trade conditions. It may, therefore, be appropriate to here summarize some of the general conclusions reached, and emphasize the points which appear to be of the greatest importance.

If a comparison is made between the general state of development of the machine tool industry in America and the different countries which the writer has visited during the past spring and summer, it must be said that America is still holding its own, and is leading in this industry. This is true both in regard to the design of machine tools and in regard to the methods of manufacture. Without underestimating the importance of design, the methods of manufacture are, however, in the opinion of the writer, of greater importance. When meeting the competition of foreign manufacturers on foreign ground, the American makers face the disadvantage of higher per capita wages, and in order to lower the cost of manufacture per machine, systematic methods must be employed. Germany, however, has not failed to see the importance of this. The advantage of the systematic methods which can be employed in specialized manufacture are being more and more recognized. It is true that in Germany there still exist many concerns which work along in the old rut, and which have not as yet specialized in any particular line; but these firms are forced to recognize the success achieved by such manufacturers as have devoted themselves to a single line, and in order to be able to compete, the former firms must finally follow the trend of the times.

England must be considered as a close third in regard to modern machine tool manufacture. Some English makers appear to be somewhat more conservative than the German, and seem to believe in the superiority of their own methods, but this is not true of all English firms, and there are many concerns which can be favorably compared with average American firms in regard to equipment and product. With the exception of France, where the machine tool industry has not reached any large proportions, the remaining European countries are small as compared with the ones mentioned; and shut out from one another by tariff walls, they find it, as a consequence, difficult to keep step with the larger nations. Forced to largely depend upon the home market, the firms of these smaller nations cannot turn out their product in very large quantities, and are consequently, in a measure, prevented from specializing to the same extent as is possible in a large country with a large home market. These smaller nations too, however, are learning the industrial watch-word of the times, "specialization."

What has been said above with reference to the situation of the machine tool industry in the different countries is, of course, true only in a general way. It must be understood that there are to be found concerns of the very highest standard in any country, no matter what its size is. These concerns have, so to speak, broken away from the peculiarities that belong to the different nations, and have become more or less international in the manner in which they are managed.

It must be considered an undeniable proof of the superiority of the design of American machine tools that they are so frequently copied abroad, sometimes even by firms having a

reputation of their own. Germany appears to be the hot-bed of this copying, but it is by no means confined to that country. The writer found evidences of such copying in a large number of places, all the way from Italy to Sweden. It should be understood, however, that it is not only American machines that are subject to imitation, but all good designs, of whatever origin, are imitated in a degree corresponding to the quality of the design and the usefulness of the machine. This same system of imitation, of course, also takes place in America, one manufacturer imitating the successful design of another. This imitation in a sense, is deplorable, because it very often prevents a concern which has expended a great deal of capital and energy in the development of a machine of high standard from reaping its due profit, and it is difficult to find a remedy outside of the protection afforded by patent laws.

In my previous letters I have pointed out, from time to time, that many American machine tools are, in some respects, too weak for European conditions and material, and opinions to this effect expressed by European machine tool users have been quoted. Although it is true that, generally speaking, the American design is weaker than the European one, it seems, however, as if some of the persons interviewed had exaggerated the matter. Although it cannot be denied that when used on very heavy work and hard material, as used in Europe, American machine tools are often too weak to stand the strain, it may sometimes be that the machines have been put to uses for which they were not intended. No matter to what extent the criticism is unjustified, however, the American manufacturer should not permit it to pass by unnoticed, because many European users believe that the American machine tools are too weak, and even if their ideas are erroneous, whatever can be done to prevent such an opinion from working an injury to American export trade ought to be done.

It should once more be emphasized in connection with this that American manufacturers who really want any European market should not neglect to thoroughly study the conditions of the machine industry over here. Many conditions here influence the American machine tool trade which appear to be comparatively unknown in America; the European industries are making rapid progress, and the situation of a dozen years ago is changing by leaps and bounds, and it is surely necessary for American machine exporters to keep posted in order to know how to handle the trade properly.

It has been pointed out to the writer by a few machine tool users that there is a tendency of the modern machine tool designer to make the machines too complicated. It has been claimed that there are features on the machines which are but very rarely used, and when the time required for placing the attachments in proper position on the machine is considered, it often eliminates any saving in time from their use. There may, of course, be several reasons for this claim. Sometimes the user himself may be at fault because of having bought the wrong machine for his needs; sometimes the operator may be inexperienced in the use of an attachment which is but seldom required, and spend an unnecessarily long time in its adjustment. At any rate, there is apparently some truth at the bottom of a matter so often pointed out. The criticism seems to particularly refer to the universal machines in which the designer attempts to have the machine accomplish almost anything, thereby making it too complicated, and consequently too expensive. When buying such a machine, the user often has to pay for some feature which he will never need.

In an open market, Europe, of course, has, if it employs modern manufacturing methods, still an advantage in the somewhat lower wages that are paid here, but the general tendency in the European countries is for a decided increase in wages, and it may be that, before many years, about the same level in wages will be reached in Europe as prevails in America. This will eliminate one of the arguments used by the advocates of a protective tariff, and might perhaps lead to a reduction in tariff duties between the various industrial countries of the world. This would mean a larger market for the manufacturers of machine tools, and leave room for a still greater degree of specialization than that of the present day, thereby making possible a better utilization of human labor, natural resources, and capital.

OBITUARY.

Lyman M. Starrett, one of the builders of the *Monitor*, and the oldest printing press pattern-maker in America, died at his home in Brooklyn Manor, Long Island, September 15, aged seventy-five years. For sixty years he had been an employe of R. H. Hoe & Co., New York. He was the inventor of the first street sweeper drawn by horses, and of a number of other valuable devices.

Gardner D. Hiscox, the author of several well-known books on technical subjects, died at his home in East Orange, N. J., September 13, aged eighty-six years. Mr. Hiscox was the author and compiler of "Mechanical Movements, Powers and Devices," "Compressed Air: Its Production, Use and Applications"; "Horseless Vehicles, Automobiles and Motor Cycles"; "Modern Steam Engineering"; "Hydraulic Engineering," etc. Although a prolific writer and a man of considerable repute as authority on mechanical subjects, Mr. Hiscox was not a college graduate, having had a common school education only. His wife, three sons and a daughter survive him.

Dr. Theodor Peters, President Verein deutscher Ingenieure (Society of German Engineers) died in Berlin, September 2, 1908. Dr. Peters had devoted all his time and energy to the interests of the society for more than 25 years, and the important position which the society to-day occupies among the leading engineering associations of the world was largely due to his untiring efforts. He was particularly interested in the publication of the *Technolexikon*. At the present time it seems as if this stupendous undertaking would be carried to a successful completion, although it was not permitted one of its ablest and most enthusiastic supporters to see the work finished.

Edward B. Pike, president of the Pike Mfg. Co., Pike, N. H., died at his home, August 24, following an operation for appendicitis, aged sixty-three years. He was salesman for the Enterprise Mfg. Co., Philadelphia, beginning in its employ some time in the early 70's, and finally becoming head salesman. His health becoming impaired, he associated with his brother, A. F. Pike, in the scythe-stone and oil-stone business in 1878, and in 1884 the A. F. Pike Mfg. Co. was organized with A. F. Pike president and E. B. Pike vice-president. The brother died in 1891 and E. B. Pike became president. The business was rapidly developed under Mr. Pike's management, and is one of the best known in the sharpening stone trade.

* * *

PERSONAL.

H. M. Lucas, president of the Lucas Machine Tool Co., Cleveland, Ohio, sailed for Europe, September 5, for a business trip in the interest of his company.

Henry C. Karlson has opened an office at 39 Cortlandt St., New York, where he will act as solicitor of patents and as designer of automatic and special machinery.

H. L. Mills, formerly of the sales department of the Whiting Foundry Equipment Co., has resigned to become president of the American Specialty Co., 1440 Monadnock Blk., Chicago, Ill. This company is marketing the "Use-Em-Up" drill socket.

W. B. Gardiner, for the past ten years employed in the model department of the Winchester Repeating Arms Co., New Haven, Conn., has been appointed superintendent of the manufacture of the Smith one-lock adjustable reamers, made by the Wm. J. Smith Co., New Haven.

Richard Froboese, recently mechanical engineer of the Imperial Gas Engine Co., San Francisco, Cal., has engaged in business for himself as consulting engineer in all matters pertaining to gas power. Mr. Froboese, who is a graduate of Braunschweig, Germany, will have an office at 507 Mission St., San Francisco. His experience in the past eight years was with the Power & Mining Machinery Co., Milwaukee, and the Union Gas Engine Co., and the Hercules Gas Engine Co., of San Francisco. He designed the present types of engines now

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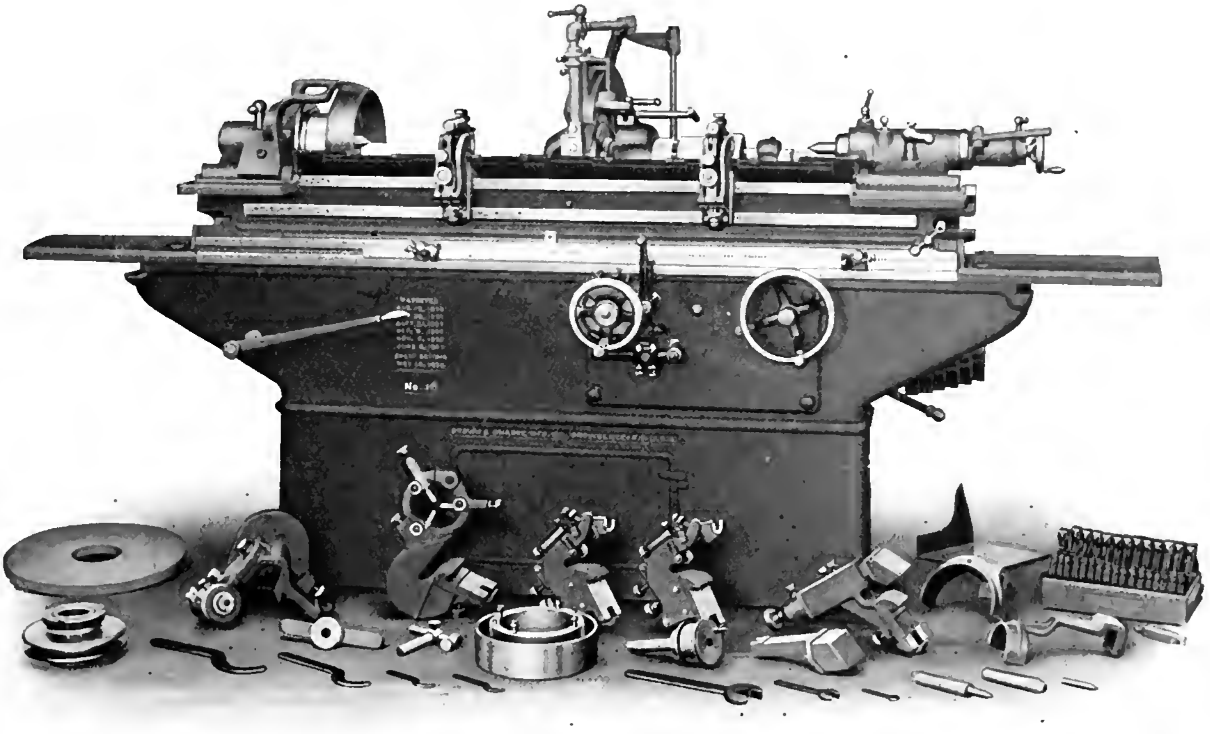


The importance of this point cannot be overestimated in that the Grinding Machine you want is the one that will wear well.

And nothing contributes so much toward the attainment of lasting accuracy as emphasis on Quality of Workmanship.

Sufficient weight that vibration may be eliminated as far as possible, each part in right relation to the whole, and correct alignments insisted upon, are all factors that establish accuracy as a permanent feature in B. & S. Grinding Machines.

A CIRCULAR OF ANY OF THE B. & S. GRINDING MACHINES SENT TO ANY ADDRESS.

being built by the latter company, and it is his intention to specialize along this line as consulting engineer.

C. L. de Muralt has been reappointed professor of electrical engineering at the University of Michigan for the coming year. Prof. Muralt will devote his attention during the winter semester to the consideration of the general aspects of applied electricity. The course of lectures will include discussion of the characteristics and application of electricity and continuous current motors; the design, construction and operation of electric plants; the principles and methods of transmitting, distributing and controlling alternating currents; the calculation and operation of electric railways; and the commercial management of electric properties and interests.

* * *

COMING EVENTS.

October 12-16. American Street and Interurban Railway Engineering Association convention at Atlantic City. Office of the Secretary-Treasurer, Engineering Societies Building, 29 West 39th St., New York.

October 13.—The season of professional meetings of the American Society of Mechanical Engineers will be opened in October by a meeting of the Gas Power Section, in the Engineering Societies Building at 29 West 39th St., New York. Mr. H. L. Doherty, chairman of the Meetings Committee of the section, will present a report for discussion, outlining plans for future work, and there will also be a discussion of standards to be used in gas power work. Two papers will be read, one by E. A. Harvey on gas-producer plants, with data upon costs, performance, etc.; and one by N. T. Harrington giving the results of tests to determine the loss of fuel weight in a freshly charged producer, due to increase of ash contents in the fuel bed. The first paper will be illustrated by lantern slides, showing actual plants and plans for the arrangement of apparatus.

October 13-15.—Annual meeting of the Railway Signal Association at Washington, D. C. C. C. Rosenberg, 12 North Linden St., Bethlehem, Pa., secretary.

October 13-15.—Annual meeting of Federation of Trade Press Associations, at Chicago, Ill. Morton Hiscox, secretary, 1431 Monadnock Block, Chicago, Ill.

October 20-21.—Annual convention of the National Machine Tool Builders' Association at the Hotel Imperial, corner of Broadway and 32d St., New York P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio, secretary.

October 22.—Machinery's annual outing.

November 19-21.—Annual meeting of the National Society for the Promotion of Industrial Education, Atlanta, Ga. James P. Haney, 546 Fifth Ave., New York, secretary.

December 1-4.—Annual convention of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York City. C. W. Rice, 29 W. 39th St., New York, secretary.

December 31-January 7.—Ninth annual show of the American Motor Car Manufacturers' Association at Grand Central Palace, New York City.

January 16-23.—Ninth annual show of the Association of Licensed Automobile Manufacturers at Madison Square Garden, New York.

NEW BOOKS AND PAMPHLETS.

Wireless Telegraphy and Telephony. By Walter W. Massie and Charles R. Underhill. 76 pages, 4¾ x 7¼ inches. 28 illustrations. Published by D. Van Nostrand Co., 23 Murray St., New York. Price $1.00.

This work describes in simple manner the nature of ether waves and the apparatus used in wireless telegraphy and telephony. It is explained that the ether waves employed in wireless telephony differ from light waves, principally in the length of the wave. Light waves range from 1/64,000 inch for extreme violet to 1/33,000 inch for extreme red, while the waves employed in wireless telegraphy vary in length from 650 feet to nearly 2 miles. The work will be found valuable by those who desire a non-technical description of the art.

A Proper Distribution of Expense Burden. By A. Hamilton Church. 116 pages, 5 x 7½ inches. Published by the *Engineering Magazine*, New York. Price $1.00.

The book is made up of a series of articles originally published in the *Engineering Magazine*. The author has given much attention to the correct distribution of the expense burden, which, as everyone knows, is one of the difficult problems in accurate cost accounting. It treats of interlocking general charges with piece costs; distributing expense to individual jobs; the scientific machine rate and the supplementary rate; classification and dissection of shop charges; mass production and new machine rate; and the apportionment of office and selling expenses.

Manual for Engineers. Compiled by Charles E. Ferris. 162 pages, 2¾ x 5½ inches. Published by the University Press, Knoxville, Tenn. Price 50 cents.

This popular compilation of tables and other data has passed into the eleventh edition. The last edition contains new and valuable matter, including a carefully arranged four-place logarithm table. A four-place logarithm table answers for many arithmetical problems in engineering work, as well as the more cumbersome tables of five, six, or more places. The work was originally compiled to bring before the minds of business men and manufacturers, the strongest possible argument in favor of technical education, giving, as it were, an object lesson of the vast fund of technical data available to those interested in mechanical work.

Internal Combustion Engines. By Rolla C. Carpenter and H. Diederichs. 597 pages, 6 x 9 inches. Illustrated. Published by the D. Van Nostrand Co., 23 Murray St., New York. Price $5.00.

The aim of the author in the preparation of this work was to present in as simple terms as possible the fundamental and theoretical principles, relating to internal combustion engines, and to describe the various methods of applying these principles to the practical construction. The contents of the work by chapters are as follows: Introduction, Definitions and Classification, Indicated and Brake Horse Power; Thermodynamics of the Gas Engine; Theoretical Comparison of Various Types of Internal Combustion Engines; The Various Events of the Constant-Volume and Constant-Pressure Cycle as Modified by Practical Conditions; The Temperature Entropy Diagram Applied to the Gas Engine; Combustion; Gas-Engine Fuels—the Solid Fuels, Gas Producers; The Gas-Engine Fuels—Carbureters and Vaporizers; Gas-Engine Fuels The Fuel Mixture, Explosibility, Pressure and Temperature; The History of the Gas Engine; Modern Types of Internal Combustion Engines; Gas-Engine Auxiliaries, Ignition, Mufflers and Starting Apparatus; Regulation of Internal Combustion Engines; The Estimation of Power of Gas Engines; Methods of Testing Internal Combustion Engines; The Performance of Gas Engines and Gas Producers; Cost of Installation and of Operation.

CATALOGUES AND CIRCULARS.

Morse, Williams & Co., Philadelphia, Pa. Catalogue No. 4 on Hindley worm gears and Hindley spirals. The catalogue is illustrated with examples of Hindley gearing used in pump drives, windlasses, turret turning apparatus, etc.

Rockwell Furnace Co., 26 Cortlandt St., New York. Catalogue of portable heaters and melting furnace for melting all metals, tinning, galvanizing, tool hardening and all operations requiring molten metal or other heated baths.

C. H. A. Dissenger & Bro., Wrightsville, Pa. Catalogue A of Capital gas and gasoline engines, made in sizes from 2½ to 200 horse-power; also catalogue B of Capital gasoline traction engines, built in sizes from 16 horse-power to 80 horse-power.

Thompson Grinder Co., Springfield, Ohio. Catalogue of Thompson universal grinding machine, showing the grinder converted into a plain grinder, a surface grinder, a die grinder, a knife grinder, an internal grinder, a cutter grinder, a high-speed grinder, etc.

Lufkin Rule Co., Saginaw, Mich. Catalogue No. 48 on measuring tapes and rules of every description. The list includes steel tapes, bronze tapes, surveyors' chain tapes, pocket steel tapes, pocket linen tapes, metallic warp tapes, steel rules, steel shrink rules, tinners and circumference rules, etc.

Lumen Bearing Co., Buffalo, N. Y. Booklet advertising Lumen bronze die castings, which are made with such accuracy that no machining is required. They are particularly adapted to the construction of typewriters, adding machines, telephone parts, and all small interchangeable machinery parts made in large quantities.

General Electric Co., Schenectady, N. Y. Pamphlet entitled "Transformer Steel," giving a brief account of the material used in transformer construction, and calling attention to the company's improved type H transformer in which the described steel is used. In writing for this pamphlet, designate it as No. 3687.

Gem Mfg. Co., 3253 Spruce St., Pittsburg, Pa. Catalogue of brass and steel oilers showing the old line of oilers manufactured by the company, and a new line just put on the market. The catalogue includes specialties such as foundry chaplets, inspectors' and locomotive torches, brass alcohol lamps, flexible shafts, portable drilling and grinding attachments, breast drills, universal joints, scratch brushes, etc.

Dayton Machine and Tool Works, Dayton, Ohio. Catalogue No. 2 for grinding machines designed for tool grinding and manufacturing. These grinders are manufactured in three sizes, and are designated as plain cutter and reamer guide grinder, universal cutter and tool grinder No. 1, universal cutter and tool grinder No. 2, which latter can be converted into a shaft and internal grinder or a surface grinder.

Winkley Co., 866 Warren Ave., W., Detroit, Mich. Catalogue of oiling devices. The Winkley Co. brought out the first oil hole covers as a substitute for open oil-holes, loose plugs, screws, etc., in 1892. The catalogue illustrates a variety of styles that have been developed, suitable for all classes of machinery. These include the self-closing and the hand-closing types. A line of grease cups has been added and specialties such as brass dowel pins for patterna and special brass work to order.

Taimont Mfg. Co., 55 to 71 Amory St., Roxbury, Mass. Catalogue of "Trimo" tools, which include the "Trimo" pipe wrench, the "Trimo" chain wrench, "Trimo" pipe cutter, "Trimo monkey-wrench," "Trimo" giant chain pipe wrench, "Trimo" special narrow jaw wrench, "Trimo" basin wrench for plumbers, etc. The company has issued a new edition of "Facts are Stubborn Things," being an account of mechanical tests made with the United States testing machine at Watertown Arsenal, Mass., to determine the strength of various makes of monkey-wrenches.

Hendey Machine Co., Torrington, Conn. Catalogue of engine lathes. The construction of the 20- and 24-inch geared-head lathe is illustrated. The geared-head lathes are built in 12-, 14-, 16-, 18-, 20- and 24-inch sizes, and this type of lathe is illustrated with both motor and belt drive. The line of cone pulley lathes with reinforcing tie-bar between the spindle bearings is illustrated in detail. Lathe attachments are illustrated for relieving cutters, turning tapers, turning balls, tool-room equipment, etc. The catalogue is one of the most interesting issued by any machine tool builder.

Rahn-Carpenter Co., 2935-2941 Spring Grove Ave., Cincinnati, Ohio. Catalogue No. 7 of engine, turret and gap lathes, built in 16 inches to 32 inches swing. The catalogue is beautifully illustrated, and besides showing the various sizes of lathes, attachments, and accessories, it illustrates the method of crating lathes for domestic and foreign shipment. The latter consideration is very important, as many American tools have received a "black eye" because of the careless and unsafe crating and protection given to the finished parts. The method of crating illustrated insures a machine being received in good condition if subjected to the ordinary rough handling that goods receive in ocean transport.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York. Catalogue No. 355 of tools for all trades, and supplies. The catalogue contains 1,200 pages 5¼ x 7¼ inches, of which 28 pages are devoted to the index alone. This fact gives an idea of the great number of tools and supplies listed. The catalogue lists tools for the machinist, carpenter, cabinet maker, piano tuner, die-sinker, toolmaker, mill-wright, electrician, lumberman, engineer, draftsman, upholsterer, tailor, painter, paper-hanger, molder, brick-layer, cement-layer, etc., and general supplies for manufacturers. It is one of the most complete catalogues of tools and supplies for manufacturers ever issued by any company of dealers, and is a credit to the concern represented. On account of the high cost per copy, the catalogue cannot be distributed free, except to purchasing agents, and those in position to influence the purchases of manufacturing concerns. Others desiring a copy can obtain same for $1, which sum will be credited on the first order amounting to $10.

MANUFACTURERS NOTES.

W. J. Smith Co., New Haven, Conn., has appointed Fred Ward & Son, Inc., First and Howard Sts., San Francisco, Cal., the Pacific Coast agents for the sale of Smith one-lock adjustable reamers.

B. P. Fortin Tool Co., Woonsocket, R. I., recently sold, through its agency, the Prentiss Supply Co. of Boston, a No. 2 and a No. 8 universal jig to the United States Government Torpedo Station, at Newport, R. I.

Crocker-Wheeler Co. has opened a new office in the Gumbel Building, Kansas City, Mo., for the sale of the Crocker-Wheeler motors, dynamos, transformers, switch-boards, etc. The office is in charge of Mr. A. W. Paine.

Lyon Metallic Mfg. Co., Aurora, Ill., has just completed a large addition to its factory, and is now operating with double the old number of employes. The concern manufactures a complete line of factory equipment, making a specialty of unit shop racks, tote boxes, barrels, office and shop lockers, gear boxes, etc.

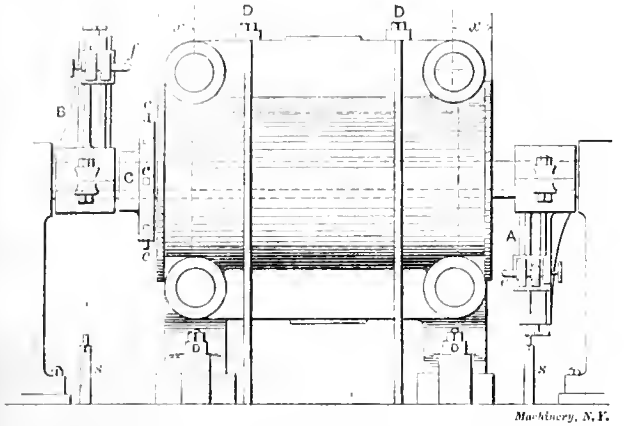
National Battery Co., Buffalo, N. Y., announces that the receivership under which it has been operating since last February was terminated August 19, and that all claims against it have been settled. Full control of the reorganized company has been secured by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., but the plant of the

Supplement to MACHINERY, November, 1908.

Operations for the Article in this number entitled "Machine Shop Practice—Boring and Planing Corliss Engine Cylinders."

SHOP OPERATION SHEET NO. 79.

M. B. Stauffer. MACHINERY, November, 1908.



To Bore a Corliss Engine Cylinder.

NOTE.—The machine best adapted for this operation is the regular Corliss cylinder boring machine, and we shall assume that such a machine is available.

1. Adjust the main boring-bar and the bars for boring the valve ports so that they will clear the work; then place the casting on the machine table.

2. Move the tail-stock along the bed until there is room enough between the facing arms *A* and *B* and the ends of the cylinder, for the tool-head *C* to clear.

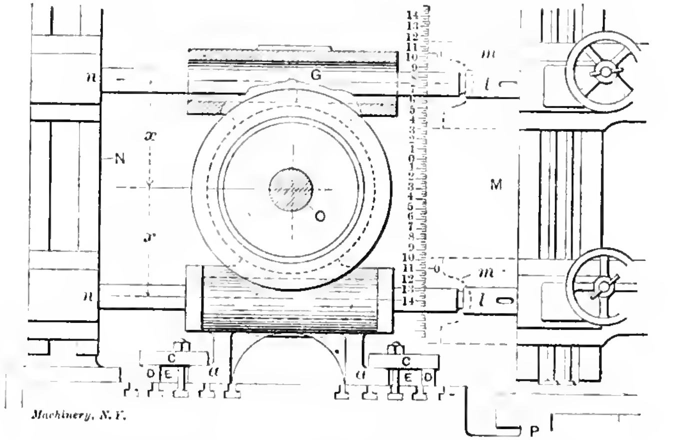
3. Set the cylinder vertically (by placing parallel pieces beneath the feet) and horizontally until the boring-bar is central, preferably, with the outside cylindrical surface of the cylinder. When set in this way, the cylinder, when bored, will have walls of a uniform thickness. With a surface gage, test the valve ports on both sides of the cylinder to see if they are parallel with the machine table, and, if necessary, adjust the casting by inserting thin steel wedges beneath its feet. Clamp the casting securely to the table by clamps *D*.

4. Fasten the roughing cutters *c* in the tool-head, and set them to bore within about 1/32 inch of the finish diameter; also insert tools *e* and *f* in the facing arms *A* and *B*. Fasten stops *s* to the platen to operate the star feed of the facing arms. Start the machine and proceed to rough bore the cylinder and face the ends, simultaneously. When facing the ends, the amount of metal to be removed should be determined by the distances *x*, as well as the dimension over all, so that the ports, when bored, will be central with the outside of the boss. When taking the roughing cut, examine the bore frequently to see that there are no imperfections in the casting which would render it useless.

5. Finish facing the ends of the cylinder, making it the required length. Take a finishing cut through the bore and counterbore both ends. The counterbore is to prevent a shoulder being formed in the cylinder, and it should extend in far enough so that the piston ring will over-lap it slightly when the piston is at the end of its travel.

SHOP OPERATION SHEET NO. 80.

M. B. Stauffer. MACHINERY, November, 1908.



To Bore the Ports of a Corliss Engine Cylinder.

NOTE.—This operation is performed with the cylinder in the same position as when being bored, and it may be done simultaneously with that operation.

1. The dimensions *x* from the center of the cylinder to the center of the ports, and also the distance from the face of the cylinder to the centers of the ports, should first be ascertained from the drawing. The next step will then be to set the port boring spindles *l* the required distance above and below the center of the cylinder, and from the ends.

2. On the side of the spindle column *M* are graduations, as shown by the dotted lines representing an end view of the column. When the zero mark on either of the spindle heads *m* coincide with the zero mark on the scale, the axis of the boring spindle is in the same plane as that of the main boring-bar *O*; therefore, the two spindles can be set vertically by this scale to the required dimensions.

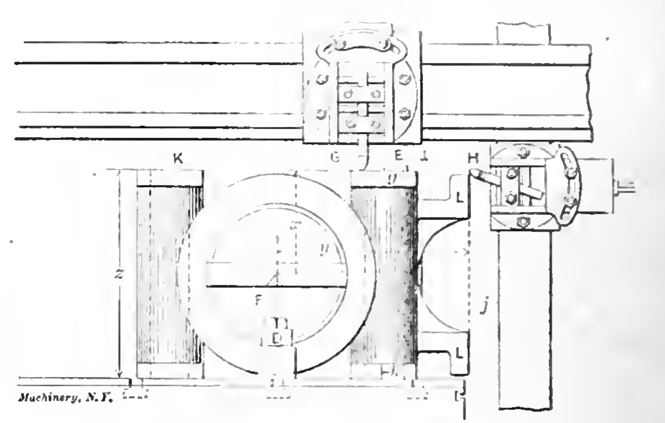
3. Place two boring-bars through the ports, and then shift the column *M* along the platen *P* until the centers of the spindles are the required distance from the face of one end of the cylinder. The outboard bearings *n* on column *N* are next set in line with the spindles *l*. On the platens at the base of each column, are graduations which are used when aligning the outboard bearings. The distance that the column *M* has moved along its bed, is noted, and then the column *N* is set to the same reading.

4. Insert the boring-bars in the spindles *l*, and take roughing cuts, making the holes within 1/64 inch of the finish diameter. Examine the ports to see that all steam edges are trued and free from imperfections. The roughing tools should do all the cutting on the front edges, that is, the cutting edge should not be beveled as this will tend to deflect the bar. Next bore the ports to the finish diameter, using tools honed to a keen edge so as to obtain a smooth finish.

5. When one set of ports is bored, the main and outboard columns are shifted a distance equal to the distance between the port centers, and the remaining ports bored.

SHOP OPERATION SHEET NO. 81.

M. B. Stauffer. MACHINERY, November, 1908.



To Plane a Corliss Engine Cylinder.

1. Set the cylinder in an upright position on the platen, resting it on the feet *L*, and insert centering pieces in both ends of either the steam or exhaust ports, and locate the centers. Set the edge of a long straight-edge *E* to coincide with the two centers on one side of the cylinder and scribe a line *g*. Repeat this operation on the other side, locating a line *h*.

2. Place the casting in the position shown in the engraving, insert centering pieces in both ends of the bore, and locate centers *F*. With a surface gage, test the centers *F* at both ends of the cylinder, and adjust the casting until they are the same height. Move the planer table until one end of the cylinder is opposite the finished edge *j* of the housing, and measure the distance from this edge to the center *F*. Move the table a distance equal to the length of the cylinder, and again measure from the center to the housing. The casting should be shifted until these measurements are equal.

3. With a long square, test the two lines *g* and *h*, and adjust the casting until they are perpendicular with the surface of the platen. The position of the casting may be changed by inserting thin steel wedges or liners beneath it.

4. Clamps *D* should be placed at each end of the bore, and stops against the outer end of the casting for taking the thrust of the cut. When the clamps are tightened, all points should be tested again, and, if necessary, readjustments made.

5. Clamp a roughing tool *G* in the tool-holder, and set it to 1/32 inch over dimension *x*. In the side head, clamp roughing tool *H* and set it to 1/32 inch over dimension *y*. Take roughing cuts over the surfaces *J* and *K* and the feet *L*, simultaneously. Rough plane the exhaust flange; replace roughing tools with finishing tools, and finish surfaces to the required dimensions. Invert the casting, resting it on the finished surfaces *J* and *K*, set the finished foot parallel with the edge of the table, and plane the opposite side of the cylinder to the dimension *z*, and the steam flange.

Supplement to MACHIN

Tables for the Articles in this number entitled "Computation Table fcr Reg

I.—FORMULAS AND FACTORS FOR SOLVING REGULAR POLYGONS.

Z = angle subtended at center by side

P = perimeter of polygon

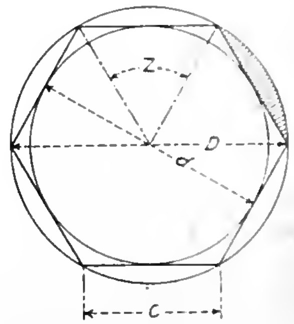
C = length of one side

A = area of polygon

N = number of sides.

d = diameter of inscribed circle

D = diameter of circumscribed circle



In the formulas below, the trigonometrical expressions necessary to use for solving regular polygons are replaced by the letters B, F, H, K and M, the numerical values of which for the most common number of sides in polygons are given in table II. The expressions these letters signify are:

$$B = \frac{1}{N} \operatorname{cosec} \frac{180^\circ}{N} \qquad F = N \tan \frac{180^\circ}{N} \qquad H = \frac{N}{8} \sin \frac{360^\circ}{N} \qquad K = \frac{N}{4} \cot \frac{180^\circ}{N}$$

$$M = 2N \sin \frac{180^\circ}{N}$$

Quantities to be found.	Quantities Known.				
	P	A	C	D	d
P		$P = 2\sqrt{FA}$	$P = CN$	$P = \frac{MD}{2}$	$P = Fd$
A	$A = \frac{KP^2}{N^2}$		$A = KC^2$	$A = HD^2$	$A = \frac{Fd^2}{4}$
C	$C = \frac{P}{N}$	$C = \frac{2\sqrt{FA}}{N}$		$C = \frac{MD}{2N}$	$C = \frac{Fd}{N}$
D	$D = BP$	$D = 2B\sqrt{FA}$	$D = NBC$		$D = BFd$
d	$d = \frac{4KP}{N^2}$	$d = \frac{4\sqrt{AK}}{N}$	$d = \frac{4KC}{N}$	$d = \frac{2MKD}{N^2}$	

Contributed by W. L. Benitz.

II.—FORMULAS AND FACTORS FOR SOLVING REGULAR POLYGONS.

N Number of Sides	F	Log. F	M	Log. M	H	Log. H	K	Log. K	B	Log. B	Z Center Angle
3	5.19615	0.71568	5.19615	0.71568	0.32476	$\bar{1}$.51156	0.43301	$\bar{1}$.63650	0.38490	$\bar{1}$.58534	120°
4	4.00000	0.60206	5.65685	0.75257	0.50000	$\bar{1}$.69897	1.00000	0.00000	0.35355	$\bar{1}$.54845	90°
5	3.63271	0.56023	5.87785	0.76921	0.59441	$\bar{1}$.77408	1.72048	0.23564	0.34026	$\bar{1}$.53181	72°
6	3.46410	0.53959	6.00000	0.77815	0.64951	$\bar{1}$.81259	2.59808	0.41465	0.33333	$\bar{1}$.52287	60°
7	3.37100	0.52775	6.07435	0.78350	0.68410	$\bar{1}$.83512	3.63393	0.56037	0.32925	$\bar{1}$.51753	51°26′
8	3.31371	0.52031	6.12294	0.78696	0.70710	$\bar{1}$.84948	4.82843	0.68380	0.32604	$\bar{1}$.51407	45°
9	3.27573	0.51530	6.15636	0.78932	0.72313	$\bar{1}$.85922	6.18182	0.79111	0.32486	$\bar{1}$.51170	40°
10	3.24920	0.51177	6.18034	0.79101	0.73473	$\bar{1}$.86612	7.69421	0.88616	0.32360	$\bar{1}$.51001	36°
11	3.22989	0.50918	6.19811	0.79225	0.74338	$\bar{1}$.87121	9.36566	0.97153	0.32267	$\bar{1}$.50877	32°44′
12	3.21539	0.50723	6.21166	0.79320	0.75000	$\bar{1}$.87506	11.1962	1.04906	0.32197	$\bar{1}$.50782	30°
13	3.20420	0.50572	6.22219	0.79394	0.75517	$\bar{1}$.87804	13.1858	1.12010	0.32143	$\bar{1}$.50708	27°42′
14	3.19543	0.50452	6.23062	0.79453	0.75929	$\bar{1}$.88041	15.3344	1.18566	0.32099	$\bar{1}$.50649	25°43′
15	3.18835	0.50356	6.23735	0.79500	0.76263	$\bar{1}$.88231	17.6424	1.24655	0.32064	$\bar{1}$.50603	24°
16	3.18260	0.50278	6.24289	0.79538	0.76536	$\bar{1}$.88387	20.1094	1.30339	0.32036	$\bar{1}$.50564	22°30′
17	3.17788	0.50213	6.24754	0.79570	0.76763	$\bar{1}$.88515	22.7353	1.35670	0.32012	$\bar{1}$.50532	21°11′
18	3.17389	0.50159	6.25133	0.79597	0.76954	$\bar{1}$.88623	25.5208	1.40689	0.31993	$\bar{1}$.50505	20°
19	3.17051	0.50113	6.25455	0.79619	0.77116	$\bar{1}$.88714	28.4654	1.45431	0.31976	$\bar{1}$.50483	18°57′
20	3.16769	0.50074	6.25738	0.79639	0.77254	$\bar{1}$.88792	31.5688	1.49925	0.31962	$\bar{1}$.50463	18°
21	3.16523	0.50040	6.25975	0.79655	0.77372	$\bar{1}$.88858	34.8316	1.54197	0.31950	$\bar{1}$.50447	17°9′
22	3.16317	0.50012	6.26195	0.79671	0.77476	$\bar{1}$.88916	38.2527	1.58266	0.31938	$\bar{1}$.50432	16°22′
23	3.16129	0.49986	6.26369	0.79683	0.77566	$\bar{1}$.88967	41.8342	1.62153	0.31930	$\bar{1}$.50420	15°39′
24	3.15966	0.49964	6.26526	0.79693	0.77645	$\bar{1}$.89011	45.5745	1.65872	0.31922	$\bar{1}$.50409	15°
25	3.15824	0.49944	6.26666	0.79703	0.77715	$\bar{1}$.89050	49.4738	1.69437	0.31914	$\bar{1}$.50399	14°24′

Contributed by W. L. Benitz.

I.—TABLE OF GEOMETRICAL PROGRESSIONS FOR SPINDLE SPEEDS.

Number of Speed Changes Required	Percentage of decrease of consecutive speeds. 15	16	17	18	19	20	21	22	23	24	25	26	27
1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
2	850	840	830	820	810	800	790	780	770	760	750	740	730
3	722	706	689	672	656	640	624	608	593	578	562	548	533
4	614	593	572	551	531	512	493	474	456	439	421	405	389
5	522	498	474	452	430	410	389	370	351	333	316	300	284
6	444	418	394	371	349	328	308	289	271	253	237	222	207
7	377	351	327	304	282	262	243	225	208	193	178	163	151
8	320	295	271	249	229	210	192	176	160	146	133	121	110
9	272	248	225	204	185	168	152	137	123	111	100	89.4	81
10	231	208	187	167	150	134	120	107	95	84.5	75	66.1	59
11	197	175	155	137	121	107	94.6	83.3	73.2	64.2	56.2	48.9	43
12	167	147	128	113	98.4	86	74.7	65	56.4	48.8	42.2	36.2	31.3
13	142	123	107	92.4	79.7	68.7	59.1	50.7	43.4	37.1	31.6	26.8	22.8
14	121	103	88.5	75.7	64.5	55	46.6	39.5	33.4	28.2	23.7	19.8	16.6
15	103	87	73.4	62.1	52.3	44	36.9	30.8	25.7	21.4	17.8	14.6	12.15
16	87.3	73	60.9	50.9	42.3	35.2	28.1	24	19.8	16.3	13.3	10.8	8.87
17	74.2	61.3	50.5	41.7	34.2	28.16	23	18.7	15.2	12.4	10	8.0	6.47
18	63	51.5	41.5	34.2	27.7	22.5	18.2	14.6	11.7	9.4	7.5	5.9	4.7
19	53.6	43.2	34.8	28	22.4	18	14.3	11.4	9.0	7.14	5.6	4.4	3.44
20	45.5	36.3	28.9	23	18.1	14.9	11.3	8.9	6.9	5.42	4.2	3.25	2.51
21	38.7	30.5	24	18.9	14.7	11.5	8.9	6.94	5.4	4.12	3.2	2.4	1.53
22	32.9	25.6	19.9	15.5	11.9	9.2	7.1	5.4	4.1	3.13	2.4	1.78	1.33
23	27.9	21.5	16.5	12.7	9.6	7.37	5.6	4.22	3.2	2.39	1.8	1.31	0.97
24	23.7	18	13.7	10.4	7.8	5.9	4.4	3.29	2.46	1.81	1.3	0.97	

Contributed by Albert Clegg.

II.—TABLE OF GEOMETRICAL PROGRESSIONS FOR SPINDLE SPEEDS.

Number of Speed Changes Required	Percentage of decrease of consecutive speeds. (Continued) 28	29	30	32	34	36	38	40	42	44	46	48	50
1	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
2	720	710	700	680	660	640	620	600	580	560	540	520	500
3	518	504	490	462	436	410	385	360	337	314.	292	270	250
4	373	358	343	315	288	263	238	216	195	176	158	141	125
5	269	254	240	214	190	169	148	129	113	98	85	73.3	62.5
6	193	180	168	146	126	108	91.7	77.5	65.5	54.8	46	38.2	31.25
7	139	128	118	99	83	69.2	56.8	46.5	38	30.7	24.8	19.9	15.62
8	100	91	82.3	68.3	54.8	44.4	35.2	27.9	22.1	17.2	13.4	10.3	7.81
9	72.2	64.5	57.6	46.5	36.2	28.4	21.8	16.8	12.8	9.6	7.23	5.37	3.91
10	52.4	45.8	40.3	31.5	23.8	18.2	13.5	10.0	7.42	5.38	3.9	2.8	1.95
11	37.4	32.5	28.2	21.4	15.8	11.63	8.38	6.0	4.3	3.0	2.1	1.45	0.97
12	26.9	23	19.8	14.5	10.4	7.46	5.2	3.6	2.5	1.68	1.13	0.75	0.475
13	19.4	16.3	13.8	9.85	6.9	4.78	3.22	2.16	1.45	0.94			
14	13.9	11.6	9.7	6.7	4.55	3.06	2.0	1.29	0.84				
15	10	8.2	6.8	4.55	3.0	1.96	1.24	0.77					
16	7.23	5.8	4.7	3.09	1.99	1.25	7.7						
17	5.21	4.14	3.32	2.1	1.32	0.8							
18	3.75	2.94	2.32	1.43	0.87								
19	2.7	2.08	1.63	0.97									
20	1.94	1.48	1.14										
21	1.39	1.05											
22	1.00												
23													
24													

Example: A lathe spindle requires 18 speed changes, from 6 to 250 R.P.M. Find the speeds in geometrical progression.

$\frac{1000}{250} = 4$ (ratio between highest R.P.M. in table and highest R.P.M. in example); $4 \times 6 = 24$. Follow the horizontal line from figure 18 in the left-hand column to the figure nearest to 24 in this line. This figure is 22.5, in the 20 percent column. The speeds required are the values given in this column opposite figures 1 to 18, divided by 4. Thus 250, 200, 160, 128, etc., are the speeds wanted.

Contributed by Albert Clegg.

MACHINERY.

November, 1908.

SETTING-ANGLES FOR MILLING ANGULAR CUTTERS AND TAPER REAMERS.*

W. A. KNIGHT.†

W. A. Knight.‡

In the calculation of setting-angles for angular cutters, end mills, taper reamers, and the like, the number of angles involved usually makes the calculations difficult and uncertain, and, as a general thing, the settings can be obtained by the cut-and-try method in less time than it takes to compute them. It is a great satisfaction, however, to be able to give a workman a blank for angular cutters with full data as to angles of elevation, set-over, or other adjustments required. In some cases, especially where the calculations can be carried out in the drafting-room, time can be saved, all guesswork eliminated, and data for the settings put on the drawing the same as other dimensions. In the case of an angular cutter the problem may be stated as follows:

Given a milling cutter blank of any angle β, to have any number of teeth n to be cut with a single angle cutter of any angle ϕ, to find the angle of elevation of index-head, so that when teeth are cut, the lands shall be of equal width throughout their length.

Fig. 1 represents a side and end view of the blank, and Fig. 2 the index head adjusted to the proper angle for the blank under consideration.

Let r = radius of blank,

n = the number of teeth,

β = the angle of blank,

ϕ = angle of cutter,

θ = tooth angle $= \dfrac{360}{n}$,

γ and δ angles, as shown in Fig. 1.

In Fig. 1, the line OA is the axis of a cone which would result from prolonging the blank down to a point. The line OC is the intersection of the two planes which form the sides of the tooth space, and hence the cutter must run parallel to this line while cutting a space. The head must then be elevated so that the line OC is parallel with the table, and in doing so we will have turned it through an angle equal to AOC, or α. Line EF is drawn perpendicular to OC. From the figure then,

$$\tan\alpha = \frac{AD}{AO}.$$

But $AD = AB - BD$, and $BD = BC \sec\alpha$.

Therefore $AD = AB - BC \sec\alpha$.

But $AB = r\cos\theta$; $BC = r\sin\theta\cot\phi$; and $AO = r\tan\beta$.

$$\text{Therefore } \tan\alpha = \frac{r\cos\theta - r\sin\theta\cot\phi\sec\alpha}{r\tan\beta} \qquad (1)$$

For convenience of calculation let $\tan\beta = x$; $\cos\theta = y$; $\sin\theta\cot\phi = z$. Cancelling out the r's and making these substitutions transforms equation (1) to

$$\tan\alpha = \frac{y - z\sec\alpha}{x}$$

$$\text{or } x\tan\alpha = y - z\sec\alpha$$

Substituting the sine and cosine for the tangent and secant, we have:

$$\frac{x\sin\alpha}{\cos\alpha} = y - \frac{z}{\cos\alpha}$$

$$\text{Squaring this gives: } \frac{x^2\sin^2\alpha}{\cos^2\alpha} = y^2 - \frac{2yz}{\cos\alpha} + \frac{z^2}{\cos^2\alpha}.$$

$$x^2\sin^2\alpha = y^2\cos^2\alpha - 2yz\cos\alpha + z^2.$$

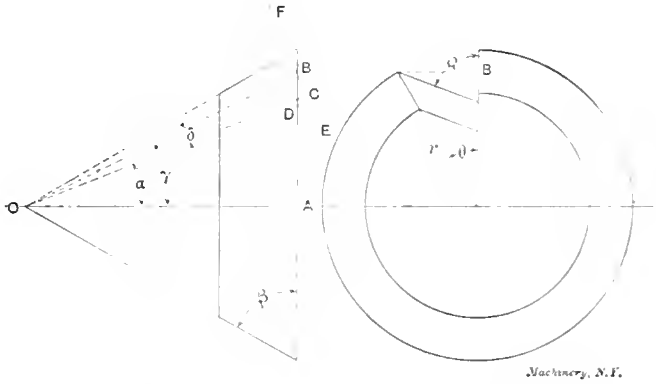


Fig. 1. Diagram for Calculating Setting-angle for Angular Cutters.

Substituting in terms of cosine gives $x^2 - x^2\cos^2\alpha = y^2\cos^2\alpha - 2yz\cos\alpha + z^2$, or $(x^2 + y^2)\cos^2\alpha - 2yz\cos\alpha + z^2 - x^2 = 0$, from which

$$\cos\alpha = \frac{yz}{x^2 + y^2} \pm \sqrt{\frac{y^2z^2}{(x^2 + y^2)^2} - \frac{z^2 - x^2}{x^2 + y^2}}$$

or, finally,

$$\cos\alpha = \frac{yz \pm x\sqrt{x^2 + y^2 - z^2}}{x^2 + y^2}$$

where $x = \tan\beta$; $y = \cos\theta$; and $z = \sin\theta\cot\phi$.

It will be observed that this is a very unwieldy and difficult equation to handle and we can arrive at a much easier solution by introducing the auxiliary angles γ and δ, the difference of which is the angle desired. In other words, by dividing the problem into two parts, we can obtain comparatively simple expressions for γ and δ, and a simple subtraction then gives α. The angle AOB or γ, Fig. 1, would be the angle of elevation if we were cutting the blank with a 90-degree cutter. In this case δ would disappear and $\gamma = \alpha$. From the figure,

$$\tan\gamma = \frac{AB}{AO}; \text{ but } AB = r\cos\theta; \text{ and } AO = r\tan\beta.$$

$$\text{Therefore } \tan\gamma = \frac{\cos\theta}{\tan\beta} \qquad (2)$$

$$\text{Also } \sin\delta = \frac{BC}{OB}; \text{ but } BC = r\sin\theta\cot\phi; \text{ and } OB = \frac{r\cos\theta}{\sin\gamma}.$$

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* For previous articles on this and related subjects see: "To Calculate the Setting of the Dividing Head when Cutting the Teeth of End Mills," by George G. Porter, April, 1904, and "Formulas for Milling End Mills and Clutches," by Irving Banwell, February, 1908.

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‡ W. A. Knight was born in Delaware County, Ohio, 1864, and received a grammar school education. In 1880 he entered the employ of the Novelty Iron Works, and after serving three years in that shop went to the A. R. Rarig Co., general founders and machinists. Later he was with Royce & Pulling Steam Pump Co., erecting pipe work and shafting, overhauling engines and doing general repair work. In 1885 he was made stationary engineer for the Union Passenger Station, Columbus, Ohio, and continued in that capacity until 1887. During the three years he filled this position he became greatly interested in physics and general science and acquired a strong desire for a technical education. Leaving the position, he associated with H. P. Minot (who had worked for twenty years in the shop of the Putnam Machine Co., Fitchburg, Mass.), overhauling engines, taking indicator diagrams, etc. A 20-light dynamo was built for lighting the shop, this being one of the early lighting machines constructed. The building of this machine led to the organization of the Minot Electric and Machine Co., of which Mr. Knight was foreman and electrician. Upon the dissolution of the company in 1892 following the death of Mr. Minot, Mr. Knight obtained employment with the Jeffrey Mfg. Co., and in 1893 obtained a position at the Ohio State University as assistant in industrial arts and foreman of the machine shop. Later he became an instructor in machine work and graduated from the institution in 1900 with a degree of mechanical engineer.

$$\text{Therefore } \sin\delta = \frac{\frac{r \sin\theta \cot\phi}{r\cos\theta}}{\sin\gamma}$$

$$\text{or } \sin\delta = \tan\theta \cot\phi \sin\gamma. \qquad (3)$$

With equations (2) and (3) we can find the value of γ and δ, and their difference is the angle of elevation.

For $\beta = 0$ (case of an end mill, teeth on the end) equation (2) becomes $\tan\gamma = \frac{\cos\theta}{0}$, or $\tan\gamma$ is infinite, from which $\gamma = 90°$. Substituting sin 90 for $\sin\gamma$ in (3) gives $\sin\delta = \tan\theta \cot\phi$. But $a = \gamma - \delta = 90 - \delta$, or $\cos a = \cos(90-\delta) = \sin\delta$, and since $\sin\delta = \tan\theta\cot\phi$ we have, finally, for the end mill.

$$\cos a = \tan\theta \cot\phi \qquad (4)$$

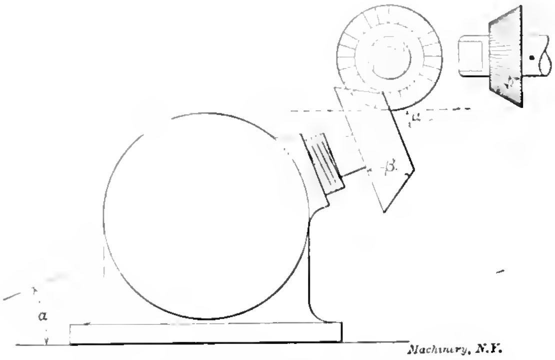

Fig. 2. Diagram of Head, Blank, and Cutter for Milling Teeth.

This is the same equation given in MACHINERY, April, 1904, by Mr. George G. Porter, and is a special case of the more general equation.

In this solution, and in the final equations, the width of land does not appear. The teeth of the cutter are considered as being cut to a sharp point; that is, without lands. This is done to simplify the mathematical work, and in no wise affects the results. It can be shown mathematically that the angle of elevation, when teeth are cut with a single angle cutter, is independent of both the width of land and radius of blank. The solution is therefore of general application. With the proper angle of elevation we can make the width of lands anything we choose, and they will be of equal width *after being backed off for clearance.*

Example: A 70-degree milling cutter blank is to have 18 teeth, and to be cut with a 65-degree single angle cutter. What will be the angle of elevation of the index head?

Fig 3 Diagram for Calculating Setting Angle for Taper Reamer.

In this example $n = 18$; $\beta = 70$ degrees; $\phi = 65$ degrees; $\theta = \frac{360}{18} = 20$ degrees.

The work would be carried out thus:

log cos 20 deg. $= \bar{1}.97299$
log tan 70 deg. $= 0.43893$

log tan γ $= \bar{1}.53406$

from which γ = 18 degrees 53 minutes.

log tan 20 deg. $= \bar{1}.56107$
log cot 65 deg. $= \bar{1}.66867$
log sin 18 deg. 53 min. $= \bar{1}.51007$

log sin δ $= \bar{2}.73981$

from which δ = 3 degrees 9 minutes.

$a = \gamma - \delta =$ 18 deg. 53 min. — 3 deg. 9 min. = 15 deg. 44 min.

The angle of elevation is therefore 15 degrees 44 minutes.

Taper Reamer Held on Centers.

In the case of a taper reamer held on centers, we wish to know how much the tail center should be elevated above the live center so that the cut shall be of correct depth at each end of the reamer. The taper per foot could be converted into degrees, and the formulas in the preceding part of this article used to determine the angle of elevation from which the elevation could readily be found; but it is more convenient to work with the taper per foot, and, proceeding as follows, we can find an expression for the elevation in terms of this taper.

[Attention should, however, be called to the fact that the formula deduced below is only approximately correct, although the error involved is so small that for all ordinary tapers, say up to one inch per foot, the difference is not of any account for practical purposes. As will be seen, the elevation of the tail center is assumed to be $OA - O_1A_1$ (see Fig. 3). The true elevation, however, is $(OA - O_1A_1) \cos v$, if v be the angle between the axis of the work and the bottom of the reamer flute. The cosine for small angles is so near unity that the difference becomes of no account. For a reamer with ¾-inch taper per foot, for instance, cos v would become 0.9995. On account of the small angle between the plane in which angle θ and angle ϕ are measured, they have been considered to be in the same plane, in order to give a more convenient formula for calculation. It should be remembered, however, that to do so is permissible only in the case of reamers with a comparatively slignt taper, and that the formulas below should not be used for reamers of abnormally large tapers. For such reamers the formula for angular milling cutters should be employed, which formula is mathematically correct.—EDITOR.]

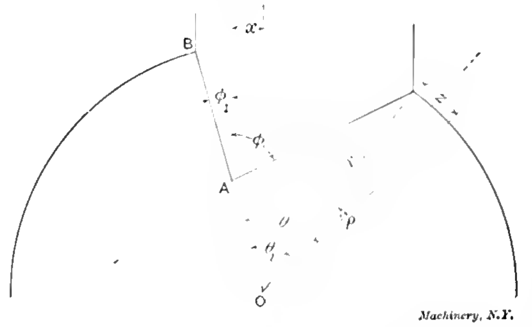

Fig. 4. Double-angle Cutter for Milling Straight Reamer Flutes.

As before, let

n = number of teeth,
ϕ = angle of cutter,
θ = teeth angle $= \frac{360}{n}$,
T = taper per foot,
l = total length of reamer, or distance between centers, in inches,
E = elevation of tail center.

From Fig. 3, $E = OA - O_1A_1$

$$OA = r\cos\theta - r\sin\theta\cot\phi;$$
$$O_1A_1 = r_1\cos\theta - r_1\sin\theta\cot\phi, \text{ and}$$
$$E = (r - r_1)(\cos\theta - \sin\theta\cot\phi),$$

$$\text{But } (r - r_1) = \frac{Tl}{12 \times 2};$$

$$\text{Therefore } E = \frac{Tl}{12 \times 2}(\cos\theta - \sin\theta\cot\phi). \qquad (5)$$

Example: A taper reamer is to have 6 teeth, a taper of ¾ inch per foot, is 8 inches long and is to be cut with an 80-degree cutter. How much should tail center be elevated?

In this case $\theta = \frac{360}{6}$, or 60 degrees, and $\phi = 80$ degrees.

Then $E = \frac{0.75 \times 8}{12 \times 2}(0.5 - 0.866 \times 0.176) = 0.087$, or elevation = 0.087 inch.

Case of the Double-angle Cutter.

The use of a double angle cutter for grooving a taper reamer or angular mill adds several complications to the setting of the machine, not met with when using single angle

ANGLES OF ELEVATION FOR END MILLS

Number of Teeth.	Angle of Cutter. 85	80	75	70	65	60	55	50
5	74°23′	57° 8′	34 27′	......	......	......	......	......
6	81 17	72 13	62 21	50 55′	36 8′	......	......	......
7	83 42	77 13	70 22	62 50	54 12	43 36′	......	......
8	84 59	79 51	74 27	68 39	62 12	54 44	44 27′	32 57′
9	85 47	81 29	77 0	72 13	66 58	61 1	54 1	45 15
10	86 21	82 38	78 46	74 40	70 12	65 12	59 25	52 26
11	86 47	83 29	80 5	76 28	72 34	68 13	63 15	57 22
12	87 6	84 9	81 6	77 52	74 23	70 32	66 9	61 2
13	87 22	84 41	81 54	78 59	75 48	72 21	68 26	63 52
14	87 35	85 8	82 35	79 54	77 1	73 51	70 17	66 10
15	87 46	85 30	83 9	80 40	78 1	75 6	71 50	68 1
16	87 55	85 49	83 38	81 20	78 52	76 10	73 8	69 40
17	88 3	86 5	84 3	81 53	79 36	77 4	74 15	71 1
18	88 11	86 19	84 24	82 23	80 14	77 52	75 14	72 13
19	88 17	86 32	84 43	82 49	80 47	78 34	76 6	73 15
20	88 22	86 43	85 0	83 13	81 17	79 11	76 51	74 11
21	88 27	86 53	85 15	83 33	81 44	79 44	77 31	74 59
22	88 32	87 2	85 29	83 52	82 8	80 14	78 8	75 44
23	88 36	87 10	85 42	84 9	82 30	80 42	78 41	76 24
24	88 39	87 18	85 53	84 24	82 49	81 6	79 11	77 0

ANGLES OF ELEVATION FOR 15 DEGREE BLANK

Number of Teeth.	Angle of Cutter. 90	85	80	75	70	65	60	55	50
5	49 4	37 3	21 52	10 32	......	......	......	......	
6	61 49	54 9	46 12	37 10	28 1	16 26	......	......	
7	66 44	60 57	55 1	48 45	41 57	34 14	25 2′	12 57	
8	69 15	61 33	59 46	54 14	49 21	43 24	36 34	28 21	17 34
9	70 43	66 45	62 41	58 28	53 58	49 3	43 30	37 2	29 4
10	71 40	68 12	64 41	61 1	57 8	52 55	48 12	42 47	36 18
11	72 20	69 16	66 8	62 54	59 27	55 14	51 37	46 56	41 21
12	72 48	70 2	67 13	64 18	61 13	57 54	54 14	50 5	45 13
13	73 10	70 39	68 5	65 26	62 38	59 37	56 18	52 34	48 14
14	73 26	71 7	68 46	66 20	63 46	61 0	57 59	54 35	50 38
15	73 39	71 30	69 20	67 5	64 42	62 10	59 22	56 15	52 39
16	73 50	71 50	69 49	67 43	65 30	63 9	60 33	57 40	54 20
17	73 58	72 6	70 12	68 14	66 11	63 58	61 33	58 51	55 46
18	74 5	72 20	70 33	68 42	66 46	64 41	62 26	59 54	57 0
19	74 11	72 32	70 51	69 6	67 17	65 19	63 11	60 49	58 6
20	74 16	72 42	71 6	69 28	67 44	65 53	63 52	61 37	59 3
21	74 20	72 51	71 20	69 46	68 7	66 22	64 27	62 20	59 54
22	74 21	72 59	71 32	70 3	68 29	66 49	65 0	62 59	60 40
23	74 27	73 6	71 43	70 18	68 49	67 13	65 29	63 33	61 22
24	74 30	73 12	71 53	70 32	69 6	67 35	65 56	64 5	61 59

ANGLES OF ELEVATION FOR 5 DEGREE BLANK.

Number of Teeth.	Angle of Cutter. 90	85	80	75	70	65	60	55	50
5	74°12	59°11′	42°43′	21°41′	......	......	......	......	......
6	80 4	71 29	62 34	53 52	41°41′	27°22′	......	......	......
7	82 1	75 47	69 22	62 35	55 9	46 33	36°12′	21°36′	......
8	82 57	77 58	72 52	67 32	61 47	55 23	48 0	38 56	25°40′
9	83 29	79 18	75 2	70 35	65 49	60 36	54 43	47 46	38 30
10	83 50	80 13	76 31	72 41	68 35	64 9	59 11	53 27	46 4
11	84 4	80 52	77 36	74 12	70 37	66 43	62 24	57 28	51 15
12	84 14	81 21	78 25	75 23	72 10	68 42	64 52	60 31	55 5
13	84 21	81 44	79 4	76 13	73 23	70 15	66 48	62 54	58 4
14	84 27	82 3	79 36	77 4	74 24	71 32	68 23	64 50	60 28
15	84 32	82 19	80 3	77 43	75 15	72 30	69 42	66 27	62 28
16	84 35	82 31	80 25	78 14	75 57	73 30	70 49	67 48	64 7
17	84 38	82 42	80 44	78 42	76 34	74 16	71 46	68 58	65 33
18	84 41	82 52	81 1	79 7	77 6	74 57	72 36	69 59	66 47
19	84 43	83 0	81 16	79 28	77 34	75 33	73 20	70 52	67 42
20	84 45	83 8	81 29	79 47	77 59	76 4	73 59	71 39	68 50
21	84 46	83 14	81 40	80 3	77 21	76 32	74 33	72 20	69 40
22	84 47	83 19	81 50	80 17	78 40	76 57	75 4	72 58	70 26
23	84 48	83 24	81 59	80 30	78 58	77 20	75 32	73 32	71 7
24	84 49	83 29	82 7	80 43	79 15	77 40	75 57	74 3	71 44

ANGLES OF ELEVATION FOR 20 DEGREE BLANK.

Number of Teeth.	Angle of Cutter. 90	85	80	75	70	65	60	55	50
5	40°20′	30° 4′	19 46′	8° 4′	......	......	......	......	......
6	53 57	46 55	39 39	31 55	23 18′	13 11′	......	......	......
7	59 43	54 17	48 42	42 51	36 30	29 23	21° 1′	10°23′	......
8	62 46	58 18	53 45	48 59	43 53	38 16	31 53	24 16	14°31′
9	64 35	60 47	56 54	52 52	48 34	43 53	38 38	32 32	25 5
10	65 47	62 28	59 4	55 33	51 50	47 47	43 18	38 9	32 1
11	66 36	63 39	60 38	57 30	54 12	50 38	46 11	42 12	36 56
12	67 12	64 32	61 49	59 0	56 2	52 50	49 18	45 19	40 40
13	67 39	65 13	62 44	60 11	57 28	54 34	51 22	47 47	43 36
14	68 0	65 46	63 29	61 8	58 39	55 59	53 4	49 47	46 0
15	68 17	66 13	64 6	61 55	59 38	57 10	54 28	51 27	47 58
16	68 30	66 34	64 36	62 34	60 26	58 9	55 39	52 51	49 38
17	68 41	66 53	65 2	63 8	61 8	59 0	56 40	54 3	51 4
18	68 50	67 8	65 24	63 37	61 44	59 44	57 32	55 5	52 17
19	68 57	67 21	65 43	64 2	62 15	60 22	58 18	55 59	53 21
20	69 3	67 32	65 59	64 23	62 43	60 55	58 58	56 47	54 18
21	69 9	67 42	66 14	64 42	63 8	61 25	59 34	57 30	55 9
22	69 14	67 51	66 28	64 59	63 30	61 52	60 7	58 9	55 55
23	69 18	67 59	66 39	65 15	63 50	62 16	60 36	58 44	56 36
24	69 21	68 5	66 49	65 30	64 7	62 38	61 2	59 14	57 12

ANGLES OF ELEVATION FOR 10 DEGREE BLANK.

Number of Teeth	Angle of Cutter. 90	85	80	75	70	65	60	55	50
5	60°16′	46°45′	32° 9′	14°31′	......	......	......	......	......
6	70 34	62 11	53 50	44 37	34° 5′	20°57′	......	......	......
7	74 12	68 8	61 55	55 20	48 9	39 57	30° 2′	16°32′	......
8	76 0	71 8	66 9	60 56	55 19	49 6	41 56	33 12	20°39′
9	77 2	72 56	68 45	64 23	59 21	54 7	48 52	42 6	33 8
10	77 42	74 8	70 31	66 44	62 44	57 22	53 30	47 54	40 42
11	78 10	75 1	71 48	68 28	64 56	61 6	56 52	52 2	45 56
12	78 30	75 40	72 46	69 47	66 37	63 12	59 26	55 10	49 50
13	78 44	76 9	73 31	70 48	67 56	64 51	61 26	57 36	52 51
14	78 56	76 34	74 9	71 39	69 2	66 12	63 6	59 36	55 19
15	79 5	76 54	74 40	72 21	69 56	67 19	64 28	61 15	57 20
16	79 12	77 10	75 5	72 57	70 41	68 16	65 37	62 39	59 1
17	79 18	77 23	75 27	73 27	71 20	69 4	66 36	63 51	60 28
18	79 22	77 34	75 45	73 52	71 53	69 46	67 27	64 58	61 43
19	79 26	77 44	76 1	74 15	72 23	70 23	68 12	65 46	62 48
20	79 30	77 54	76 16	74 35	72 44	70 56	68 52	66 34	63 47
21	79 33	78 2	76 29	74 53	73 12	71 25	69 28	67 17	64 38
22	79 35	78 8	76 40	75 9	73 33	71 51	69 59	67 55	65 25
23	79 37	78 18	76 50	75 23	73 52	72 14	70 28	68 29	66 6
24	79 39	78 20	76 59	75 30	74 9	72 35	70 54	69 1	66 44

ANGLES OF ELEVATION FOR 25 DEGREE BLANK.

Number of Teeth.	Angle of Cutter. 90	85	80	75	70	65	60	55	50
5	33°32′	25° 0′	16° 5′	6° 27′	......	......	......	......	......
6	47 0	40 38	34 6	27 10	19 33′	10 48′	......	......	......
7	53 12	48 10	43 0	37 35	31 43	25 17	17 44	8 31	......
8	56 36	52 25	48 8	43 40	38 55	33 41	27 47	20 50	11 33
9	58 40	55 4	51 24	47 36	43 33	39 8	34 13	28 33	21 15
10	60 2	56 53	53 40	50 21	46 47	42 58	38 43	32 53	27 47
11	61 0	58 11	55 18	52 20	49 12	45 48	42 4	37 49	32 32
12	61 42	59 9	56 33	53 52	51 2	47 59	44 38	40 51	36 10
13	62 14	59 54	57 32	55 5	52 30	49 44	46 41	43 15	39 2
14	62 38	60 29	58 19	56 3	53 41	51 8	48 20	45 12	41 22
15	62 57	61 0	58 57	56 52	54 39	52 18	49 43	46 50	43 18
16	63 13	61 22	59 29	57 32	55 29	53 17	50 53	48 13	44 57
17	63 26	61 42	59 54	58 6	56 11	54 8	51 54	49 23	46 21
18	63 37	61 59	60 19	58 36	56 48	54 52	52 46	50 25	47 34
19	63 46	62 13	60 38	51 1	57 20	55 30	53 31	51 19	48 38
20	63 53	62 25	60 56	59 23	57 47	56 4	54 11	52 6	49 33
21	63 59	62 36	61 11	59 43	58 11	56 34	54 47	52 48	50 23
22	64 5	62 46	61 25	60 1	58 34	57 1	55 19	53 26	51 9
23	64 10	62 55	61 37	60 17	58 54	57 25	55 48	54 0	51 50
24	64 14	63 3	61 47	60 31	59 12	57 46	56 13	54 30	52 26

cutters. In the first place the center must be offset a certain distance so that when the cutter is sunk into the blank the proper depth, the faces of teeth will be radial. Secondly, the reamer or mill must be turned through a horizontal angle as well as a vertical one in order that the plane of the face of the teeth shall pass through the center or axis of the cone. Stated differently, the cutting edge should be an element of the cone, and since the offset distance is different for the large and small ends of the reamer, to adjust for this, the tail-center must be set over a distance equal to the difference of these values. Thirdly, the radius and width of land must be taken into account. And fourthly, the expressions for the angle of elevation are altogether more complicated, so much so in fact as to be of little practical value.

ANGLES OF ELEVATION FOR 30 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	28 9	20 51	13 17	......	......	......	......	......	......
6	40 51	35 12	29 22	23 13	16 32'	8 59	......	......	......
7	47 12	42 35	37 52	32 56	27 38	21 47	15 6'	7 5	......
8	50 46	46 53	42 55	38 47	34 24'	29 36	24 12	17 55	10 11'
9	53 0	49 38	46 13	42 40	38 53	34 48	30 14	25 1	18 47
10	54 29	51 31	48 30	45 22	42 3	38 29	34 31	30 1	24 44
11	55 32	52 52	50 10	47 22	44 25	41 13	37 43	33 45	29 8
12	56 18	53 53	51 26	48 54	46 14	43 21	40 12	36 38	32 32
13	56 54	54 42	52 27	50 8	47 41	45 4	42 12	38 58	35 15
14	57 21	55 19	53 15	51 7	48 52	46 27	43 49	40 51	37 27
15	57 42	55 49	53 54	51 55	49 50	47 35	45 9	42 25	39 17
16	58 0	56 14	54 27	52 36	50 39	48 31	46 19	43 47	40 52
17	58 14	56 35	54 54	53 10	51 21	49 24	47 17	44 55	42 12
18	58 26	56 53	55 18	53 40	51 57	50 7	48 7	45 53	43 20
19	58 36	57 8	55 38	54 6	52 29	50 45	48 51	46 46	44 22
20	58 44	57 21	55 55	54 28	52 56	51 18	49 30	47 31	45 15
21	58 51	57 32	56 10	54 47	53 20	51 47	50 5	48 12	46 3
22	58 57	57 42	56 24	55 5	53 42	52 13	50 36	44 48	46 46
23	59 3	57 51	56 37	55 21	54 2	52 37	51 4	49 21	47 25
24	59 8	57 59	56 48	55 36	54 20	52 59	51 30	49 52	48 0

ANGLES OF ELEVATION FOR 45 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	17 10	12 36'	7 57'	3° 5	......	......	......	......	......
6	26 34	22 41	18 43	14 35	10 11'	5 23	......	......	......
7	31 56	28 36	25 13	21 42	17 56	13 55	9°24'	4°15'	....
8	35 16	32 22	29 25	26 22	23 8	19 39	15 48	11 25	5°58'
9	37 27	34 54	32 17	29 36	26 45	23 41	20 19	16 31	11 49
10	38 58	36 41	34 21	31 57	29 24	26 40	23 40	20 18	16 10
11	40 4	38 0	35 53	33 42	31 24	28 57	26 15	23 14	19 32
12	40 51	39 0	37 5	35 5	33 0	30 45	28 18	25 33	22 13
13	41 32	39 47	38 1	36 11	34 15	32 12	29 57	27 36	24 23
14	42 1	40 24	38 46	37 4	35 17	33 22	31 18	28 58	26 9
15	42 25	40 55	39 23	37 48	36 9	34 22	32 26	30 17	27 40
16	42 41	41 20	39 54	38 25	36 52	35 12	33 24	31 23	28 57
17	43 0	41 41	40 20	38 57	37 29	35 55	34 14	32 20	30 4
18	43 13	41 58	40 42	39 24	38 1	36 33	34 56	33 10	31 1
19	43 21	42 13	41 1	39 47	38 28	37 5	35 34	33 54	31 51
20	43 34	42 26	41 18	40 8	38 53	37 34	36 8	34 33	32 37
21	43 42	42 37	41 33	40 26	39 15	38 0	36 38	35 7	33 17
22	43 49	42 47	41 46	40 42	39 34	38 23	37 5	35 38	34 53
23	43 55	42 56	41 57	40 56	39 52	38 43	37 29	36 6	35 26
24	44 0	43 4	42 7	41 9	40 7	39 1	37 50	36 31	35 55

ANGLES OF ELEVATION FOR 35 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	23 19'	17 35	11 10	4 22'	......	......	......	......	......
6	35 32	30 29	25 19	19 53	14 3'	7 1'	......	......	......
7	41 41	37 20	33 14	28 46	24 1	18 48	12°54'	5°58'	......
8	45 17	41 43	38 5	34 19	30 18	25 56	21 4	15 27	8 41'
9	47 34	44 28	41 18	38 1	34 32	30 47	26 37	21 52	16 16
10	49 7	46 22	43 33	40 39	37 35	34 17	30 38	26 30	21 40
11	50 14	47 46	45 14	42 38	39 53	36 55	33 40	30 0	25 44
12	51 3	48 48	46 30	44 8	41 39	38 58	36 2	32 44	28 55
13	51 40	49 36	47 30	45 20	43 3	40 36	37 55	34 55	31 28
14	52 9	50 15	48 19	46 18	44 12	41 57	39 28	36 42	33 33
15	52 32	50 46	48 58	47 6	45 9	43 4	40 46	38 12	35 17
16	52 50	51 11	49 20	47 46	45 56	43 59	41 51	39 28	36 45
17	53 5	51 32	49 57	48 20	46 37	44 47	42 47	40 33	38 1
18	53 18	51 50	50 21	48 49	47 12	45 29	43 36	41 31	39 8
19	53 29	52 6	50 42	49 14	47 43	46 5	44 19	42 21	40 6
20	53 38	52 19	50 59	49 36	48 10	46 37	44 57	43 5	40 57
21	53 46	52 31	51 15	49 56	48 34	47 6	45 31	43 44	41 43
22	53 53	52 42	51 29	50 14	48 56	47 32	46 1	44 19	42 24
23	53 59	52 51	51 42	50 30	49 15	47 55	46 28	44 51	43 1
24	54 4	52 59	51 53	50 44	49 32	48 16	46 52	45 20	43 35

ANGLES OF ELEVATION FOR 50 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	14°32'	10°39'	6°42'	2°33'	......	......	......	......	......
6	22 45	19 23	15 58	12 24	8 38'	4°32'	......	......	......
7	27 37	24 42	21 44	18 39	15 24	11 54	8° 1'	3°36'	......
8	30 41	28 8	25 31	22 50	19 59	16 55	18 33	9 45	5°20'
9	32 44	30 28	28 9	25 45	23 14	20 31	17 32	14 13	10 22
10	34 10	32 7	30 2	27 54	25 39	23 12	20 32	17 34	14 9
11	35 13	33 22	31 28	29 31	27 28	25 16	22 52	20 11	17 6
12	36 0	34 18	32 34	30 47	28 53	26 54	24 42	22 15	19 27
13	36 36	35 2	33 26	31 48	30 3	28 13	26 11	23 56	21 22
14	37 5	35 38	34 9	32 47	31 1	29 18	27 26	25 21	22 58
15	37 28	36 7	34 44	33 18	31 49	30 13	28 28	26 32	24 20
16	37 47	36 31	35 13	33 53	32 29	31 0	29 22	27 33	25 30
17	38 2	36 50	35 37	34 22	33 3	31 38	30 7	28 24	26 29
18	38 15	37 7	35 58	34 47	33 33	32 13	30 46	29 10	27 21
19	38 26	37 22	36 17	35 9	33 59	32 43	31 21	29 50	28 7
20	38 35	37 34	36 32	35 28	34 21	33 9	31 52	30 25	28 47
21	38 43	37 45	36 46	35 45	34 41	33 33	32 19	30 57	29 24
22	38 50	37 55	36 58	36 0	34 59	33 55	32 44	31 26	29 57
23	38 56	38 3	37 9	36 14	35 15	34 14	33 6	31 51	30 26
24	39 1	38 10	37 19	36 25	35 30	34 30	33 25	32 14	30 52

ANGLES OF ELEVATION FOR 40 DEGREE BLANK.

Number of Teeth	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	20°13'	14 53'	9°24'	3°39'	......	......	......	......	......
6	30 48	26 21	21 48	17 3	11°58'	6°22'	......	......	......
7	36 37	32 52	29 2	25 3	20 49	16 12	11° 1'	5° 2'	......
8	40 7	36 53	33 36	30 10	26 33	22 38	18 16	13 20	7°23'
9	42 24	39 34	36 41	33 41	30 31	27 26	23 20	19 4	14 3
10	43 57	41 26	38 51	36 11	33 32	30 21	27 3	23 16	18 55
11	45 4	42 48	40 28	38 4	35 32	32 49	29 50	26 29	22 38
12	45 54	43 50	41 43	39 32	37 14	34 45	32 3	29 2	25 33
13	46 33	44 38	42 42	40 41	38 35	36 19	33 50	31 4	27 54
14	47 3	45 17	43 29	41 38	39 41	37 36	35 19	32 46	29 51
15	47 26	45 47	44 7	42 24	40 35	38 39	36 32	34 10	31 28
16	47 45	46 13	44 39	43 3	41 21	39 32	37 33	35 21	32 50
17	48 1	46 34	45 6	43 36	42 0	40 18	38 27	36 23	34 2
18	48 14	46 52	45 29	44 4	42 34	40 58	39 13	37 17	35 5
19	48 25	47 8	45 49	44 28	43 3	41 33	39 54	38 4	35 59
20	48 35	47 22	46 7	44 50	43 30	42 4	40 30	38 46	36 47
21	48 43	47 33	46 23	45 9	43 53	42 31	41 2	39 23	37 30
22	48 50	47 43	46 36	45 26	44 13	42 55	41 30	39 56	38 8
23	48 56	47 52	46 48	45 41	44 31	43 17	41 55	40 25	38 42
24	49 1	48 0	46 58	45 55	44 48	43 36	42 19	40 52	39 15

ANGLES OF ELEVATION FOR 55 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	12°13'	8°57'	5°37'	2°10'	......	......	......	......	......
6	19 17	16 25	13 30	10 28	7°15'	3°48'	......	......	......
7	23 35	21 4	18 31	15 51	13 4	10 3	6°44'	3° 1'	......
8	26 21	24 8	21 52	19 31	17 3	14 25	11 30	8 17	4°17
9	28 13	26 14	24 12	22 7	19 55	17 34	14 59	12 6	8 34
10	29 32	27 45	25 55	24 2	22 3	19 55	17 36	15 1	11 52
11	30 30	28 52	27 12	25 29	23 41	21 45	19 39	17 18	14 27
12	31 14	29 44	28 12	26 38	24 59	23 13	21 17	19 8	16 32
13	31 48	30 25	29 0	27 33	26 2	24 24	22 37	20 38	18 15
14	32 15	30 58	29 39	28 18	26 53	25 25	23 43	21 53	19 40
15	32 36	31 24	30 11	28 55	27 35	26 11	24 38	22 56	20 52
16	32 54	31 47	30 38	29 27	28 12	26 53	25 26	23 51	21 54
17	33 9	32 6	31 1	29 54	28 44	27 29	26 7	24 38	22 49
18	33 21	32 21	31 20	30 17	29 10	28 0	26 43	25 18	23 35
19	33 31	32 34	31 36	30 36	29 33	28 27	27 14	25 54	24 17
20	33 40	32 46	31 51	30 54	29 54	28 51	27 42	26 25	24 53
21	33 47	32 56	32 3	31 9	30 12	29 12	28 6	26 53	25 25
22	33 54	33 5	32 15	31 23	30 29	29 31	28 28	27 19	25 55
23	34 0	33 13	32 25	31 36	30 44	29 48	28 48	27 42	26 22
24	34 5	33 20	32 34	31 47	30 57	30 4	29 7	28 3	26 46

Since, however, the angles of a taper reamer are small, we can, by neglecting some of the factors which affect the result but slightly, arrive at something like workable expressions for the different settings.

Consider, first, the offset for a cylindrical piece, or say a straight hand reamer. Fig. 4 represents the end with one space cut. The cutter with which the space is cut has angles ϕ and ϕ_1 either side of the center so that the angle cut in the reamer is $(\phi + \phi_1)$.

Let z = width of land; ρ half the angle subtended from the center by z; and x the offset.

We have, first, $\theta_1 = \theta - 2\rho$ and $\sin \rho = \dfrac{z}{2r}$. (6)

$$x = OA \sin \phi_1.$$

ANGLES OF ELEVATION FOR 60 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	10° 7'	7°25'	4°39'	1°47'	......	......	......	......	......
6	16 6	13 41	11 12	8 42	6° 2'	3° 9'	......	......	......
7	19 48	17 40	15 30	13 16	10 55	8 22	5°36'	2°30'	......
8	22 13	20 19	18 24	16 24	14 19	12 4	9 37	6 53	3 44
9	23 52	22 10	20 26	18 39	16 46	14 46	12 34	10 7	7 19
10	25 2	23 30	21 56	20 19	18 37	16 48	14 49	12 36	10 5
11	25 54	24 30	23 4	21 35	20 2	18 23	16 34	14 34	12 16
12	26 34	25 16	23 57	22 36	21 10	19 39	17 59	16 9	14 13
13	27 5	25 53	24 40	23 25	22 6	20 41	19 9	17 27	15 31
14	27 29	26 22	25 14	24 4	22 51	21 32	20 6	18 32	16 41
15	27 49	26 46	25 43	24 37	23 29	22 15	20 55	19 27	17 47
16	28 5	27 6	26 7	25 5	24 1	22 52	21 37	20 14	18 40
17	28 18	27 23	26 27	25 29	24 28	23 23	22 13	20 55	19 26
18	28 29	27 37	26 44	25 49	24 52	23 50	22 44	21 30	20 6
19	28 38	27 49	26 58	26 7	25 12	24 14	23 11	22 1	20 42
20	28 46	27 59	27 11	26 22	25 30	24 35	23 35	22 29	21 14
21	28 53	28 8	27 23	26 36	25 46	24 54	23 57	22 54	21 42
22	29 0	28 17	27 34	26 49	26 2	25 12	24 17	23 17	22 8
23	29 5	28 24	27 43	27 0	26 15	25 27	24 35	23 37	22 32
24	29 9	28 30	27 50	27 9	26 26	25 40	24 50	23 55	22 52

ANGLES OF ELEVATION FOR 65 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	8°12'	6° 0'	3°46'	1°27'	......	......	......	......	......
6	13 7	11 10	9 8	7 4	4°53'	2°33'	......	......	......
7	16 13	14 28	12 41	10 50	8 54	6 49	4°33'	2° 1'	......
8	18 15	16 40	15 6	13 26	11 42	9 51	7 50	5 30	3° 1
9	19 39	18 14	16 48	15 19	13 45	12 5	10 16	8 14	5 57
10	20 40	19 23	18 4	16 44	15 19	13 48	12 9	10 19	8 15
11	21 25	20 14	19 3	17 49	16 31	15 9	13 38	11 58	10 4
12	21 59	20 54	19 48	18 40	17 28	16 12	14 49	13 17	11 32
13	22 26	21 26	20 35	19 22	18 15	17 5	15 48	14 23	12 46
14	22 48	21 52	20 55	19 56	18 54	17 48	16 37	15 17	13 48
15	23 5	22 13	21 19	20 24	19 26	18 24	17 18	16 4	14 40
16	23 18	22 29	21 39	20 47	19 53	18 55	17 53	16 43	15 24
17	23 30	22 43	21 56	21 8	20 17	19 22	18 23	17 17	16 3
18	23 40	22 55	22 11	21 25	20 37	19 46	18 50	17 47	16 37
19	23 48	23 5	22 24	21 40	20 55	20 6	19 13	18 14	17 7
20	23 55	23 14	22 35	21 54	21 10	20 24	19 33	18 38	17 34
21	24 1	23 22	22 45	22 6	21 24	20 39	19 51	18 58	17 58
22	24 6	23 29	22 53	22 16	21 36	20 53	20 8	19 17	18 20
23	24 11	23 36	23 1	22 26	21 47	21 7	20 23	19 34	18 39
24	24 15	23 43	23 8	22 34	21 57	21 18	20 36	19 50	18 57

ANGLES OF ELEVATION FOR 70 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	6°25'	4°42'	2°57'	......	......	......	......	......	......
6	10 18	8 44	7 9	5°32'	3°48	......	......	......	......
7	12 47	11 23	9 59	8 31	6 58	5°21'	3°33'	......	......
8	14 26	13 11	11 55	10 36	9 14	7 45	6 9	4°23'	2 21
9	15 35	14 27	13 18	12 7	10 53	9 33	8 6	6 30	4 41
10	16 25	15 23	14 21	13 15	12 8	10 55	9 37	8 9	6 30
11	17 2	16 5	15 8	14 8	13 7	12 0	10 48	9 28	7 57
12	17 30	16 38	15 45	14 50	13 53	12 51	11 45	10 31	9 8
13	17 52	17 4	16 15	15 24	14 30	13 33	12 32	11 23	10 6
14	18 9	17 24	16 38	15 51	15 1	14 8	13 11	12 7	10 55
15	18 23	17 41	16 58	16 14	15 28	14 38	13 44	12 44	11 37
16	18 35	17 55	17 15	16 33	15 50	15 3	14 13	13 17	12 13
17	18 45	18 7	17 30	16 50	16 9	15 25	14 38	13 46	12 45
18	18 53	18 17	17 42	17 5	16 26	15 44	14 59	14 10	13 13
19	19 0	18 26	17 52	17 17	16 40	16 1	15 18	14 32	13 38
20	19 6	18 35	18 1	17 28	16 53	16 16	15 35	14 51	13 59
21	19 11	18 41	18 9	17 38	17 5	16 29	15 50	15 8	14 18
22	19 15	18 46	18 16	17 46	17 15	16 40	16 3	15 22	14 35
23	19 19	18 51	18 23	17 54	17 25	16 50	16 15	15 36	14 51
24	19 22	18 55	18 29	18 0	17 33	16 59	16 25	15 48	15 5

ANGLES OF ELEVATION FOR 75 DEGREE BLANK

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	4 44'	3 28'	2 10		......	......	......	......	......
6	7 38	6 29	5 19	4 6	2 50	1 29	......	......	......
7	9 29	8 27	7 24	6 17	5 10	3 57	2 38'	1 10	.
8	10 44	9 48	8 51	7 50	6 51	5 45	4 34	3 14	1 45
9	11 36	10 46	9 54	9 0	8 5	7 5	6 0	4 19	3 27
10	12 14	11 28	10 40	9 52	9 1	8 7	7 8	6 3	4 49
11	12 42	12 0	11 16	10 32	9 45	8 56	8 2	7 1	5 54
12	13 4	12 25	11 45	11 4	10 21	9 35	8 45	7 49	6 47
13	13 21	12 45	12 8	11 29	10 50	10 7	9 21	8 29	7 31
14	13 34	13 0	12 26	11 50	11 13	10 33	9 50	9 2	8 7
15	13 45	13 13	12 41	12 7	11 33	10 55	10 15	9 30	8 39
16	13 54	13 24	12 51	12 22	11 50	11 14	10 37	9 51	9 7
17	14 2	13 33	13 5	12 35	12 5	11 31	10 56	10 16	9 31
18	14 8	13 41	13 14	12 46	12 17	11 45	11 12	10 34	9 51
19	14 13	13 48	13 22	12 55	12 28	11 58	11 26	10 50	10 10
20	14 18	13 54	13 29	13 4	12 38	12 9	11 39	11 5	10 27
21	14 22	13 59	13 36	13 12	12 46	12 19	11 50	11 17	10 41
22	14 25	14 3	13 41	13 18	12 53	12 28	12 0	11 29	10 54
23	14 28	14 7	13 46	13 24	13 0	12 36	12 9	11 40	11 6
24	14 31	14 11	13 50	13 29	13 7	12 44	12 18	11 50	11 18

ANGLES OF ELEVATION FOR 80 DEGREE BLANK

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	3° 7'	2°17'	1°26'	0°43'	......	......	......	......	......
6	5 2	4 16	3 30	2 42	1°52'	0 58'	......	......	......
7	6 16	5 35	4 53	4 10	3 25	2 36	1°45'	0°46'	......
8	7 6	6 29	5 51	5 12	4 31	3 48	3 2	2 8	1 8
9	7 42	7 8	6 34	5 58	5 21	4 42	3 59	3 11	2 17
10	8 7	7 36	7 5	6 33	5 59	5 22	4 41	4 0	3 11
11	8 26	7 58	7 29	7 0	6 28	5 55	5 19	4 39	3 54
12	8 41	8 15	7 48	7 21	6 52	6 22	5 48	5 11	4 29
13	8 53	8 29	8 4	7 38	7 12	6 43	6 12	5 38	4 59
14	9 2	8 40	8 16	7 52	7 28	7 1	6 32	6 0	5 24
15	9 9	8 48	8 26	8 4	7 40	7 16	6 48	6 19	5 45
16	9 15	8 55	8 35	8 14	7 51	7 28	7 3	6 33	6 3
17	9 20	9 1	8 42	8 22	8 1	7 39	7 15	6 49	6 19
18	9 24	9 6	8 48	8 29	8 10	7 49	7 26	7 1	6 33
19	9 28	9 11	8 53	8 36	8 17	7 58	7 36	7 12	6 45
20	9 31	9 15	8 58	8 42	8 24	8 5	7 44	7 21	6 56
21	9 34	9 19	9 3	8 47	8 30	8 12	7 52	7 30	7 6
22	9 36	9 22	9 6	8 51	8 35	8 18	7 59	7 38	7 15
23	9 38	9 24	9 9	8 55	8 39	8 23	8 5	7 45	7 23
24	9 40	9 26	9 13	8 59	8 43	8 28	8 11	7 51	7 30

ANGLES OF ELEVATION FOR 85 DEGREE BLANK.

Number of Teeth.	Angle of Cutter.								
	90	85	80	75	70	65	60	55	50
5	1°33'	1° 8'	......	......	......	......	......	......	......
6	2 30	2 7	1°44'	1°20'	0°55'	......	......	......	......
7	3 7	2 46	2 26	2 4	1 42	1 18'	0 50'	......	......
8	3 32	3 13	2 55	2 35	2 15	1 53	1 29	1° 3'	0°34
9	3 50	3 33	3 16	2 58	2 40	2 20	1 59	1 35	1 8
10	4 3	3 48	3 32	3 16	2 59	2 41	2 21	1 59	1 35
11	4 13	3 59	3 44	3 30	3 14	2 57	2 39	2 19	1 57
12	4 20	4 7	3 53	3 40	3 25	3 10	2 53	2 35	2 15
13	4 26	4 14	4 1	3 48	3 35	3 21	3 6	2 48	2 30
14	4 30	4 19	4 7	3 55	3 43	3 29	3 15	2 59	2 42
15	4 34	4 23	4 12	4 1	3 50	3 37	3 24	3 9	2 52
16	4 37	4 27	4 17	4 6	3 56	3 44	3 30	3 17	3 1
17	4 40	4 30	4 21	4 11	4 1	3 50	3 37	3 24	3 9
18	4 42	4 33	4 24	4 15	4 5	3 55	3 43	3 30	3 16
19	4 44	4 35	4 27	4 18	4 9	3 59	3 48	3 36	3 22
20	4 46	4 37	4 29	4 21	4 12	4 3	3 52	3 41	3 28
21	4 47	4 39	4 31	4 23	4 15	4 6	3 56	3 45	3 33
22	4 48	4 41	4 33	4 25	4 18	4 9	3 59	3 49	3 37
23	4 49	4 42	4 35	4 27	4 20	4 12	4 2	3 53	3 41
24	4 50	4 43	4 36	4 29	4 22	4 14	4 5	3 56	3 45

From well-known trigonometrical relations,

$$\frac{r}{\sin\,[180-(\phi+\phi_1)]}=\frac{OA}{\sin\,[180-(180-(\phi+\phi_1)\;-\theta_1)]}$$

from which $$OA=\frac{r\,\sin\,[(\phi+\phi_1)-\theta_1]}{\sin\,(\phi+\phi_1)}.$$

Therefore $$x=\frac{r\,\sin\,\phi_1\,\sin\,(\phi+\phi_1-\theta_1)}{\sin\,(\phi+\phi_1)}. \qquad (7)$$

Example: What would be the offset for a 1 1/8-inch reamer, 8 teeth, lands 1/16 inch wide, to be cut with a double angle cutter having angles of 15 and 65 degrees?

$$\theta = \frac{360}{8} = 45 \text{ deg., } \sin \rho = \frac{0.0625}{1.125} = 0.0555, \text{ or } \rho = 3 \text{ deg. } 11 \text{ min.}$$

$$\theta_1 = 45 \text{ deg.} - 6 \text{ deg. } 22 \text{ min.} = 38 \text{ deg. } 38 \text{ min.}$$

$$\phi + \phi_1 = 80 \text{ degrees.}$$

$$\phi + \phi_1 - \theta_1 = 80 \text{ deg.} - 38 \text{ deg. } 38 \text{ min.} = 41 \text{ deg. } 22 \text{ min.}$$

$$\text{Then } x = \frac{0.562 \sin 15 \text{ deg.} \times \sin 41 \text{ deg. } 22 \text{ min.}}{\sin 80 \text{ deg.}} =$$

$$\frac{0.562 \times 0.2588 \times 0.6608}{0.9848} = 0.098.$$

Reamers are usually cut with 90-degree cutters, the Brown & Sharpe standard tap and reamer cutter having angles of 30 and 60 degrees. If we were using one of these instead of the one considered, the work of calculation would be much simplified, for with $\phi + \phi = 90$, equation (7) becomes

$$x = r \sin \phi_1 \cos \theta_1 \qquad (8)$$

Equation (7) is strictly true for a straight tap or reamer, but only approximately so for a taper tap or reamer. The reason for this is that in deducing the expression for set-over, our angles lie in a plane perpendicular to the axis of cylinder. As soon as this axis is changed by elevating the tail center as in the case with a taper, we shift this plane by an angle equal to the angle of elevation. Projecting the angles back then onto the original plane modifies them to some extent, and hence the error. For a taper reamer with a taper not exceeding 1 inch per foot, the error can be neglected, being within the limits of accuracy of the setting of the machine. We may, therefore, use equations (7) and (8) for taper reamers with tapers not exceeding 1 inch per foot, the same as equation (5) previously referred to.

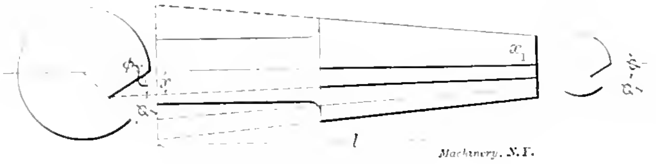

Fig. 5. Case of a Taper Reamer milled by a Double-angle Cutter.

It should be borne in mind that there are two kinds of set over, one which may be called the *table set over* in which the table, centers and all are moved over a certain distance, and another, the *center set over* in which one or the other of the centers is set over. To make this a little more apparent suppose we have a reamer ½ inch diameter at the small end and 1 inch at the large end. By equation (7) we find the set over for the large end to be 0.17 inch, while for the small end, it is 0.12 inch. If we move the table off center 0.17 inch for the large end, it will be over too far for the small end, while if it is adjusted right for the small end, the large end will not be over far enough. Swinging the table through a horizontal angle will not compensate for this difference, for the line of travel of the table will still be in the line of centers. It is therefore necessary to shift one or the other of the centers by an amount equal to the difference between the table set-over for the large and small ends of the reamer. See Fig. 5.

It follows from what has been said that unless provision has been made to adjust the tail center of a milling machine sidewise, it is impossible to cut a taper reamer with a double angle cutter without having the cutting edges of the teeth twisted with relation to the center line. If the work be held on the index head independently of the tail center, the head must be turned through a horizontal angle to escape the same consequences.

There is still one more thing to be considered. The vertical adjustment or elevation of the tail center as given by equation (5) is for a single angle cutter. For a double angle cutter this should be multiplied by the cosine of the angle of the double angle cutter which cuts the radial face of the tooth, or if we call this new elevation E_1,

$$\text{then } E_1 = E \cos \phi_1, \qquad (9)$$

Collecting these equations together, we have:

Single angle cutter

$$\text{Angle of elevation, } \alpha, \text{ for angular cutters} = \gamma - \delta, \qquad (1)$$

$$\tan \gamma = \cos \theta \cot \beta, \qquad (2)$$

$$\sin \delta = \tan \theta \cot \phi \sin \gamma, \qquad (3)$$

$$\text{For end mill } \cos \alpha = \tan \theta \cot \phi, \qquad (4)$$

In terms of taper per foot, elevation of tail center

$$E = \frac{Tl}{24} (\cos \theta - \sin \theta \cot \phi), \qquad (5)$$

Double cutter angle

$$\theta_1 = \theta - 2 \rho; \ \sin \rho = \frac{z}{2r}, \qquad (6)$$

$$\text{Table set over } x = \frac{r \sin \phi_1 \sin (\phi + \phi_1 - \theta_1)}{\sin (\phi + \phi_1)} \qquad (7)$$

$$\text{Table set over for 90-deg. cutter } x = r \sin \phi_1 \cos \theta_1 \qquad (8)$$

$$\text{Elevation of tail center } E_1 = E \cos \phi_1. \qquad (9)$$

The use of a double angle cutter has several advantages over the single. The pressure of cut comes more nearly over the center of the work, and there is no drag of the cutter teeth along the radial faces of teeth being cut, and hence a smoother cut is possible. A small angle to the side of a cutter makes it clear the work much the same as swinging the tool box of a planer causes the tool to clear on the return stroke when planing a vertical surface. We are enabled to use formed cutters which can be ground without changing their form. However, in view of the difficulties in making the adjustments, it is questionable whether the single angle cutter would not be the better.

* * *

The writer of a sensational story in the *Saturday Evening Post* which details the alleged experience of a convict in a States' prison, causes his chief figure in the drama to do certain stunts that rather take away a mechanic's breath. For example: "From the machine shop in the foundry (sic) he stole a big heavy file . . . At length he stole from the machine shop another file, a smaller one of diamond (sic) steel and with it he began to sharpen the big one of softer steel into a knife." This seems like a rather big and discouraging job, even for a convict with unlimited time at his command. Again: "He took ten needles and fitted them into the wooden stem of a brier pipe . . . close together like the teeth of a comb. They were hard; they made a diminutive saw; and they bit steel. With these needles he began to saw off his bars. He sawed for a year and had three bars nearly through," etc. A convict who can make a saw out of ten sewing needles that will cut through three steel bars ¾ inch in diameter ought to have a gold medal. He is a genius whose ability exceeds that of an Edison. Some file makers should get his name and address. The lucky one will make a revolution in file manufacture!

* * *

The construction and location of a machine shop tool room often is a somewhat difficult matter to decide upon. The location should be as central as the construction of the shop will permit, and its construction should be elastic to permit of growth with the growth of the shop, but any system of wooden drawers and shelves is objectionable, both because of lack of elasticity and the fire risk. Mr. Lucas, of the Lucas Machine Tool Co., Cleveland, O., proposes to make a new tool room in his enlarged shop of steel unit-drawn sections about four feet high, 12 to 14 inches wide, and 30 inches long, placed side by side, so as to enclose an area large enough for the tool room machines and attendants. All these steel units contain drawers for tools and supplies, but not all the units will have the drawers opening into the tool room. Part of them will be reversed so that the drawers will be accessible to the operators of machines in the immediate vicinity. This scheme has the merit of simplicity and extensibility. The only addition required to the steel units to form a tool room enclosure is a gate and a low wire net fence along the top. Such a construction does not interpose an obstruction to a general survey of the shop. It permits the tool room to be easily moved, extended or changed whenever the shop conditions require it, and is a construction durable and fireproof.

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS—3.

W. P. SARGENT.*

In considering the building of a new and enlarged plant with the aim of attaining the lowest possible cost of product and the highest possible productive efficiency, the first question is naturally—"Where shall we build?" In answering this question, with the country at large as a field, one would probably choose a site in the vicinity of Pittsburg or Birmingham if the cost of material greatly exceeded the cost of labor in a given product. Chicago, St. Louis, or Cincinnati, would be the choice for superior shipping facilities, and the vicinity of Niagara Falls would be favored for low cost of power. The outskirts of large manufacturing cities would be the most favorable from the standpoint of adequate labor supply. Taking all things into consideration, the Middle West, in the light of its wonderful industrial advance during the past decade, furnishes a happy medium between the advantages of the other sections of the country. It will provide an adequate labor supply of all grades, cheap fuel (coal at $1.00 to $2.00 per ton), and an abundance of excellent factory sites at a reasonable cost for land.

Who has not, within a few minutes after leaving any of the large manufacturing cities of this section, looked from the car window, first, on flat tracts of land parcelled into lots with cement sidewalks and occasional houses, and with electric interurban cars probably in view, and a little later upon level farms, with possibly a water course in the foreground and a streamer of smoke in the distance indicating the existence of another railroad. There is a good site for a large works, as such land can be purchased for $250 to $500 per acre, and often in single tracts of 150 to 200 acres from one owner. Low spots somewhat removed from the natural building location should not be considered as detrimental, as they are needed for dumps for foundry dirt and ashes, which will amount to 5,000 cubic yards per year from a plant such as will be described.

Fig. 19. A Site for a Large Works, possessing Many Advantages.

A farm may not seem to be the best site for machine shops, perhaps because the intense activity of a large plant is in such contrast to the quietude of a farm that the superior advantages may not appeal strongly; and doubts may be entertained of the securing and retaining of men in competition with the glamor of residing in the crowded city districts. That adjacent land, however, will be parcelled out for building lots, and that there will be a colony of homes before a large new works is in operation, is almost a certainty; and that the more reliable class of workmen will be attracted, is equally certain.

If the site chosen is within the city limits, there will be but a single fare on street cars, and the new plant will secure the benefits of municipal fire, water, and sanitary service to supplement its own service. But the non-success of securing a desirable site within the city limits need not deter the building of the plant just outside the limits. Any railroad will be glad to run a special morning and evening service to accommodate the workmen living within the city. Fire insurance rates will, however, approximate 25 cents per $100 more, if the plant is outside the municipal fire service limits. The well known tendency of cities to grow in the direction of industries in the outskirts, will in time bring fire service, at least soon enough to provide reserve facilities when extension of the works is necessary. But, of course, works of large size should be sufficiently protected by their own appliances not to be dependent.

Fig. 19 shows one of a number of fine sites about three miles from the center of a manufacturing city of 35,000 inhabitants. The line of trees in the distance is on the bank of a stream that would furnish water for all purposes except for drinking. Wells can be driven almost anywhere in the vicinity, and an abundance of pure cold water obtained. Beyond and paralleling the stream is a street with an interurban electric line; and about half a mile south a steam road crosses the street and parallels the stream, thus giving to the site a road on either side. The space is sufficient to allow of a rectangular site being laid out about 1,500 feet east and west and 2,000 or 3,000 feet north and south.

Preliminary Estimate.

We will now get to work on a general estimate of the amount of land required, and of the approximate cost of the project, basing the space figures on those given in column 1 of Table VIII. We will tentatively plan the layout of a new and complete plant to employ 1,500 men on medium and heavy machine tools. How much land will be required and how much space under roof will be required to work 1,500 men in all departments, or, in other words, to increase the production to $3,000,000 per year at $2,000 per man? The number of square feet per man under roof is given as 368, which applies during crowded conditions and includes a number of shacks and a large percentage of pattern storage. It should be noted that the percentage of total space under roof to the total space for machining is 540 as compared with 341, the mean of the plants Nos. 5, 6, 7, 8 and 9, but as all the details will not be considered in this broad estimate, we will use the figure given, being on the safe side, and will consider that the corporation officials would make their own allowances on the sum total of the money to be spent, anyway.

Space Occupied by Buildings and Total Ground Space.

For the total floor space take 1,500 men at 368 square feet each, as requiring in round numbers 550,000 square feet. We will assume that 25 per cent of this space will be galleries, reducing the total 137,500 square feet, and making the total ground floor space under roof 412,500 square feet. We will adopt a rectangular layout similar to that of the West Allis Plant and will therefore multiply 412,500 by 2 and get 825,000 square feet as the total of the ground space within the building rectangle. Increasing this by 60 per cent, to provide for extensions to make the total number of men employed 2,500, adds 495,000 square feet, making 1,320,000 square feet, sufficient to cover all the building ground space ever required. The area for trackage may be taken as 50 per cent or 660,000, making the grand total that should be purchased 1,980,000 square feet or 45.5 acres, or 50 acres in round numbers.

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Approximate Cost Estimate of New Plant.

Taking a maximum of $500 per acre makes the investment in land $25,000	$ 25,000
We will aim to keep the cost of buildings of all classes within an average of $1.70 per square foot, and for 550,000 feet of floor space the total cost of buildings may be placed at $935,000	935,000
For power equipment we will assume one I. H. P. per man; 1,500 H. P. of boilers, including reserve battery stokers, piping, auxiliaries, engines, generators, switch-boards, and coal-handling and storage apparatus at $90 per H. P., totals	135,000
It is rather difficult to arrive at the cost of cranes using a unit figure, but if we assume that 400,000 square feet of space inside and outside will be served by cranes at 50 cents per square foot, the total cost will be about $200,000	200,000
Heating: Taking 412,500 square feet occupied by buildings and multiplying by an average height of 50 feet gives us 21,000,000 cubic feet as the approximate cubical contents; with a ratio of 150, this requires the equivalent of 140,000 feet of direct radiation, which at 60 cents per foot, and with some extra allowance, makes the cost for this item in the neighborhood of $90,000	90,000
The nominal horse-power of motors required for direct and group driving approximates 1 H. P. per man and 1,500H. P. of motors at $15 per H. P.	22,500
Trackage in the yards will approximate 6 miles at $9,000 per mile	54,000
Switch engine, locomotive crane, and rolling stock	12,000
The sprinkler equipment and inside piping will cost 7 cents per square foot for 550,000 square feet—$38,500—and 10 cents per square foot for yard piping, tanks, etc.—$55,000—totals	93,500
The machine tool equipment will cost about $600 per man or for 1,500 men $900,000 or about $8.00 per square foot of space used for machining. But if a new shop replaces an old one, the machine tool equipment would certainly be moved, and it is probable that the new tools needed at the beginning would be covered by the sum of $200,000, leaving the remaining tools to be purchased when needed	200,000

The above items indicate a gross expenditure of $1,767,000

TABLE VIII. COMPARATIVE FLOOR SPACE DATA IN SOME REPRESENTATIVE SHOPS.

	No. 1		No. 2		No. 3.		No. 4		No. 5.		No. 6.		No. 7.		No. 8.		No. 9.	
	Square Feet.	Per cent	Square Feet.	Per cent	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.	Square Feet.	Per cent.
Machining, First Floor	55,900	100.0	30,500	100.0	276,500	100.0	63,000	100.0	122,000	100.0	135,700	100.0	158,000	100.0	137,000	100.0	55,000	100.0
" Gallery	19,000		....	......							51,050		62,600		....	......	....	
Assembling	70,000	93.0	16,500	54.0	43,500	16.0	26,700	42.0	68,000	55.0	40,750	21.5	109,000	50.0	55,400	40.0	30,100	54.0
Work in Progress	1,600	2.0	....	......	....	......	6,000	9.5	10,000	8.0	....	......	....	......	....	......	....	......
Tool Making	2,600	3.5	....	......	....	......	8,000	12.5	10,000	8.0	....	......	6,400	3.0	....	......	....	......
Tool Storage	3,700	5.0	....	......	....	......	8,000	12.5	15,000	12.0	....	......	....	......	....	......	....	......
Machine Shop Stores	5,100	7.0	8,150	26.5	....	......	13,000	20.0	36,500	30.0	....	......	12,800	6.0	....	......	13,300	24.0
Wash Room	500	0.5	....	......	....	......	8,000	12.5	13,000	10.5	....	......	....	......	....	......	....	......
Shop Offices	100	......	....	......	....	......	1,000	1.5	1,000	1.0	....	......	....	......	....	......	....	......
Machine Shop, Total	158,500	211.0	55,150	180.5	320,000	116.0	133,700	210.5	275,500	224.5	230,500	121.5	348,000	159.0	192,400	140.0	98,400	180.0
Finished Storage	13,000	17.5	8,150	26.5	....	......	15,000	24.0	20,000	24.0	....	......	17,000	7.5	31,000	22.5	10,000	18.0
Shipping	9,700	13.0	....	......	....	......	7,500	12.0	8,000	6.5	21,500	11.5	22,000	10.0				
Foundry, Iron	83,650	112.0	16,000		....	......	....	......	....	......	....	......	140,300	63.0	106,500	78.0	....	......
" Brass	5,820	8.0	....	......	....	......	....	......	....	......	....	......	22,000	10.0	2,400	2.0	....	......
" Steel	....	......	....	......	....	......	....	......	....	......	....	......	....	......	....	......	....	......
Foundry Total	89,470	120.0	16,000	52.0	143,000	52.0	20,000	32.0	31,000	25.0	132,000	70.0	162,300	73.0	108,900	80.0	43,350	79.0
Casting Storage	15,000	20.0	....	......	....	......	42,000	67.0	....	......	....	......	67,500	30.5	....	......	....	......
Storage, Flask	32,000	43.0	....	......	....	......	30,000	48.0	20,000	16.5	....	......	....	......	25,000	18.0	30,000	54.0
" Pig Iron	30,000	40.0	....	......	....	......	2,000	3.0	600	0.5	....	......	80,000	36.0	14,000	10.0	6,600	12.0
" Coke	2,300	3.0	....	......	....	......	300	0.5	400	0.5	....	......						
" Sand	5,000	7.0	500	1.5	....	......	700	1.0	5,000	4.0	....	......	9,000	4.0	10,200	9.5	....	......
" Supplies	7,600	10.0	....	......	....	......	....	......	200		....	......	....	......	....	......	....	......
Smith Shop	12,500	16.5	1,730	5.5	12,000	4.5	9,000	14.5	9,000	7.5	50,150	26.5	9,100	4.0	19,200	14.0	3,100	5.5
Iron Storage	5,000	7.0	....	......	....	......	10,000	16.0	10,000	8.0	....	......	....	......	....	......	....	......
Coal Storage	1,600	2.0	....	......	....	......	....	......	....	......	....	......	....	......	....	......	....	......
Pattern Shop	11,000	14.5	1,730	5.5	29,000	10.5	4,500	7.0	8,900	7.5	31,000	16.5	22,600	10.0	14,400	10.5	7,400	13.5
" Storage	60,000	80.0	8,900	29.0	83,000	30.0	16,000	25.0	26,000	21.0	144,900	76.0	67,500	30.5	50,400	37.0	29,200	54.0
Carpenter Shop	3,100	4.0	1,670	5.5	....	......	....	......	....	......	....	......	....	......	5,600	4.0	....	......
Lumber Storage	7,400	10.0	....	......	....	......	4,000	......	4,000	3.5	....	......	....	......	....	......	....	......
Engine Room	5,000	7.0	700	2.5	....	......	1,400	2.0	....	......	8,850	4.5	8,540	4.0	9,260	6.5	2,100	4.0
Boiler Room	4,100	5.5	1,080	3.5	....	......	2,100	3.5	1,750	1.5	8,850	4.5	8,700	4.0	8,500	6.0	1,920	3.5
Pump Room	800	1.0	....	......	....	......	....	......	900	1.0	....	......	....	......	....	......	....	......
Electricians	300	0.5	....	......	....	......	800	1.0	1,400	1.0	....	......	18,000	8.0	....	......	....	......
Coal Shed	7,000	9.5	....	......	....	......	....	......	2,400	2.0	....	......	2,500	1.0	5,000	3.5	....	......
Offices	3,500	4.5	4,000	13.0	29,000	10.5	4,600	7.0	15,000	12.0	....	......	22,500	10.0	24,000	17.5	1,500	2.5
Drawing Room	5,200	7.0			11,000	4.0	4,000	6.5	6,000	5.0	....	......	7,500	3.5			3,000	5.5
Space Occupied	479,070	640.0	....	......	....	......	307,600	488.0	455,050	373.0	....	......	873,540	396.0	517,860	378.0	236,570	430.0
" Under Roof	404,670	540.0	99,610	326.0	627,000	227.0	298,600	363.0	420,850	345.0	627,750	330.0	717,040	325.0	467,860	341.0	199,970	363.0
" Occupied per Man	436	......	....	......	....	......	342	......	....	......	....	......	....	......	....	......	....	......
" Under Roof, per man	368	......	....	......	330	......	254	......	....	......	....	......	....	......	....	......	....	......
Number of Buildings	50	......	15	......	....	......	20	......	11	......	6	......	10	......	17	......	14	......
Number of Men	1,100	......	....	......	1,900		900	......	....	......	....	......	....	......	....	......	....	......
Product.	Medium and Heavy Machine Tools.		Light and Medium Machine Tools.		Medium and Heavy Engines and Mining Machines.		Light and Medium Machine Tools.		No. 1 after Rebuilding Space Allotted		Heavy Engines, Expansion of No. 3.		Light, Medium, Heavy Pumps, Condensers.		Compressors, Rock Drills, Light, Medium, Heavy.		Corliss Engines, Turbines, Pumps.	

Plants Nos. 1, 2, 3, and 4 are unimproved. Plant No. 5 is rebuilt. Others are entirely new.

Taking a range both ways we will say that the plant can be built for $1,600,000 to $2,000,000, of which there could be charged off an amount equal to the market value of the old plant and of equipment not removed to the new plant.

It is a difficult thing to find a customer for old shoes which the owner has outgrown and worn out, especially of such a size, and it is hardly probable that a corporation will release to the ravages of time and man, a property which for $500,000 could be enlarged and improved to employ 1,500 men even though the limit of expansion would be reached. Only a corporation so happily situated as to have built and grown in the heart of a metropolis, with the value of its real estate enhanced to the extent that the proceeds of the sale of its ground would partly build the new plant, would consider a proposition of this size. Possibly also a concern having absolutely reached its limits of expansion would decide upon eventually having a plant that would be right, and would plan as a whole, and build in part, as their needs necessitated and their resources would permit.

A new plant, however, is what all overgrown concerns would like to see, and the writer will proceed on the assumption that the means would be forthcoming, especially as the designing of a new plant of this size will cover most of the problems that arise in planning the extension of old plants.

The General Layout.

Referring to Table VIII, the reader will notice that the percentages are based on the space used for machining (sepa-

rated from the tool-making and supply departments, which are included in the figures given for the machine shop total), but should be considered as approximate for the plants that are not given in detail. Table IX takes into account the number of men, and the modifications necessary to form unit figures that can be used as the basis for laying out the new plant.

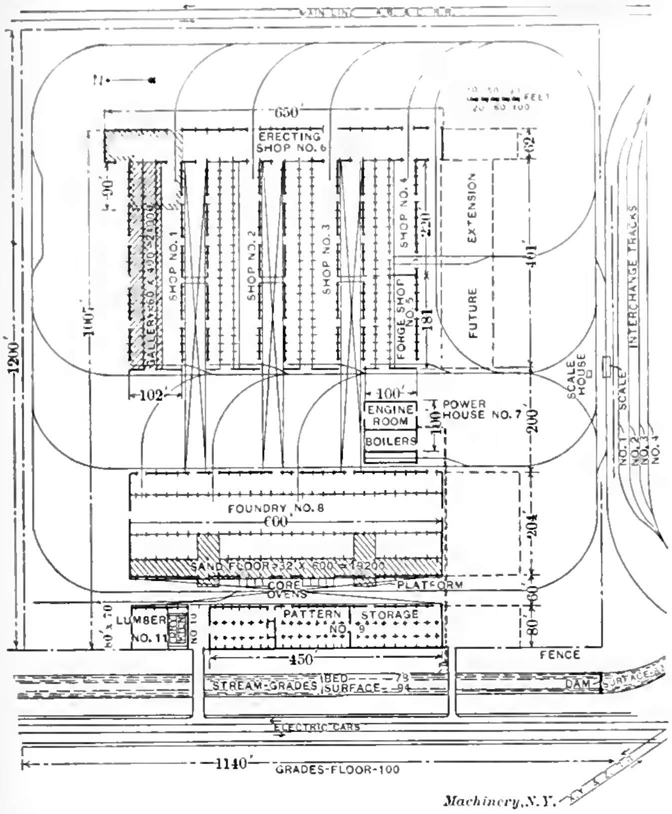

Fig. 20. Block Plan of Model Plant.

As the relative number of men in the different departments is constantly changing, and the departments are not all at their highest efficiency at the same period, it is necessary to analyze each department separately, and the composite figures obtained will probably differ from the data obtained for any definite date. For instance, the number of men given in Table IX is not the number employed at the time that the foundry complement was compiled, but figures are taken that balance better.

In the works from which these figures were obtained the space is badly broken up. The main erecting bay—50 feet wide—is not wide enough to erect a double line of the heavy machines at one time and utilize the space to the best advantage. Work that should be placed adjacent to the tools ready for machining is sandwiched in between machines undergoing erection, thus making the erecting space, to a great extent, merely storage space for work in progress. In a building intended for erecting only, the amount of this waste space should be transferred to the machining space, and it should be noted that the figures for square foot per man are modified, and 300 square feet per man is taken as a unit for both erecting and machining space. The foundry space is crowded, so the unit per man is made 250 square feet. The total number of men is reduced to a unit of 357 or approximately 1/3, allowance being made in the foundry for expected superior arrangement, and in the pattern shop for the employment of a greater proportion of men to expedite work from the drawing-room to the foundry. It should be noted that the modified space ratios correspond better with those of the new plants in Table VIII.

The unit figures are multiplied by 4 to provide for an increase in force to 1,500 men, or approximately 33 per cent more. If later extensions are needed, the addition of another unit will provide an increase of 25 per cent; and if we lay out our buildings right, the extensions can be made without interfering with the production in the least. We can now block out roughly the size of the main buildings, basing our conclusions on the data from Table X.

Erecting Shop.

The heavy erecting space in bays 2 and 6 in Table X is 27,500 square feet, and the medium erecting in bays 1, 3, 4, 5, and 9, occupies 30,500 square feet. The widths of the bays vary from 35 to 50 feet, and as the widest are not wide enough to erect a double line of machines, and the narrow ones do not economize room, we will consider that a width of 60 feet will not be excessive or detrimental to the effective use of the cranes. It should be remembered that the bridge traverse of cranes is more rapid than the trolley traverse; traverse of cranes is more rapid than the trolley traverse, can be increased proportionately; or, what amounts to the same thing, the trolley will have a chance to accelerate to the highest speed and even get a short run at the high speed, on a crane speeded as they ordinarily are.

From the erecting space (67,200 square feet) in Table IX, the amount required for fitting (17,200 square feet) is deducted, leaving 50,000 square feet as the space that should be considered for the main erecting space. Dividing by 62 feet (the crane span plus 2 feet) we get 806 feet as the approximate length of the erecting shop. This is merely a tentative figure, as we may want to modify the dimensions on account of considerations of space distribution.

For the machining, we have plenty of latitude in the arrangement of space, as the percentage of the total machine space that requires cranes of 15-ton capacity is about 11

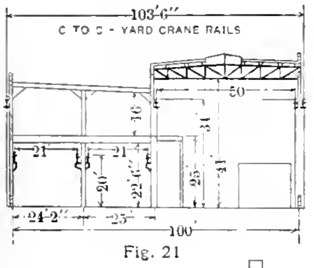

Fig. 21

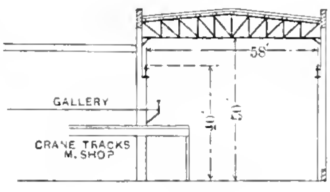

Fig. 22

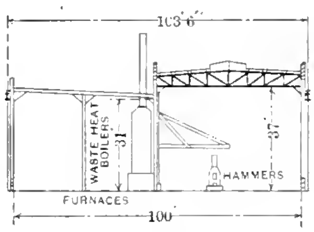

Fig. 23

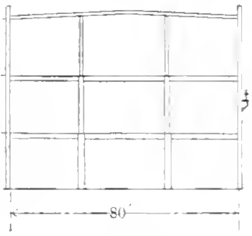

Fig. 24

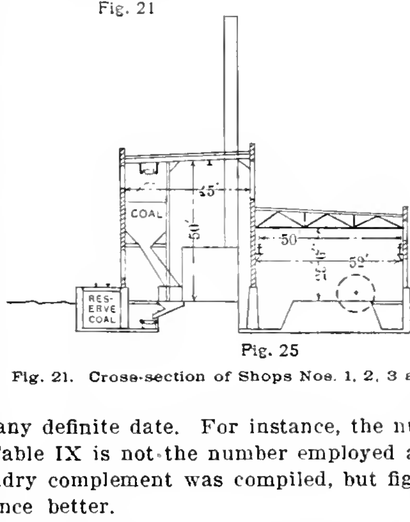

Fig. 25

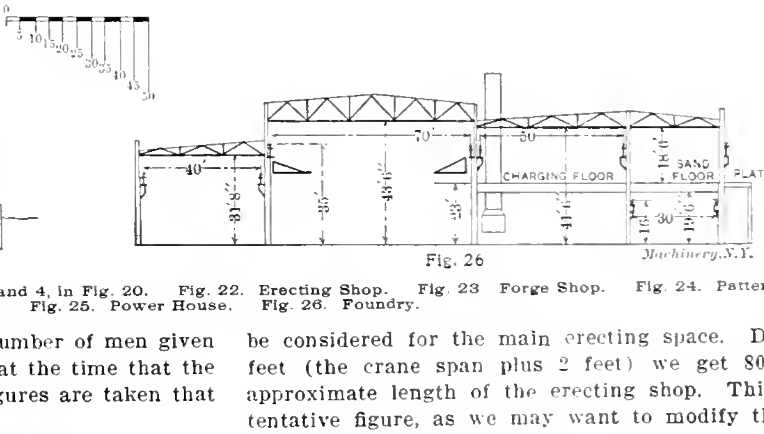

Fig. 26

Fig. 21. Cross-section of Shops Nos. 1, 2, 3 and 4, in Fig. 20. Fig. 22. Erecting Shop. Fig. 23 Forge Shop. Fig. 24. Pattern Storage. Fig. 25. Power House. Fig. 26. Foundry.

per cent. This percentage of the 172,800 square feet required for machining is 19,000 square feet, and a bay 52 feet wide and 400 feet long will be ample, leaving 152,000 square feet to be taken care of by galleries and smaller crane bays. Before settling on a cross-section for the machine shops, the percentages of the space under cranes, and that used for the heavy and medium work should be determined from Table X, and the amount of space for a complete unit (from Table IX) apportioned accordingly.

We have the following figures from the preceding discussion. 1. A width of about 60 feet for the erecting shop. 2. A main bay in one machine shop about 50 feet wide and 400 feet long. Summing up the machining space in Table X that is not served by cranes, we get 48,000 square feet and this equals 54 per cent of the total of 88,000 square feet in the old shops. Taking 54 per cent of the desired 172,800 square feet, we get 93,000 square feet of space that can be on galleries or under galleries. The planers occupy about 29 per cent, and this calls for 50,000 square feet in the new shops.

To secure low cost and quick delivery of construction material, it is self-evident that the buildings should be as nearly alike as possible in dimensions and details, following the methods of all successful manufacturing, in providing for duplicate parts in large lots. As the space will not permit of the discussion of all the steps leading up to a tentative plan, the block plan Fig. 20 is presented together with a brief explanation of the reasons for the arrangement and proportions, wherever the conclusion has not been reached in the preceding paragraphs.

It should be noticed that 180 feet in length of Unit No. 4 has been modified for use as smith shop. As we have been generous in the space allowed per man in this department, this shop (by night work, if

TABLE IX. GENERAL DATA AS COMPILED FROM PLANT NO. 1 AND AS MODIFIED FOR USE IN DETERMINING SPACE-FIGURES FOR A NEW PLANT WITH 1500 MEN.

	Actual Data.				Modified Data.					
					One Unit.			Four Units.		
Department.	Square Feet.	Ratio, per cent.	Men.	Sq. Ft. per Man.	Men.	Sq. Ft. per Man.	Sq. Ft. per Unit.	Ratio. per ct.	Men, Total.	Total Sq. Ft.
Machining	88,000	100.0	382	230	144	300	43,200	100.0	576	172,800
Erecting	58,000	80.0	188	370	56	300	16,800	38.8	224	67,200
Assembling	12,000									
Total..	158,000	180.0	570	277	200	300	60,000	138.8	800	240,000
Foundry, Iron.....	83,650	95.0	350	240	122	250	....	......	....	....
" Brass....	5,820	6.5	25	233	8	250	......	....	......	....
Foundry Total...	89,470	101.5	375	238	130	250	32,500	75.0	520	130,000
Pattern Shop......	11,000	12.5	30	365	15	365	5,480	12.7	60	21,920
Smith Shop	12,500	13.0	35	380	12	380	4,560	10.5	48	18,240
Total..	270,970	307.0	1,010	268	357	287	102,540	237.0	1,428	410,160

TABLE X. DATA FROM PLANT NO. 1.

A—Crane Track Span. B—Crane Track Height. C—Floor to Roof-truss. D—Width between Columns.

Bay No.	A	B	C	D	Cranes.	Machining Space.	Erecting Space.	Assembling Space.	Remarks.
1	51′	21′ 5″	27′ 9″	50′	2–15 ton	....	10,000	....	Medium Work.
2	50′	23′ 4″	31′ 6″	49′	1–25 ton 2–20 ton	....	20,000	....	Heavy Work.
3	41′	24′ 4″	30′ 6″	40′	1–15 ton*	... .	6,000	....	Medium Work.
4	40′ 8″	22′	27′	42′	2–10 ton	6,000	8,000	....	Boring Mills. Medium Erecting
5	38′ 2″	24′	31′ 2″	37′	1–15 ton*	2,000	4,000	....	Medium Erecting. Planers.
6	36′ 1″	24′	31′ 2″	35′	1–20 ton	6,500	.... ..	....	Large Planers.
					1–15 ton	....	7,500	....	Large Erecting.
7	20′	15′	17′ 9″	21′	3– 3 ton	2,000	....	6,000	Next to No. 2.
8	....	....	17′ 9″	21′	....	4,000	....	4,000	Next to No. 7.
9	....	....	18′	45′	2-hand	4,500	2,500	2,000	Medium Work.
10	....	....	12′	45′	.....	19,000	... .	....	Gallery.
11	....	....	17′	37′	....	13,000	....	....	Small Planers.
12	......	....	16′	17′	....	3,400	....	... ...	Light Work.
13	.....	....	14′	41′	......	8,000	....	......	Light Work.
14	....	....	15′	20′	....	3,300	....	....	Planers.
15	....	....	15′	20′	....	3,300	....	....	Light Work.
16	....	....	14′	40′	....	13,000	....	....	Light Work.
	Totals of Machine Shop Departments					88,000	58,000	12,000	
1	58′	30′ 4″	38′ 4″	56′ 9″	3–30 ton	....	....	....	Foundry.
2	30′	17′ 3″	18′ 9″	30′ 7″	1– 5 ton	....	....	....	Side Bay.
3	30′	17′ 3″	18′ 9″	29′ 7″	1– 5 ton	....	... ..	.. ....	Side Bay.
......	....	....	12′	41′	....	....	....	....	Pattern Shop.
.....	....	....	20′	63′	....	....	....	....	Smith Shop.

* Cranes in Bays Nos. 3 and 5 are obsolete.

TABLE XI. SPACE ALLOTMENT. MODEL PLANT.

Building Number..........	1	2	3	4	5	6	7	8	Totals.	Per cent.
Department.										
Machining—										
First Floor.........	31,000	31,000	31,000	... .	....	.... .	.. ...	......	....	.....
Gallery.............	24,000	24,000	24,000	11,000	....	.	......	....	176,000	100.0
Erecting.........	9,000	9,000	9,000	4,000	....	36,000	....	....	67,000	38.0
Foundry............	....	.....	......	....	......	....	....	121,200	....	......
Sand Floor.........	....	....	......	....	....	....	....	19,200	140,400	80.0
Pattern shop.........	No. 9 22,000	....	......	....	....	....	....	....	22,000	12.5
Smith Shop	....	....	......	....	18,000	....	....	... .	18,000	10.2
Total of Manufacturing Departments...........................									423,400	241.0
Shipping and Storage.	....	....	......	18,000 4,000	....	3,000	....	... .	25,000	14.2
Pattern Storage......	No. 9 63,000	....	....	....	....	....	....	....	63,000	35.8
Lumber Storage.......	....	No. 10 1,600	No. 11 5,600	....	....	....	....	....	7,200	4.1
Engine Room.........	....	....	....	....	....	....	5,200	....	5,200	2.9
Boiler Room..........	....	....	....	....	....	....	4,500	....	4,500	2.5
Coal Storage	....	....	....	....	....	....	3,000	.....	3,000	1.7
Drawing Room.......	10,000	....	....	....	....	....	....	....	10,000	5.7
Office	10,000	....	....	....	....	....	....	....	10,000	5.7
Total Floor-space under Roof..................................									551,000	313.3

necessary, which is profitable for heavy forge working) should be ample to take care of a 25 per cent increase in the rest of the plant.

A width of 100 feet inside is taken as basis for the wing shops. A gallery 50 feet wide, adjacent to the 50-foot main bay, and 25 feet from the floor, affords good light and ventilation under the gallery. A gallery 10 feet wide projecting into the main bay does not interfere with the placing or operation of the heavy tools and provides a central location for stairways, elevators, wash-rooms, shop offices, tool-rooms, storage, etc., without encroaching on the main gallery floor. With this cross-section, the floor area per unit is 40,000 square feet on the first floor and 24,000 square feet on the gallery, totaling 64,000 square feet, or more than is called for in Table IX for both machining and erecting. Therefore three shops 90 feet in length are assigned to erecting and assembling, which shortens the main erecting shop to about the length of the foundry. A portion of the space in shop No. 4 is assigned to storage and shipping, and also a portion at the south end of the main erecting shop. A width of 204 feet is adopted for the foundry.

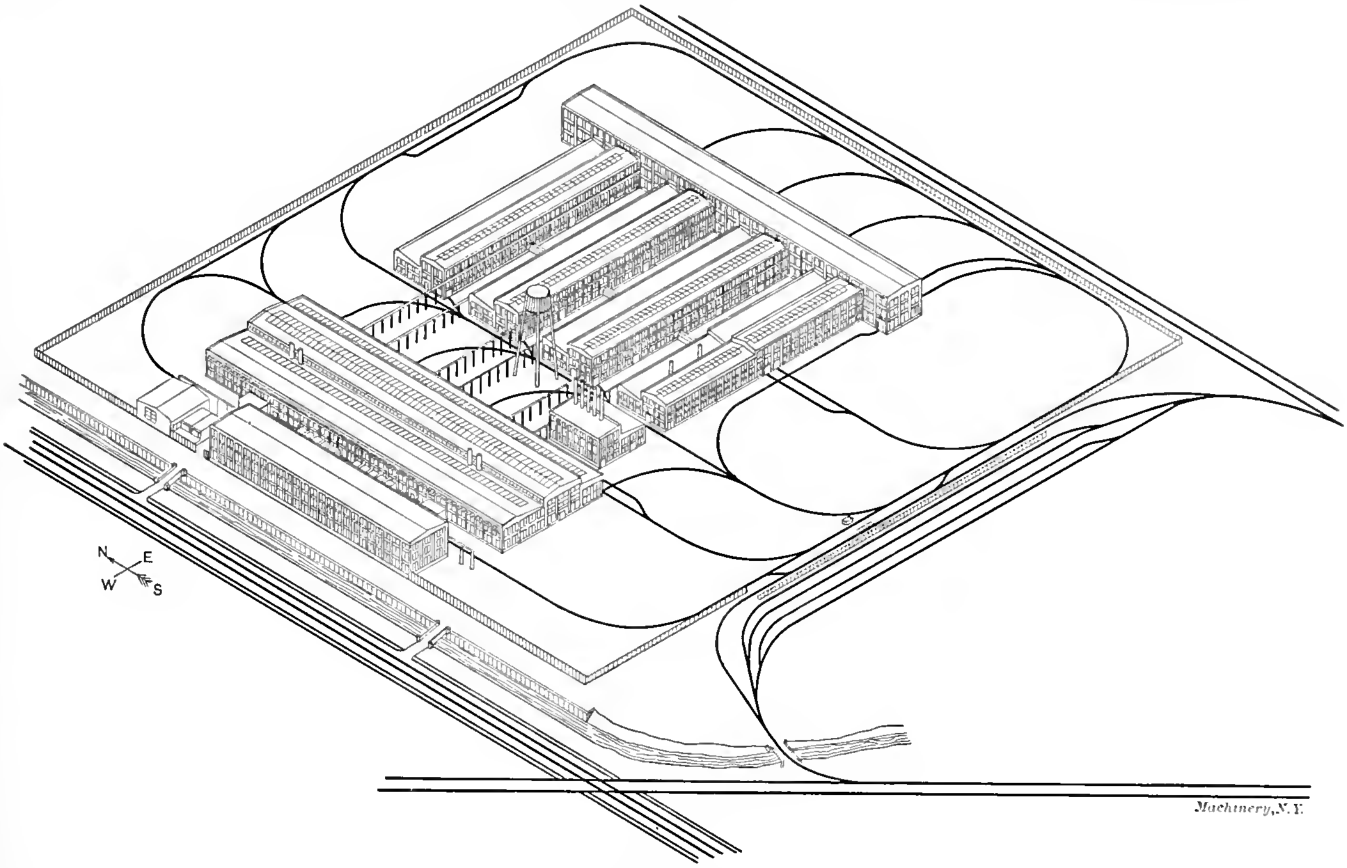

Fig. 27. Perspective of Model Plant

Assuming that 10,000 square feet each would be required by the drafting department and office (from Table VIII), and taking 22,000 square feet for the pattern shop (from Table IX), and 63,000 square feet for the pattern storage (slightly more than given in Table VIII for Plant No. 1), the total of 105,000 square feet is deemed sufficient for these departments. Making one building 80 feet wide and 3 stories high, the length is kept to about 450 feet.

This arrangement provides for the drawing room on the top floor, the offices on the second floor and the pattern shop on the ground floor. These departments will therefore get light from all sides but the south. Lumber storage is provided near the pattern shop and this corner of the works will be relatively free from the smoke of switch-engines and the dirt from the foundry, as the prevailing winds are from the southwest. The direction of the prevailing winds in warm weather should be well considered, and the plant laid out to get the benefit of them, if no more important feature has to be sacrificed by so doing.

Cross-section of Buildings.

The distance from floor to roof truss in the various buildings is determined by the required height of crane rails (distance under the hook is approximately the same), and tho clearance required for the cranes themselves. The following table gives clearances sufficient to permit of installing the cranes built by the leading makers.

		Clearance	
Capacity.	Span	Rail to Truss	Rail to Column
5-ton (Trolley on lower flange of girder.)	33′	2′ 6″	7″
10-ton	50′	6′	8″
15-ton	60′	6′ 6″	10″
20-ton	60′	6′ 6″	10″
30-ton	70′	8′ 6″	12″
40-ton	70′	8′ 9″	12″

The forge shop, Fig. 23, is given plenty of head-room, with swinging windows close to the roof, to provide adequate natural ventilation. Ordinary circular ventilators seem to fail in clearing such a shop of smoke and gases, and monitor louvres, as commonly placed, are not a great deal better.

The velocity of the efflux of the smoke and foul air is governed by the difference in temperatures between the air inside and the air outside. The average temperature in a forge shop is seldom greater than 90 degrees; with the outside temperature at 55 degrees (a yearly average for the Central states), the difference in weight of the two columns of air is so little that the foul air escapes only in a small amount through ventilators in the roof. Even at zero-temperature outside, the velocity of efflux is but slightly greater, as the velocity increases as the square root of the differences in temperatures.

The writer advocates the use of windows near the roof. These windows, when open, allow any horizontal air currents to blow straight through, as even a gentle breeze will have a higher velocity than is obtained through roof ventilators. Heating radiation will of necessity be supplied to make up for the loss of heat from the building. This method of ventilating is provided for all the other buildings, and especially in the boiler room. The air in the shops will be renewed in winter time by the natural filtration of air through the walls, and by the opening of doors. Heating engineers often figure on three changes per hour in large shops on account of these losses.

Central skylights of ribbed glass, in the roofs of the high buildings, will diffuse the direct rays of the sun so that

the workmen will not be seriously bothered. An overhead skylight on a roof within 30 feet of the floor is almost an absurdity, as its effectiveness for lighting must be greatly nullified by painting in order to protect the men from the heat of the direct rays. This, of course, does not apply to saw-tooth skylights.

The headroom of the pattern shop building, Fig. 24, is 20 feet, or one-fourth of the width. This ratio is given by a number of authorities as necessary for good lighting. The rule works out in practice, as may be observed in many instances.

Arrangement of Space Model Plant.

The following figures are given for comparison with the Table V of the October issue, covering plants already built.

	Square Feet	Percentage.
Rectangular space bounding buildings, 650 by 1,007 feet, equalling	654,000	100
Covered by buildings............	389,000	59.4
Under yard cranes..............	93,600	14.3
Tracks and vacant space..........	172,400	26.3
Average haul of castings to shops..........		500 feet
Maximum distance of electric transmission..		700 feet

The layout shown in Fig. 20 permits of the allotment of space for the different departments in close accord with the desired figures of Table IX, as will be seen by comparing Table XI with Table IX.

Allowing space for erecting and assembling in the wing shops has many advantages. Scraping and fitting and group assembling can be done in under the gallery floor, served by light cranes. When the groups are ready for erecting, they can be carried out into the main space by the cranes on the runways projecting into the No. 6 building. This reserves the high shop strictly for its designed and most productive purpose. Then again the portion of the 50-foot bay of the wing shop reserved or allotted to erecting, forms a neutral ground between the machining and erecting departments, and is ready for instant use to accommodate an overflow from either branch of the work. In other words, this space can take care of the surges of forced production, and the common trouble attendant upon the placing of a new and very large tool in a space already overcrowded, is obviated.

Yard Cranes.

The cranes in the yard between the foundry and the pattern storage buildings will handle the charging trucks loaded with pig iron from the storage piles to the outside platforms, which form extensions to the charging floors. The cranes will also handle the heavy flasks and core-boxes between the points of storage and use.

Water Source.

A stream of water, even though the flow is small but steady, is worth a good deal to a large works, as a dam will form a reservoir of a far greater capacity than needed. And the water can flow through the condensers to the lower level of the stream with but little pumping, and also keep the fire-pump primed without a tank.

The block plan Fig. 20 and the isometric view Fig. 27 are self-explanatory, especially to one who has followed the previous papers of this series.

Unless the engineer-in-charge has a large force of tried men and plenty of time, it is much better, in fact, almost necessary, to use the service of an architect on a project of this size. The architect's estimate of cost will check that of the engineer.

The succeeding instalment will cover the data and instructions that would be required to start an architect on the definite plans for the buildings, and will give costs that will form a basis for estimating the many details of works construction.

* * *

An interesting substitute for the ordinary forms of wall paper has, according to the *English Mechanic and World of Science*, been introduced in India, in the form of a damp-proof wall covering made from copper. The material varies in thickness from 0.0012 to 0.006 inch. Apart from its wearing qualities this wall covering is insect-proof, as well as damp-proof, which makes it particularly desirable in India during the rainy season.

HOW TOM CROSSED THE RUBICON.[*]

A. P. PRESS.

I met Tom the other noon at lunch—that is, he was Tom when I knew him last. He is Mr. Smith now, and he is superintendent of the Laporte Machine Co.; but when we were foremen together at the E. G. Co., he was just plain Tom, and he ran the "West" shop. Tom left the E. G. Co. a long while ago, and I hadn't seen him for years till this week. Monday when I was out at lunch in came Tom, or Mr. Smith, I should have said; he took a seat at the same table with me, and we had a good old talk.

I never knew why he left the E. G. Co., and, as Tom said, he didn't know himself for a long while. As I told you at the start Tom was foreman of the "West" shop for years and he "made good"—so good, in fact, that other firms in the same lines of work wanted him, and they kept making him good offers, and that got him "on the run." Tom didn't seek the jobs, but the jobs came around looking for him. Finally one firm made him an offer of $1,800 a year, and as he was getting only $27 per, he couldn't say "no." He didn't close the deal, but he sent a note up to the "super" that he wanted to leave; "see me on this," was what he got back, and Saturday noon he went up and saw the "super."

"Well, have you crossed the Rubicon yet?" were the first words the "super" said to Tom as he came in the door.

Now, Tom was a good man; he could handle a lathe or a planer, and he could get a lot of good work out of a poor set of men, but he was not strong on Roman history, and though he had heard the name before, he wasn't sure whether it was a river in Asia or whether it was a part of the third degree of the lodge that he had been put through a week before. In fact, he rather thought it was the lodge, so he answered back promptly, "I suppose I have, sir."

"Well," said the "super," "I never like to change the personnel of the foremen, but if it's too late it can't be helped."

He went on and gave Tom a lot of good advice, but not a word did he say about more money; and after he was done Tom went out feeling kind of queer. As he told his wife when he got home, he didn't know whether he had a compliment or a "call down," but the "Old Man" had used him fine, but after he got through he didn't know where he was at.

He went with the Laporte Co. and made good all right, but, as Tom said, "It never came to me till I got hold of an old book on Roman history, what the 'Old Man' meant by 'crossing the Rubicon.'" But as things have turned out I guess it is just as well.

* * *

A dirty line-shaft is a reproach to a shop foreman, and also is a fire hazard, especially in shops where considerable quantities of dust and lint are flying about. Accumulations of fuzz and grease on line-shafts are said to have started fires, and insurance companies in some cases require that the line-shafts be kept clean. The simplest and perhaps most effective method of doing this is by means of straw-board "travelers," which are simply annular disks of straw-board cut with the hole slightly larger than the diameter of the shaft. These disks are cut through from the hole to the exterior on one side so that they may be sprung over the shaft. In the magnificent machine shops of the Western Electric Co., Hawthorne, Ill., the travelers are largely used on the line-shafts, and the sight is somewhat uncanny. Hundreds of them are traveling back and forth all day, doing their work most effectively. The line-shafts are kept bright and perfectly clean of all accumulations, and the general appearance of the shop greatly improved.

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[*] In Roman history "crossing the Rubicon" is the act of Julius Cæsar returning to Italy at the head of his army contrary to the orders of the Roman senate. He was governor of Gaul, and the commanding-general of the Roman army required to keep the province subjugated. His campaign had been a brilliant success, and in its progress he neared the boundary of Italy, where the desire to return to Rome became too strong to be resisted. To return he had to cross the Rubicon, a small river separating ancient Gaul from Italy, and this he could not do as commander of the army without committing treason, but personal desire overcame his patriotic scruples. Cæsar's entrance into Italy at the head of his victorious army caused the downfall of Pompey and the Roman republic, and the rise of the empire, of which he was the first emperor. Hence, "crossing the Rubicon" is a saying applied to any move that may have important consequences to the one making it.

THE WINDSOR MACHINE CO.—EXAMPLES OF ITS SHOP PRACTICE.

As everyone familiar with the machine tool business knows, there is a remarkable trio of machine shops hidden in the narrow valleys of the out-of-the-way State of Vermont. All three of these shops (which are within a few miles of each other, two at Springfield and the other at Windsor) are remarkable for the originality of their methods and their products, and thus give evidence of originality in the men behind them, as well. The writer had the good fortune, on his last visit to that locality, to enjoy there a period of crisp, sunny autumn weather, and it left the inevitable impression on his mind that the brisk Vermont air, and the freedom from the countless distractions of the city, must have a tonic and clarifying effect on the minds of these resident mechanical geniuses.

All speculation aside, however, the methods and products of the three shops mentioned will repay the careful study of anyone concerned with the building or using of machine tools. Much has been written about the work of two of these firms—the Jones & Lamson Machine Co., and the Fellows Gear Shaper Co., of Springfield, Vt. Less has been said, however, about the Windsor Machine Co., the third member of this trinity. This is probably due to the fact that while in point of years it is the oldest of the three, it has only of late years been rejuvenated to the extent of becoming an active factor in the machine tool trade. The following pages, therefore, devoted to a brief description of selected operations taken from the work of their plant, treat of material hitherto unpublished.

The Town and the Shop

Windsor is situated on the Connecticut River, about 110 miles from Boston, and 260 miles from New York, with the latter of which cities it has through train service in the summer. It lies in a region which is one of the beauty spots of the globe, and the chosen home of celebrated artists and writers. The salient features of the region, as may be seen from the view of the town shown above, are the winding Connecticut River, with its fertile, tree-shaded valley, and "blue Ascutney looking down" over its foot-hills from the westward. The roomy, old-fashioned mansions and story-and-a-half cottages of the town are fairly hidden in the great elms for which this valley is famous, and would make little showing in the picture, had it not been taken in the spring before the trees leaved out.

The shop gives plain evidence of having grown by gradual accretion from almost infinitesimal beginnings. It stretches

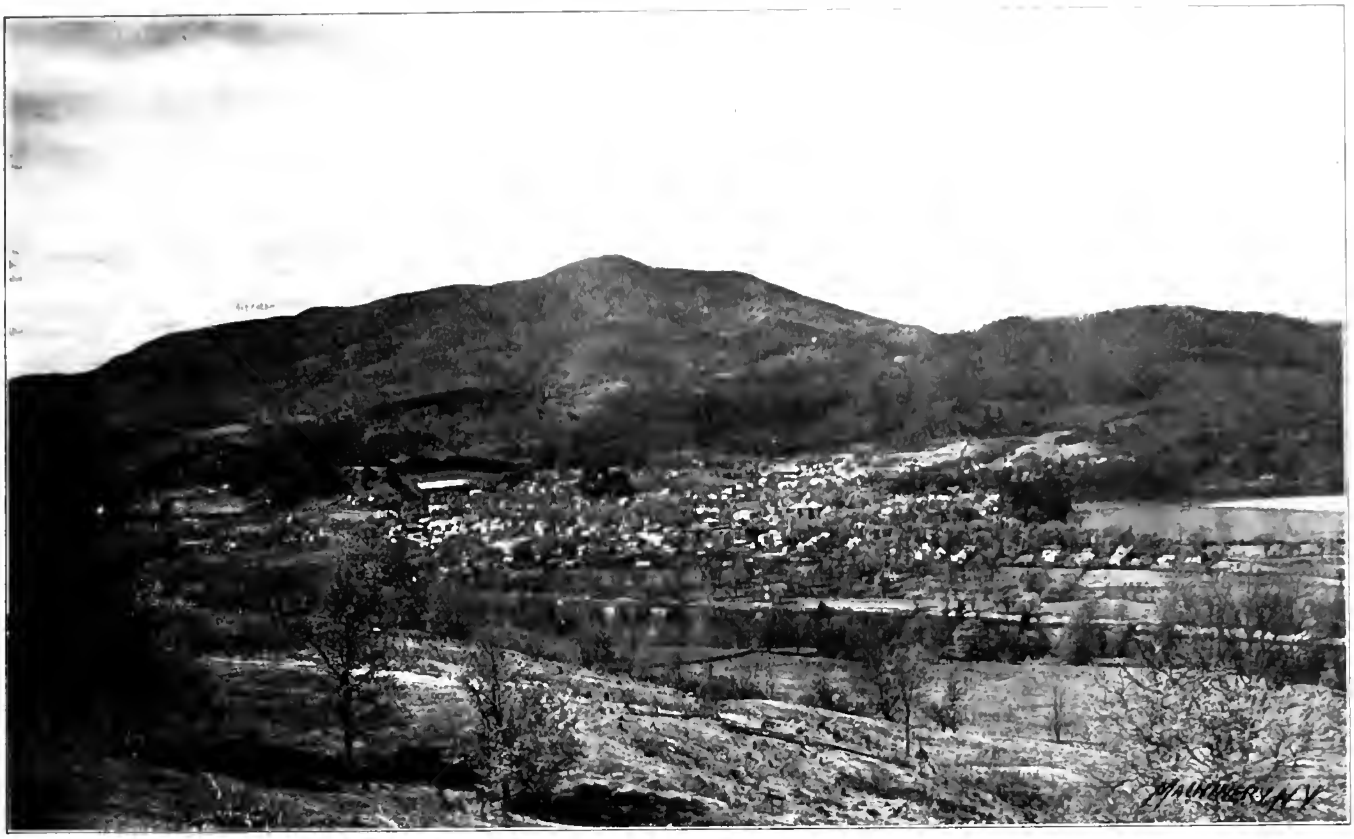
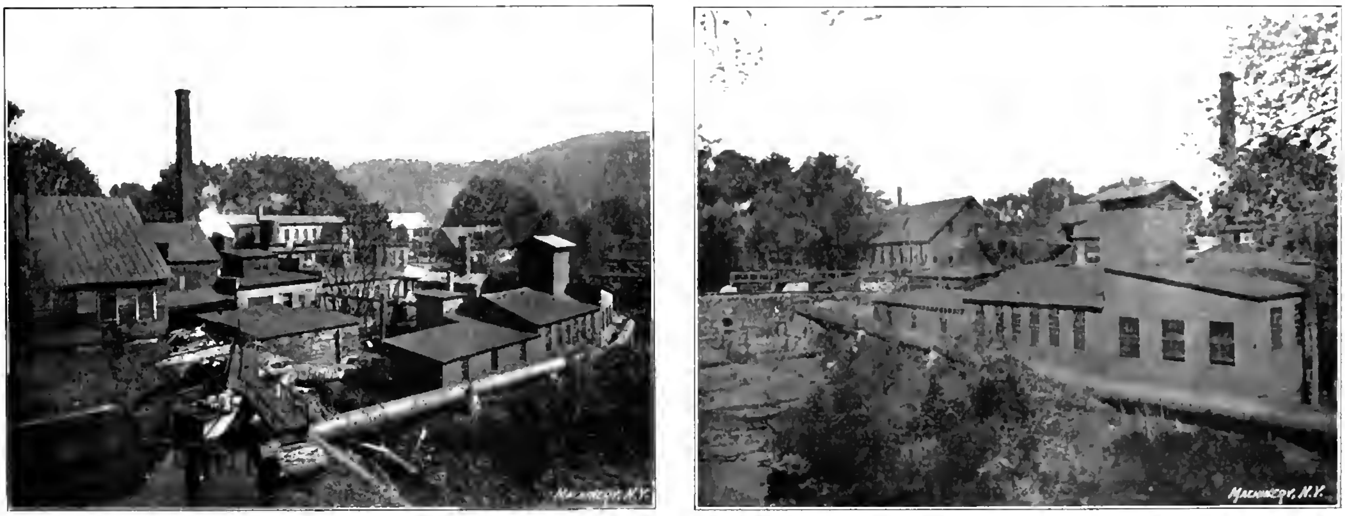


Fig. 1. The Home of the Gridley Turret Lathe; the Town of Windsor, the Connecticut River, and Mount Ascutney.



Figs. 2 and 3. Shops of the Windsor Machine Co. This Plant, like Topsy, was not born, but "just growed."

along the bank of Mill Brook, which comes tumbling down through the town from the hills in the rear (the reader must not judge of the "tumbling" from the picture, which was taken in a dry time), parting with its energy, as it goes, to the succession of water wheels with which the thrifty inhabitants have checked the precipitancy of its course. One of these turbines helps to drive the line shafting of the Windsor Machine Co., in times of normal rainfall. For the past few months, however, the work has fallen entirely on the Brown engine and the Sturtevant engine-dynamo set, which are needed even under normal conditions to help out the water power.

The Product of the Windsor Machine Co.

The Windsor Machine Co. makes the Gridley automatic turret lathes or screw machines. The single spindle form of this machine has been on the market for some years, and may be seen at work in almost any part of the screw-machine-using world. The four-spindle automatic design belongs to a more recent period, and was described for the first time in the department of "New Machinery and Tools" in the February, 1908, issue of MACHINERY, where the ingenious and original features of its construction were explained in detail and illustrated in a number of engravings. It will be remembered that the salient feature of the design of that machine was the construction of the spindle head, shown in Fig. 4. This has a bearing in the one-piece frame of the machine on the outside diameter of the spindle flanges, and on the journal formed on its shank, thus holding it firmly in alignment.

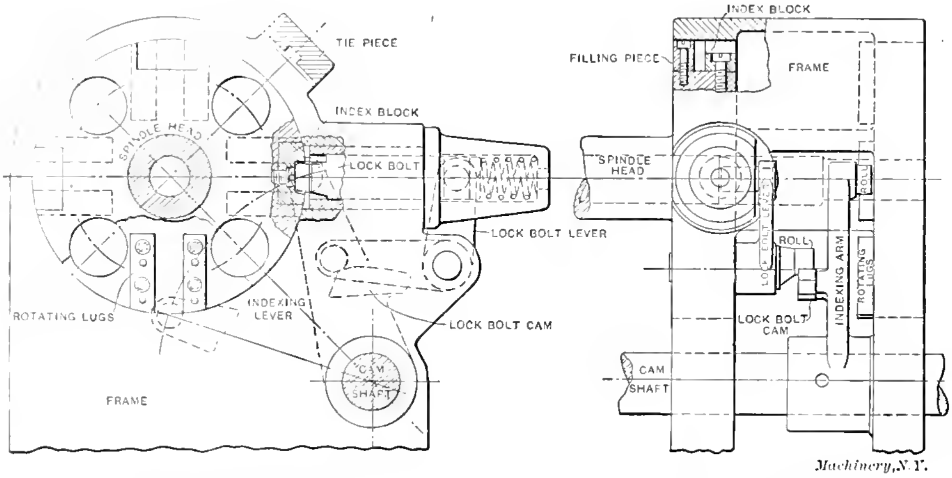


Fig. 4. Sketch showing the Spindle Head and the Indexing and Locking Mechanism.

Still more important than this item, in the vital task of preserving the alignment of the four spindles, is the mounting of the four-sided tool-holder on the solid shank of this revolving head, thus preserving the proper relations of the tools and the spindles even in the scarcely possible case of serious wear of the head in the frame. This feature, together with the locking of the head and the guiding of the sliding toolholder, at radial distances considerably greater than the radius of the circle in which the spindles revolve, gives a construction it is difficult to criticise, off hand.

In this, as in any other multiple spindle screw machine, the important point in the building of the machine, so far as accuracy is concerned, is the location of the spindle holes and of the indexing blocks in the revolving head. In a single spindle machine, if the index ring of the turret is not exactly divided, the machine may still be made to do its work accurately, as the holes in the turret may still be bored to line exactly with the spindle in each position. In a multiple spindle machine, however, if the spindle head is not exactly divided, there is no possibility of accurate work. The toolholder may be machined to line up with the spindle in one position, but when the head is indexed to the next position, this coincidence is lost beyond recovery. On account of this necessity for extreme accuracy, the machining of the spindle head will be described from start to finish, in the following paragraphs, being chosen as a representative piece of work, and one capable of testing the mettle of the most skilled mechanic.

Lathe Operations on the Spindle Head.

The first machine operation on the cast-iron spindle head, is that of boring and reaming the central hole. This is done in the lathe shown in Fig. 5. The operator of the lathe took the greatest pleasure imaginable in explaining each step of this operation to the writer. He hustled around and brought out one special tool after another, pausing after the explanation of each step only long enough to get a fresh breath, and, with a prefatory "now then," start off on the next lap. His enthusiasm is by no means unmatched among the machinists of these country towns, and is in marked and refreshing contrast with the time-serving spirit found among the workmen in large industrial centers. But perhaps these more sophisticated, city-trained workmen are not entirely to blame for their unsatisfactory attitude.

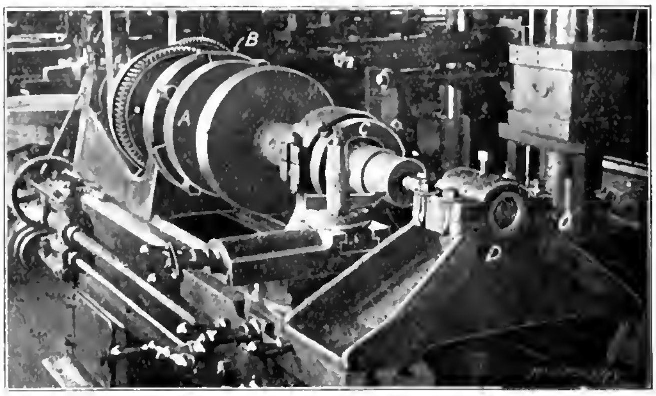


Fig. 5. Boring and Reaming the Central Bushing Hole in the Spindle Head.

The lathe carried a four jaw, independent chuck *B*, with a central bushing for supporting a boring-bar, as will be described later. The large end of the casting *A* is grasped and centered in this chuck, and the shank is rapped until it runs very nearly true. Then the revolving steady rest or "cat head" *C*, is pushed on over the shank, and the eight screws of the revolving bushing are set down gently on the work, after which a light chip is taken with an ordinary turning tool for an inch or so from the end of the shank. Then the screws in bushing *C* are released, and a test indicator is applied to the turned portion. If, as is almost invariably the case, the work runs out a trifle, the shank is rapped until the indicator shows a true running surface. Then the bushing screws are set down again, and the indicator is applied for a second time to see that the surface still runs true. All this is simply to make sure that the work is supported in an unstrained condition.

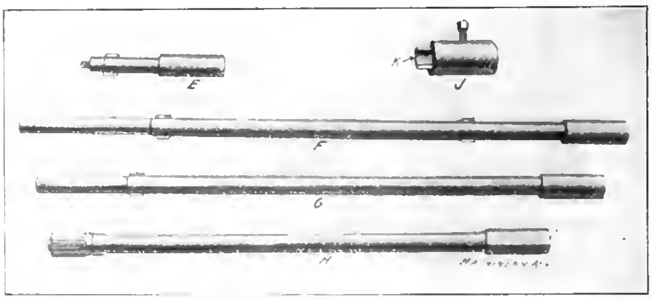


Fig. 6. Boring-bars, Reamers, etc , used in the Operation shown in Fig. 5.

To the wings of the carriage is bolted the heavy boring tool support *D*. In the first boring operation, this carries the short, stiff boring tool *E* (see Figs. 5 and 6). As may be seen in Fig. 4, the bore of the head is cored out to form an unfinished recess for the greater part of its length, leaving finished seats at either end for the "Lumen" bushings which

support the driving shaft. It is the work of this stiff boring tool *E* to rough bore the outer bushing seat at the shank end.

In the next operation, boring-bar *F* (see Fig. 6) is used. This has a pilot shank which fits in the hardened bushing in the chuck, and it carries two cutters—one for finish boring the outer or shank end of the hole, and the other for simultaneously rough boring the inner seat. The next bar *G* finish bores the inner seat, being steadied by the pilot which bears in the bushing in the chuck, as before.

The next operation is rough reaming. For the outer end, the shank of long reamer *H* is grasped at a point near the business end in the support *D*. For this purpose, bushing *J* is inserted in the support, along with half bushing *K*, down onto which the reduced stem of the reamer is held and seated by the set-screw. For rough reaming the further end, the half bushing is withdrawn, and the reamer is pulled out to its full length, so that its regular shank, seated in bushing *J*, is held in support *D*. At the conclusion of this operation, the work is removed from the machine, and the holes are finish reamed from either end by hand.

The head is now ready for the turning operations. Hardened plugs, ground so as to be very nearly absolutely true with their centers, are driven into the reamed holes from either end. The plug at the shank end has a notch cut in it which furnishes a seat for a bar, which, when hammered on the other end, serves to remove the plug. The plug at the head end is knocked out, in the obvious way, with a bar passing through the bore. Mounted on the centers in these plugs, the exterior of the head is finished all over in the lathe to accurate dimension, except on the outside diameters of the shank and of the two flanges. These are left large, to be finished by grinding. The threading at the end of the shank is also done at this time.

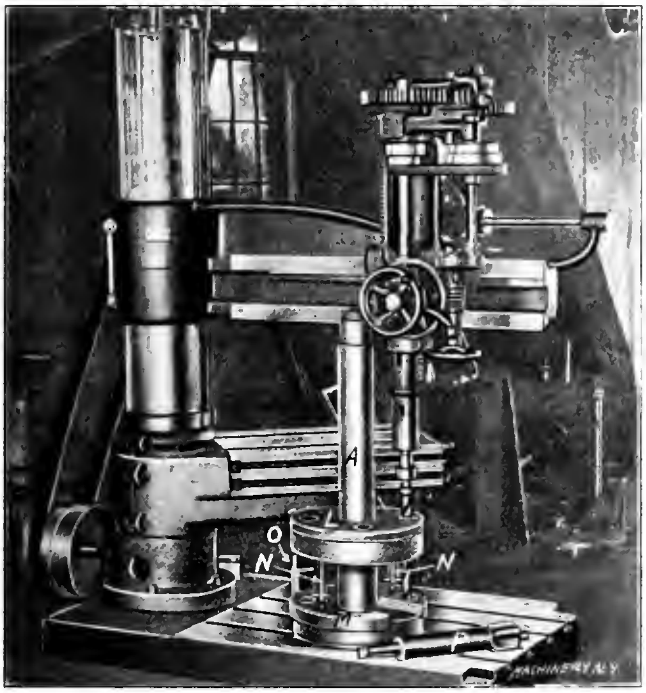


Fig. 7. Roughing Out the Spindle Holes in the Radial Drill by Drilling and Counterboring.

Boring the Spindle Holes.

The next, and the crucial operation, is the boring of the holes in the head for the spindle bushings. These holes are first rough bored under the radial drill. This operation is shown in Fig. 7. A jig is used which consists of two plates, *L* and *M*, the first fitting around the shank of the head, and dropped down over it to rest on the top of the upper flange, as shown, while the lower plate *M* is slotted through to the center to permit being slipped sidewise into position. Plate *M* is provided with a lip all around, which fits down over the periphery of the lower flange, and thus centers itself. It is clamped in position by two studs *N* with cross pin handles, which are screwed up against the bottom of the upper flange. A tongue *O*, screwed to *M*, enters a groove in *L*, and thus lines up the two members.

In this operation the long drill shown in place is first run down through the bushing in *L* and on through the upper flange, down into the bushing in *M*, and so through the lower flange, for each of the four holes. Then plates *L* and *M* are removed, and the drill is replaced with counterbore *P*, which clears the holes out to within 1/16 inch of their finished diameter.

After this, the heads are taken to the grinding machine, and finished very accurately on the outside diameters of the flanges and the shank, to insure accurate fitting in the subsequent jigs and in the final resting place in the frame of the machine. The reason for rough boring the holes before grinding is to prevent the possibility of bulging out, by the boring, the thin wall of metal between the holes and the finished edge of the flange.

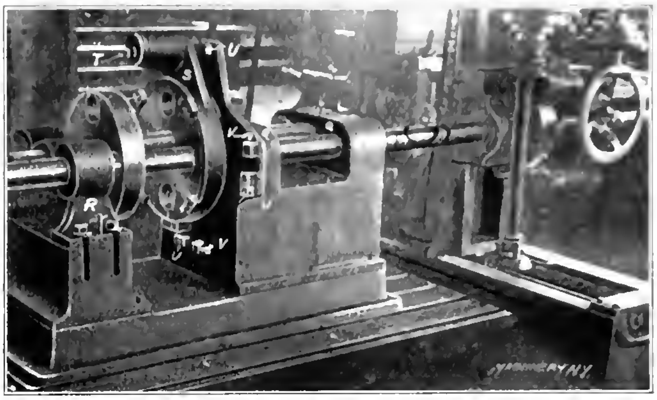


Fig. 8. Finish Boring the Spindle Holes in an Accurate Indexing Jig

After the grinding, the holes are accurately bored by the method shown in Fig. 8. The jig shown, mounted on the table of a Beaman & Smith boring machine, is provided with accurately sized journals at *Q* and *Q*, into which the shank of the head is slipped, bushing holder *R* being swung back out of the way for the purpose. On the inner flange of the head is clamped the dog *S*, in whose tail is seated at *T* a closely fitted, floating plunger, whose opposite sides are milled off flat on the projecting end. On the face of the jig are located four blocks, three of which are seen at *U*, *U*, and *U*, and four set-screws *V*. The flatted end of plunger *T* is pushed in between each of blocks *U* and set-screws *V*, in turn, and is clamped against the former by the latter. This is the means provided for indexing the work accurately to four positions.

Although the jig has bushings on both sides of the center line for boring-bars, as shown, only those on the front are used, the rough boring being done under the radial drill, as described. The boring bar is driven from the spindle of the machine through a universal joint, the bushings in *R* and *Q* being depended on entirely to control the alignment. Holder *R*, which swings back to permit changing the work, is located in its working position by an accurately-fitted dowel pin and suitable bolts.

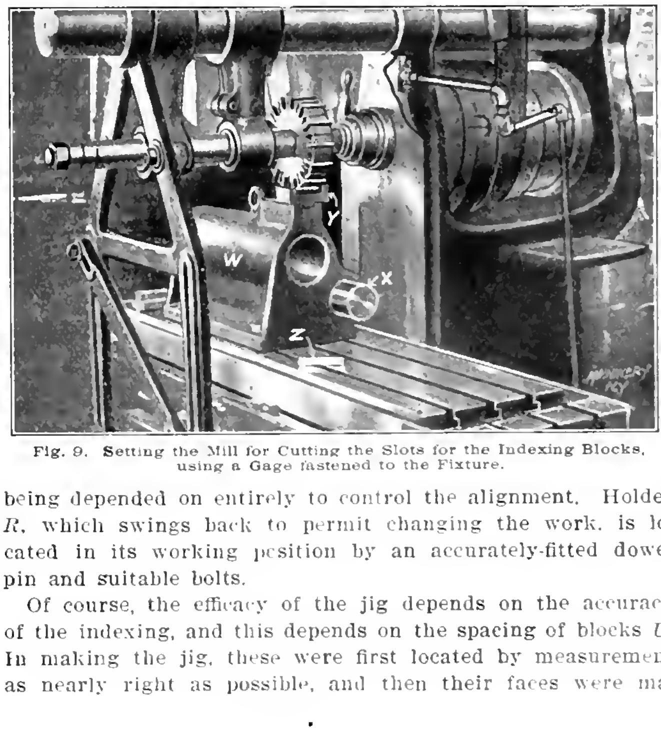


Fig. 9. Setting the Mill for Cutting the Slots for the Indexing Blocks, using a Gage fastened to the Fixture.

Of course, the efficacy of the jig depends on the accuracy of the indexing, and this depends on the spacing of blocks *U*. In making the jig, these were first located by measurement as nearly right as possible, and then their faces were ma-

chined and finally scraped to the proper dimension. This final fitting was done by actually boring a piece of work in the jig, and calipering the distance from one hole to the next, all around, until the scraping of the block brought the indexing to the required degree of accuracy.

Milling the Slots for tho Indexing Blocks.

The position of the spindles being thus located by the operation just described, it is next necessary to locate the indexing blocks for the spindle bushing holes. These blocks, as may be seen in Fig. 4, are fitted in slots milled in the periphery of the inner flange of the head. They are hardened and ground all over, and are provided with a milled groove having one straight and one taper face, fitting corresponding surfaces on the locking bolt. The straight face is the locating surface, the taper merely furnishing the means for forcing the straight face against the bolt. In making the blocks, the width and the straight side of the slot are carefully sized; this insures accurate indexing if the slots in the head are a good fit for the block, and if they are properly located with reference to the spindles. These requirements are attended to in the operation illustrated in Figs. 9 and 10.

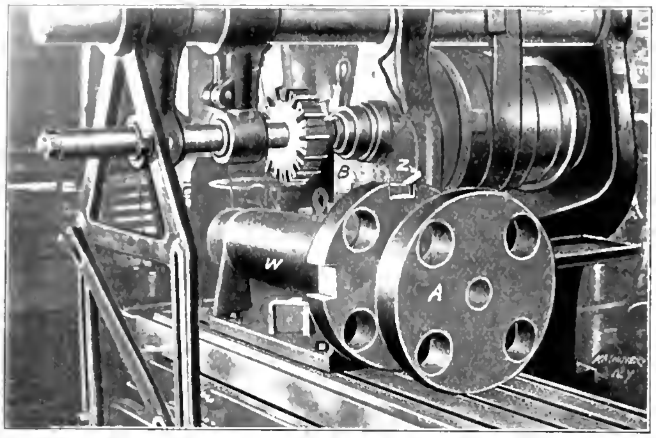


Fig. 10. Testing the Accuracy of the Slots in the Indexing Blocks, using a Test Block fastened to the Fixture.

On the table of the milling machine is clamped a fixture *W*, having a hole bored through it to accurately fit the ground shank of the work. At *X* is a plunger of the proper diameter and properly located, to closely fit the spindle bushing holes bored in the head. In a groove milled in the top of the fixture is located, by a closely fitting tongue, the setting gage *Y*. This gage has a groove of the exact depth desired for the groove in the work, but is wider on each side of the cutter by an amount equal to the thickness of the hardened "feeler" *Z* shown lying on the table. Two cuts are taken through the slots, the first with a cutter a few thousandths narrower than the required width and the second with a cutter of a thickness to exactly finish the slot to dimensions. The cutters are set for depth by raising the table until the revolving teeth just barely bite a tissue paper strip laid on the bottom of the groove in *Y*. The centering of the cutter is effected by the use of feeler *Z*, which must lie with equal freedom on each side, between the teeth of the roughing mill and the side of the slot in *Y*, and must just fit on each side, in the same position, for the finishing mill. The work is held in place by locating plunger *X*, and by a nut screwed into the threaded shank of the work, which brings the flange up against the face of the fixture.

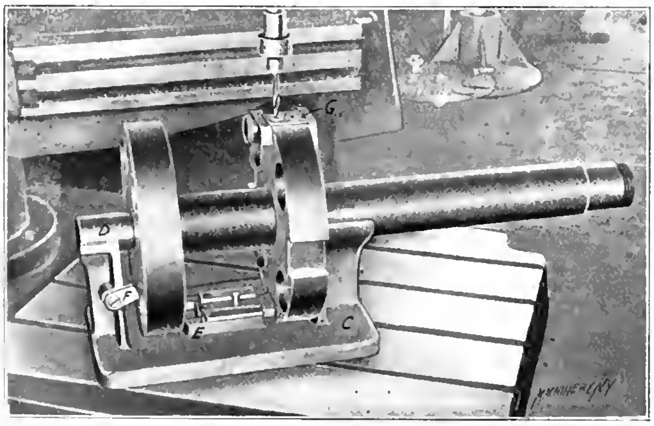


Fig. 11. Drilling the Screw Holes for Holding the Indexing Blocks and the Filling Pieces.

After each groove is cut through with the finishing mill, it is tested as shown in Fig. 10. The setting gage *Y* of the preceding illustration is replaced with a testing gage *B*, which fits in the same groove in the top of fixture *W*. It is provided with a projecting block, which enters the finished slot, and is of such width that the feeler *Z* (the same as shown in Fig. 9) should just fit on each side between the block and the sides of the milled groove. The advantage of using the feeler instead of having block *B* fill the slot, is obvious. Block *B*, under the former conditions, might be pushed along its groove until it entered the slot in the work, but if it met with a slight resistance so that it had to be jammed in, it might be quite difficult to tell on which side the interference occurred. With the feeler, this difficulty disappears.

Final Drilling Operations.

The head has next to be drilled for the screws and dowels which hold the indexing blocks in the slots. For this operation, as shown in Fig. 11, a plug *D* is driven into the flanged end of the work, which is laid in half round bearings in the fixture *C*, resting on this plug and on the ground shank. In the base of the fixture a block *E* is mounted, which slides into that one of the index slots which happens to be lowermost at the time; this locates the work. Latch *F* is swung around against the face of the flange and keeps the piece from shifting endwise.

Fig. 12. Drilling the Dowel and Screw Holes for the Rotating Lugs.

All of the fixture, as so far described, is used simply for holding the work, and presenting it properly to the drill. The jig proper is seen at *G*. As shown, it consists of a hardened block which fits closely into the slot in the work, and is clamped there by the strap and thumb-screw shown. The holes in this block guide the drill in locating the holes in the work. Besides the screw for the index block, a screw hole for the filling piece shown in Fig. 4 is provided for.

The final operation is that of drilling holes for the screws and dowels which hold the rotating strips seen in Fig. 4. As shown in the engraving, the head is indexed periodically by a roller on the end of a revolving indexing arm, which enters the space between two rotating strips at each revolution, and thus rotates the head after the manner of the well-known Geneva stop motion.

The arrangement for drilling the holes for these rotating strips is shown in Fig. 12. The shank of the head is set into the flanged base *H*, and is supported under the drilling

by the jackscrew arrangement seen at *J*. The jig proper is shown separately in Fig. 13. It consists of a plate *K*, carrying hardened bushings for the various holes to be drilled, and located by two plugs *L* and *M*, the first of which enters the central hole, while the other sets into one of the spindle holes. This plug *M* is provided with a pair of oppositely disposed radial plungers, one of which is seen at *O*. These are normally kept pressed in by a semi-circular spring snapped into the groove shown around the plug, but they may be forced out by a cone which presses against their inner ends, and is operated by the knurled knob *P* (see Fig. 12). When the jig has been set with plug *L* in the central hole and *M* in one of the spindle holes, and with plungers *O* pressed against the sides of the hole by the screwing up of nut *P*, the work is ready, as shown in Fig. 12, for the drilling.

While the strips are located on the inner face of the flanges, the drilling has, perforce, to be done from the outer side. This means that the holes must be put through very straight indeed. To accomplish this, the work is first spotted by a drill the full diameter of the bushing, and then a small drill is put clear through, followed by two successively larger ones, until finally the hole is cleaned out by a bit of the full diameter required. This gives holes so straight that the dowels fit accurately into the jig drilled holes in the strips of the opposite side. This operation completes the machining of this most important member of the Gridley four-spindle automatic screw machine.

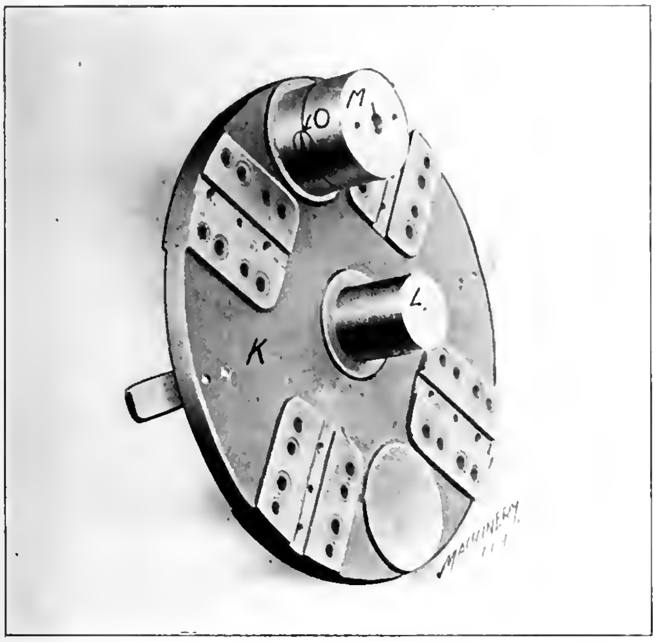


Fig. 13. Bushing Plate for the Drilling Operation shown in Fig. 12.

While the photographs from which the accompanying half-tones were made were not, in themselves, as may easily be seen, examples of the highest order of photographic art, the taking of them was no mean achievement. As was intimated in the beginning, the business of the Windsor Machine Co. has grown so gradually from such small beginnings, that the arrangement of the buildings leaves much to be desired. As a consequence, the place is crowded with machinery, so arranged that progress through the plant is slow and painful for a stranger. The difficulties of taking photographs may be imagined when it is stated that Figs. 9 and 10 were taken with the camera out in the yard, and pointed in through an open window. In other cases the camera tripod was precariously perched on planer tables or piles of castings, and at times it would have been convenient could the acrobatic local photographer have hung by his toes from the line shafting, like a bat.

It is probable that if Mr. ——— is elected president and business picks up, this firm will build new shops down by the railroad track, before many months. If these shops are built, and if as much ingenuity goes into their construction and operation, as into the doing of work in their present confined quarters, they will be well worth visiting and describing.

R. E. F.

JIGS AND FIXTURES—8.

EINAR MORIN *

DESIGN OF CLOSED JIGS.

In the sixth and seventh installments of this series, the subject of the design of open drill jigs has been dealt with. In the present installment it is proposed to outline the development of the design of closed or box jigs.

We will assume that the holes in the piece of work, as shown in Fig. 83, are to be drilled. Holes *A* are drilled straight through the work, while holes *B* and *C* are so-called "blind holes," drilled into the work from the opposite sides. As these holes must not be drilled through, it is evident that the work must be drilled from two sides, and the guiding bushings for the two blind holes must be put in opposite sides of the jig. The simplest form of jig for this work is shown in Fig. 84. The piece of work *D* is located between the two plates *E*, which form the jig, and which, if the jig be small, are made of machine steel and case-hardened. If the jig is large these plates are made of cast iron. The work *D* is simply located by the outlines of the plates, which are made to the same dimensions, as regards width, as the work itself. The plates are held in position in relation to each other by the guiding dowel pins *F*. These pins are driven into the lower plate and have a sliding fit in the upper one. In some cases, blocks or lugs on one plate would be used to fit into a slot in the other plate instead of pins. These minor changes, of course, depend upon the nature of the work, the principle involved being that some means must be provided to prevent the two plates from shifting in relation to each other while drilling. The whole device is finally held together by clamps of suitable form. The holes *A* may be drilled from either side of the jig, as they pass right through the work, and the guides for the drills for these holes may, therefore, be placed in either plate. Opposite the bushings in either plate a hole is drilled in the other plate for clearance for the drill when passing through, and for the escape of the chips.

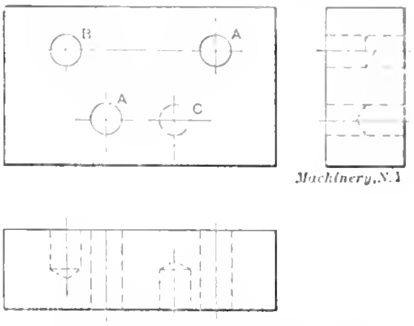


Fig. 83. Work to be Drilled.

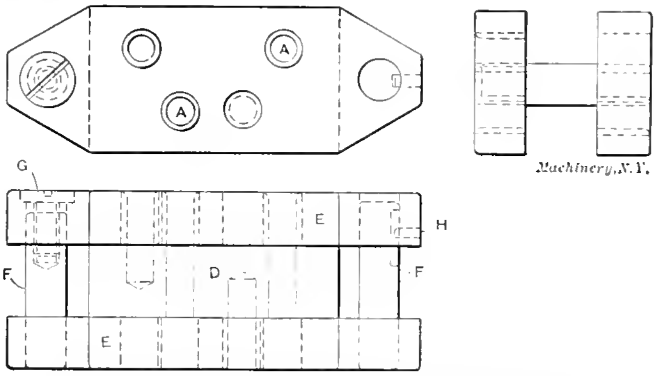


Fig. 84. Simplest Form of Closed Jig for Drilling Work in Fig. 83.

The two plates should be marked with necessary general information regarding the tools to be used, the position of the plates, etc., to prevent mistakes by the operator. It is also an advantage, not to say a necessity, to use some kind of connection between the plates in order to avoid mistakes, such, for instance, as the placing of the upper plate in a reversed position, the wrong pins entering into the dowel pin holes. This, of course, would locate the holes in a faulty position. Besides, if the upper plate be entirely loose from the lower, it may drop off when the jig is stored, and get mixed up with other tools. Some means of holding the two parts together, even when not in use, or when not clamped

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down on the work, should therefore be provided. Such a means is employed in Fig. 84, where the screw *G* enters into the guiding dowel pin at the left, and holds the upper plate in place. A pin *H*, fitting into an elongated slot in the dowel pin as shown at the left, could also be used instead of the screw. The design shown presents the very simplest form of box jig, consisting, as it does, of only two plates for holding the necessary guiding arrangements, and two pins or other means for locating the plates in relation to each other.

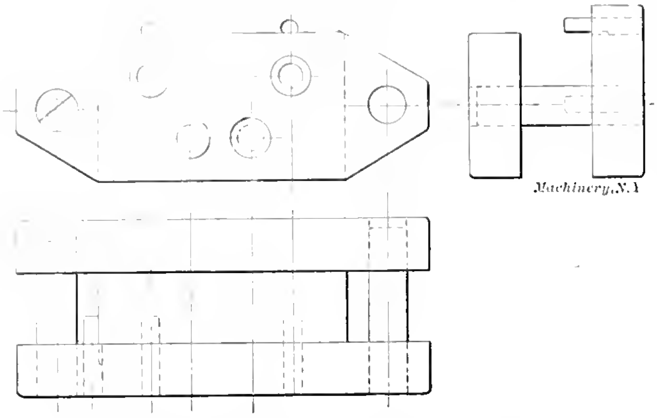


Fig. 85. Jig in Fig 84 Improved by adding Locating Pins.

In manufacturing where a great number of duplicate parts would be encountered, a jig designed in the simple manner shown in Fig. 84 would, however, be wholly inadequate. The simplest form of a jig that may be used in such a case would be one where some kind of locating means are employed, as indicated in Fig. 85, where three pins are provided, two along the side of the work and one for the end of the work, against which the work may be pushed up, prior to the clamping together of the two jig plates. In this figure the jig bushings are not shown in the elevation and end view, in order to avoid confusion of lines. The next improvement to which this jig would be subject would be the adding of walls at the end of the jig and the screwing together of the upper and lower plate, the result being a jig as shown in Fig. 86. This design presents a more advanced style of closed jig, and one of a type which could be recommended for manufacturing purposes. While the same fundamental principles are still in evidence, we have here a jig embodying most of the requirements necessary for rapid work. This design provides for integral clamping means within the jig itself, this being provided in this case by the screws *J*. The upper plate *K* is fastened to the walls of the lower plate *L* by four or more screws *M*, and two dowel pins *N*. The cover *K* could also be put on, as shown in Fig. 87, by making the two parts a good fit at *O*, one piece being tongued into the other. This gives greater rigidity to the jig. In this jig, also, solid locating lugs *F* are used instead of pins.

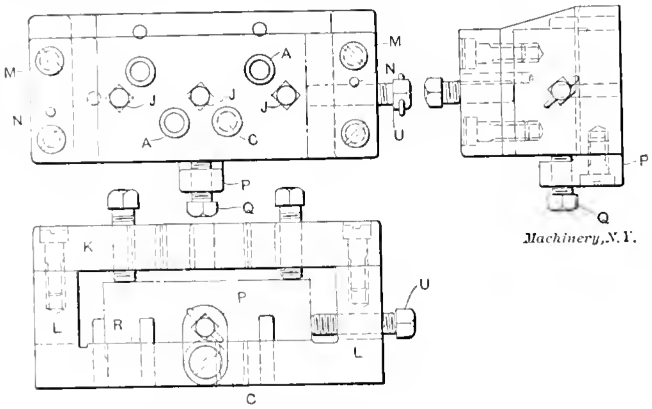


Fig. 86. Further Improvements in Jig, suiting it to Manufacturing Purposes.

Referring again to Fig. 86, by having a swinging arm *P* with a set-screw *Q* provided, the work can be taken out and can be inserted from the side of the jig, which will save making any provisions for taking off or putting on the top cover for every piece being drilled. If there is enough clearance between the top cover and the piece being drilled, the screw *Q* could, of course, be mounted in a solid lug, but it would not be advantageous to have so large a space between the top plate and the work, as the drill would have to extend unguided for some distance before it would reach the work. The set-screws *Q* and *U* hold the work against the locating points, and the set-screws *J* on the top of the jig, previously referred to, hold the work down on the finished pad *R* on the bottom plate. These screws also take the thrust when the hole *C* is drilled from the bottom side. It is rather immaterial on which side the bushings for guiding the drills for the two holes *A* are placed, but by placing them in the cover rather than in the bottom plate, three out of the four bushings will be located in the top part, and when using a multiple spindle drill, the face *R* will take the larger thrust, which is better than to place the thrust on the binding screws *J*. In the designs in Figs. 86 and 87 the whole top and bottom face of the jig must be finished, or a strip marked *f* in Fig. 88, at both ends of the top and bottom surfaces, must be provided, so that it can be finished, and the jig placed on parallels *D* as illustrated.

While the jig itself, developed so far, possesses most of the necessary points for rapid production and accurate work, the use of parallels, as indicated in Fig. 88, for supporting the jig when turned over so that the screw heads of the clamping screws point downward, is rather unhandy. Therefore, by adding feet to the jig, as shown in Fig. 89, the handling of the jig will be a great deal more convenient. The adding of the protruding handle *S* will still further increase the convenience of using the jig. The design in Fig. 89 also presents an improvement over that in Fig. 86 in that besides the adding of feet and handle, the leaf or strap *E* is used for holding screw *Q* instead of the arm *P*. This latter is more apt to bend if not very heavy, and would then bring the set-screw in an angle upwards, which would have a tendency to tilt the work. The strap can be more safely relied upon to clamp the work squarely. Two set-screws *J* are shown for holding the work in place. The number of these set-screws, of course, depends entirely upon the size of the work and the size of the holes to be drilled. Sometimes one set-screw is quite sufficient, which, in this case, would be placed in the center, as indicated by the dotted lines in Fig. 86.

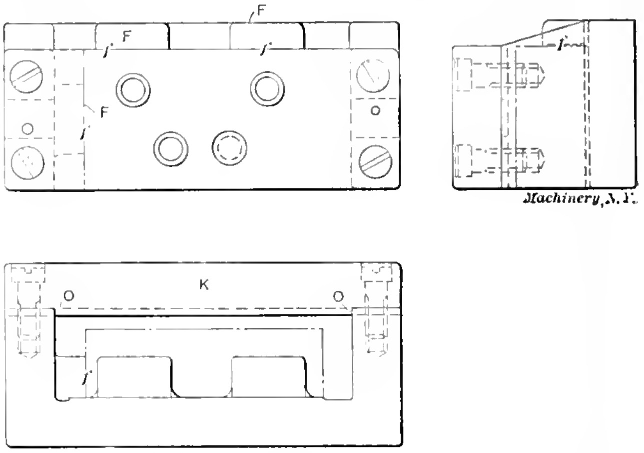


Fig. 87. Alternative Design of Jig shown in Fig. 86.

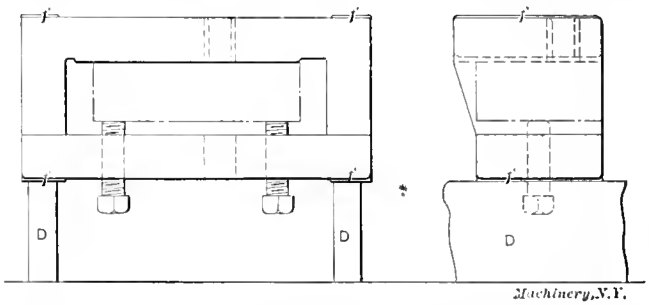


Fig. 88. Showing use of Jig in Fig. 86 in Combination with Two Parallels.

The type of jig shown in Fig. 89 now possesses all the features generally required for a good jig, and presents a

type which is largely used in manufacturing plants, particularly for fairly heavy work. The jig shown in Fig. 90, however, represents another type, somewhat different from the jig in Fig. 89. The jig in Fig. 89 is composed of two large separate pieces, which, for large jigs, means two separate castings, involving some extra expense in the pattern-shop and foundry. The reason for making the jig in two parts, instead of casting it in one, is because it makes it more convenient when machining the jig. The locating points, however, are somewhat hidden from view when the piece is inserted. The jig shown in Fig. 90 consists of only one casting *L*, provided with feet, and resembles an open drill jig. The work is located in a manner similar to that already described, and the leaf *D*, wide enough to take in all the bushings except the one for the hole that must be drilled from the opposite side, is fitted across the jig and given a good bearing between the lugs in the jig wall. It swings around the pin *E*, and is held down by the eye-bolt *F* with a nut and washer. Sometimes a wing-nut is handier than a hexagon nut. Care should be taken that the feet reach below the top of the nut and screw. The set-screw *G* holds the work down, and takes the thrust when the hole from the bottom side is drilled. The three holes *AA* and *B* are drilled from the top so that the thrust of the drilling of these three holes will be taken by the bottom of the jig body *L*. If one set-screw *G* is not sufficient for holding the work in place, the leaf may be made wider so as to accommodate more binding screws.

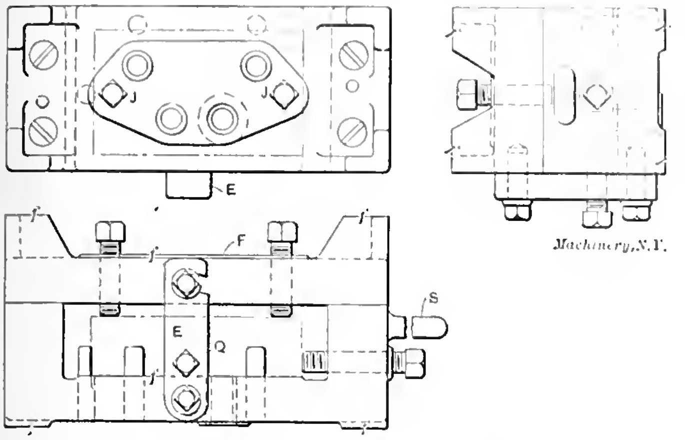


Fig. 89. Jig Improved by adding Feet Opposite Faces containing Drill Bushings.

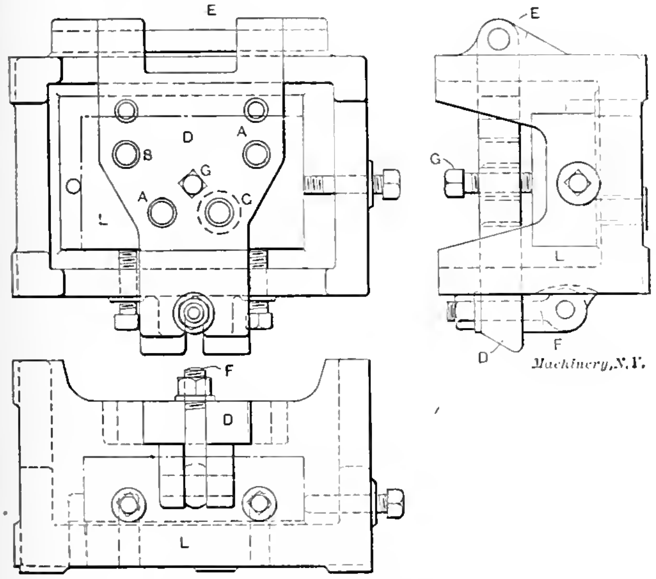


Fig. 90. Alternative Design of Jig in Fig. 89.

It should be mentioned here, however, that it is an objectionable feature to place the clamping screws in the bushing plate. If the leaf has not a perfect fit in its seats and on the swiveling pin, the screws will tilt the leaf one way or another, and thus cause the bushings to stand at an angle with the work, producing faulty results. In order to avoid this objectionable feature, a further improvement on the jig, indicated in Fig. 91, is proposed. In the jig body, the locating points and the set-screws which hold the work against the locating pins are placed so that they will not interfere with two straps *G*, which are provided with elongated slots, and hold the work securely in place, also sustaining the thrust from the cutting tools. These straps should be heavily designed, in order to be able to take the thrust of the multiple spindle drill, because in this case all the bushings except the one for hole *B* are placed in the bottom of the jig body. The leaf is made narrower and is not as heavy as the one shown in Fig. 90, because it does not, in this case, take any thrust when drilling, and simply serves the purpose of holding the bushing for hole *B*. The leaves and loose bushing plates for jigs of this kind are generally made of machine steel, but for larger sized jigs they may be made of cast iron. The leaf in Fig. 91 is simply held down by the thumb screw *H* of a type as shown in Fig. 48 in the July installment of this series.

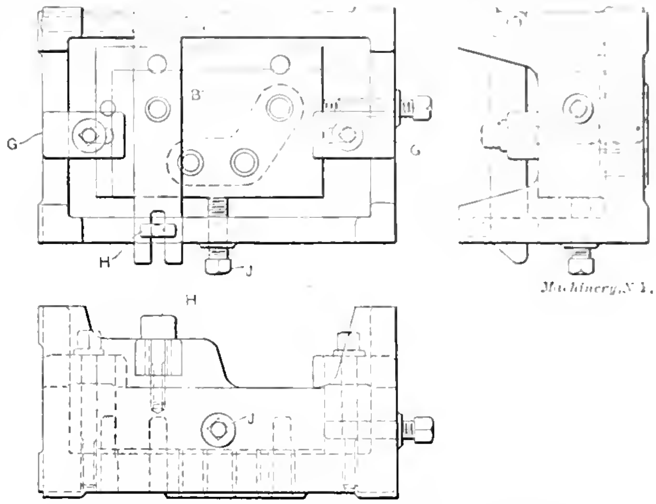


Fig. 91. Jig where Thrust of Drilling Operation is taken by Clamps.

If the hole *B* should be near to one wall of the jig, it may not be necessary to have a leaf, but the jig casting may be made with a projecting lug *D*, as shown in Fig. 92, the jig otherwise being of the same type as the one illustrated in Fig. 91. The projecting part *D*, Fig. 92, is strengthened, when necessary, by a rib *E*, as indicated. Care must be taken that there is sufficient clearance for the piece to be inserted and removed. Once in a while it happens, even with fairly good jig designers, that an otherwise well-designed jig with good locating, clamping, and guiding arrangements, is rendered useless for the simple reason that there is not enough clearance to allow the insertion of the work. The jig shown in Fig. 92 resembles, in reality, an open jig more than a closed jig.

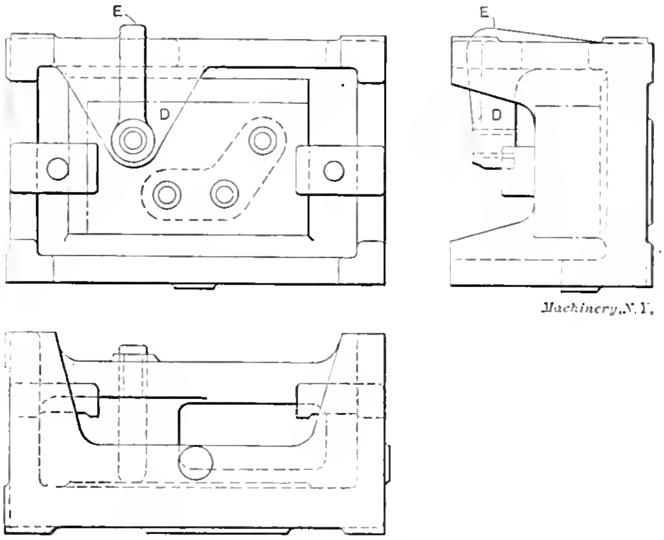


Fig. 92. Modification of Jig in Fig. 91, which practically brings it into the Class of Open Drill Jigs.

Fig. 93 shows the same jig as before, but with the additional feature of permitting a hole in the work to be drilled from the end and side as indicated, the bushings *E* and *F*

being added for this purpose. It will be noticed that the bushings in this case extend through the jig wall for some distance, in order to guide the drill closely to the work. Bosses may also be cast on the jig body, as indicated by the dotted lines, to give a longer bearing for the bushings.

Feet or lugs are cast and finished on the sides of the jig opposite to the bushings, so that the jig can be placed conveniently on the drill press table for drilling in any direction. It will be noticed that when drilling the holes from the bushings *E* and *F*, the thrust is taken by the stationary locating pins. It is objectionable to use set-screws to take the thrust, although in some cases it is necessary to do so. When designing a jig of this type, care must be taken that strapping arrangements and locating points are placed so that they, in no way, will interfere with the cutting tools or guiding means. In this case the strap *H* is moved over to one side in order to give room for the bushings *F* and the set-screw *K*. Strap *G* should then be moved also, because moving the two straps in opposite directions still gives them a balanced clamping action on the work. If the strap *G* had been left in place, with the strap *H* moved sideways, there would have been some tendency to tilt the work.

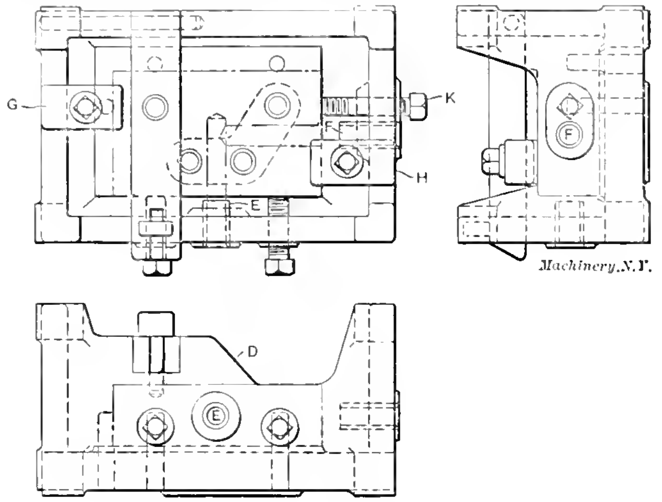


Fig. 93. Jig for Drilling Holes from Two Directions.

Sometimes one hole in the work comes at an agle with the faces of the work. In such a case the jig must be made along the lines indicated in Fig. 94, the feet on the sides opposite to where the drill bushings are placed being planed so that their faces will be perpendicular to the axis through the hole *A*. This will, in no way, interfere with the drilling of holes which are perpendicular to the faces of the work, as these can be drilled from the opposite side of the work, the jig then resting on the feet *B*. Should it, however, be necessary to drill one hole at an angle, and other holes perpendicular to the face of the work from the same side, an arrangement as shown in Fig. 95 would be used. The jig here is made in the same manner as the jig shown in Fig. 93, with the difference that the bushing *A* is placed at the required angle. It will be seen, however, that as the other holes drilled from the same side must be drilled perpendicular to the faces of the work, it would not be of advantage to plane the feet so that the hole *A* could be drilled in the manner previously shown in Fig. 94. Therefore the feet are left to suit the perpendicular holes, and the separate base bracket *B*, Fig. 95, is used to hold the jig in the desired inclined position when the hole *A* is drilled.

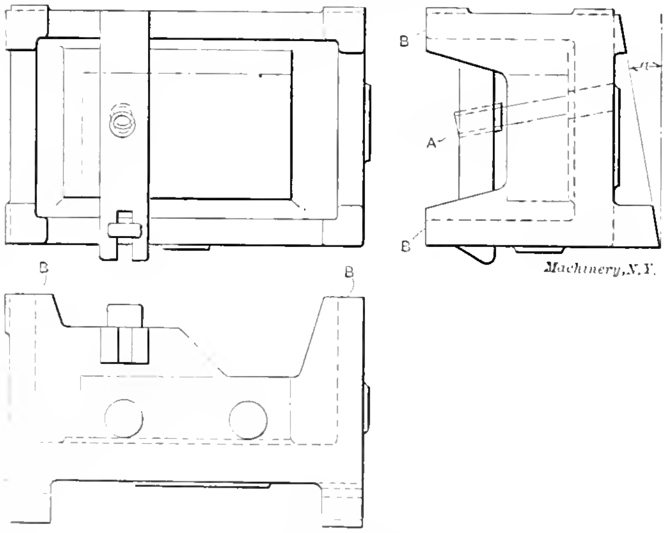


Fig. 94 Jig for Drilling Holes at an Angle.

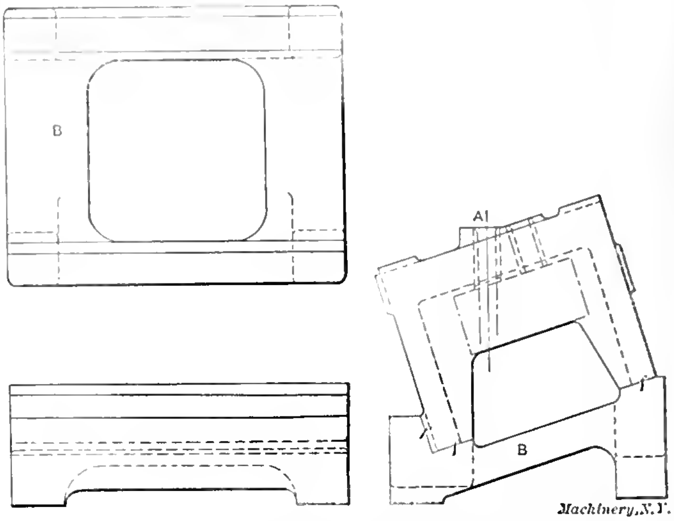


Fig 95. Jig and Stand for Drilling Holes at an Angle.

Stand *B* in Fig. 95 is very suitable for this special work. It will be noticed that it is made up as light as possible, it being cored at the center, so as to remove superfluous metal. These stands are sometimes provided with a clamping device for holding the jig to the stand. Special stands are not only used for drilling holes at angles with the remaining holes to be drilled, but sometimes special stands are made to suit the jig in cases where it would be inconvenient to provide the jig with feet, finished bosses or lugs, for resting directly on the drill press table.

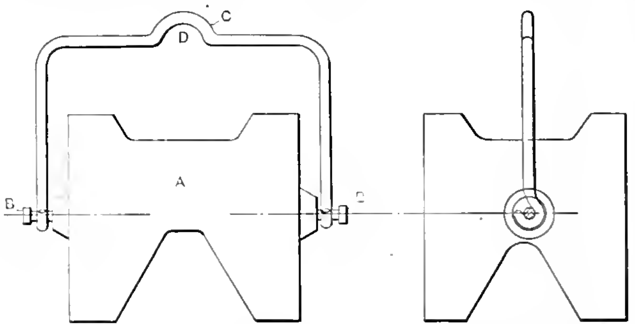


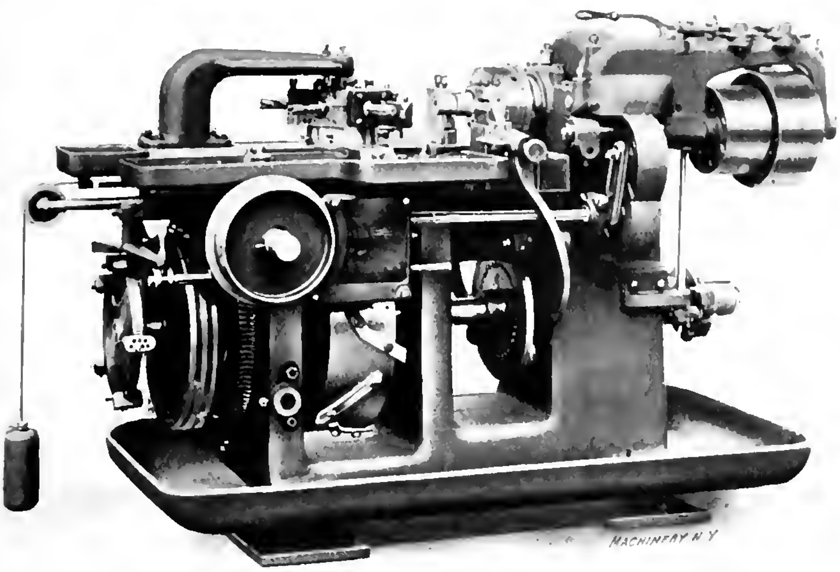
Fig. 96. Device for Turning over and Handling Heavy Jigs.

When a jig of large dimensions is to be turned over, either for the insertion or removal of the work, or for drilling holes from opposite sides, a helper will have to be called upon to assist the operator. The disadvantage of this is readily seen. In cases where the use of a crane or hoist can be obtained, it is very satisfactory to have a special device attached to the jig for turning it over. Fig. 96 shows such an arrangement. In this engraving, *A* represents the jig which is to be turned over. The two studs *B* are driven into the jig in convenient places, as near as possible in line with a gravity axis. These studs then rest in the yoke *C*, which is lifted by the crane hook placed at *D*. The jig, when lifted off the table, can then easily be swung around. The yoke is made simply out of round machine steel.

Comparing what has been said above with the outline of the development of open jigs in the September issue of MACHINERY, it will be seen that the principles involved are exactly the same, and that the development of jigs for various purposes is simply the application of these principles, with an appropriate amount of common sense, to the work in hand. The previous statements may be considered the A, B, C of jig making, and contain, of necessity, only the main principles on which the jig design is based.

HERBERT AUTOMATIC TURRET LATHE WITH SELF-SELECTING FEEDS.

On page 7 of the engineering edition of the September issue of MACHINERY was described, among other machine tools exhibited at the Franco-British Exhibition, an automatic turret lathe built by Alfred Herbert, Ltd., of Coventry, England. As described, the machine is intended for working on individual castings or forgings, or on blanks previously cut off. The work is chucked by hand, but all the operations performed on it are automatic, including the stopping of the machine at the completion of its cycle of operations. The head is gear-driven, and is provided with two sets of tight and loose pulleys, giving two speeds forward, or a forward and reverse motion, either of which may be shifted automatically, according to the requirements of the work. The machine in its general construction closely resembles the automatic screw machine built by the same firm, the modifications being, in general, only such as are required to fit it for finishing separate pieces as described, instead of making them complete from the bar.



An Automatic Turret Lathe for Castings, Forgings, and Cut Stock, in which Feeds may be varied for any Operation without Changing the Cams.

One of the most interesting features of the machine was not specifically mentioned in the description. This is the self-selecting feed mechanism, by means of which the rate of feed of the various tools in the turret may be varied independently of each other without changing the cams. The mechanism for this is most plainly seen in the rear view of the machine, shown herewith. In principle, the mechanism of the machine itself is identical with that of the original Spencer automatic screw machine. The feeding and controlling movements, such as the moving of the turret and cross-slides, the feeding of the stock, opening and closing of the chuck, reversing of the spindle, etc., are effected by cams and dogs carried on a long cam shaft, extending the length of the machine, beneath the bed. This is shown in the engraving. As in the original Spencer machine, this cam shaft may be given a rapid movement for the feeding and idle motions of the mechanism (such as returning the turret slide, etc.) or a slow movement for feeding the cutting tools, the change from one to the other being regulated automatically by dogs. The improvement consists in furnishing a number of rates of feed for the slow movement, making it possible to change the feed for any tool without changing the cams, as was formerly necessary. On this machine, in fact, the turret feed cams (which are mounted on the large drum seen directly beneath the turret) are all of the same shape, the feed mechanism being depended on entirely for the change in feed.

The self-selective arrangement is controlled by a disk keyed to the cam shaft at its extreme outer, or left-hand end, as seen in the engraving. This disk carries a series of dogs, as shown, each of which is provided with 7 holes, in any one of which a pin may be placed. As the cam shaft revolves this pin, just before the beginning of a new operation enters the V formed by the two projecting wings of the horizontal lever shown above the disk, thus shifting it to a position corresponding to the position of the pin in the dog. The long end of this lever (provided with a handle, as shown,) carries a roller confined between collars on the splined worm shaft which gives the slow movement to the cam driving mechanism. This splined shaft, which is thus adjusted from one position to another as occasion requires, is driven by a cone of 7 gears in the gear box at the back of the machine. This gear-box is shown in the engraving with the regular cover removed, and replaced with one having a glass window to show the mechanism. The shifting of the shaft by the pins and dogs shifts the position of the key in the cone of gears, thus connecting the proper one with the feed mechanism and giving the desired feed to the cutting tool.

It will be noticed that the shaft by which the cone of feed gears is driven, is connected by change gearing with the spindle driving shaft. This arrangement gives a certain definite feed in turns per inch or thickness of chip, for each one of the 7 sets of gears in the feed-box, no matter what changes may be made in the spindle speed. Provision is also made in the connecting mechanism for giving a forward movement to the feed whether the spindle is running forward or backward. The feeding movement is thus properly controlled at all times. The use of change gears permits raising or lowering the whole range of feeds to suit any material the machine may be required to work on. The fast movements of the cam-shaft are derived from the pulley shown just to the left of the feed-box, which runs at constant speed so that these movements always take place in the quickest practicable time, without reference to the rate of rotation of the spindle and the consequent rapidity of the feeding movement.

While the machine here shown is intended primarily, as described, for working on castings and stock held in the chuck, there would seem to be no reason why the same idea could not be applied in a modified form to the automatic screw machine working on bar stock, thus materially increasing its usefulness. It would probably be necessary in such a case to have the threading cam of steeper pitch than the others, and it might be necessary to make it adjustable. Except for this, the arrangement would seem to be easily applied in the form here shown. The greatest usefulness of the device would appear to be in the opportunity it affords to change the feed for a given tool without altering that of any of the others. It would also appear to simplify the matter of setting up, to a considerable degree.

* * *

Isinglass is a term commonly confused with mica, although it is a totally different substance. Mica is a silicate mineral mined from the earth, while isinglass is an animal product made from the air-bladders of certain fishes. The best isinglass, which is used in superior belt cements, is made from the air-bladders of the Russian sturgeon caught in the Baltic Sea. This fish is the same as the sturgeon caught in American waters, but some peculiarity of the water or food in the Baltic makes a great difference in the quality of the air-bladder. The bladders taken from the American sturgeon are thin and of poor quality, being valued at about $1.50 per pound wholesale, while those taken from the Russian sturgeon are three or four times as thick and of far better quality, being valued at about $3.50 per pound. The difference is important to manufacturers and machine shop proprietors, as belt cement made with the best isinglass as its basis is stronger than leather. A belt properly joined with the best cement will break at some other point rather than at the cemented joint.

TOOLS FOR INCREASING PRODUCTION IN BLACKSMITH SHOPS.*

JAMES CRAN †

The blacksmith has more difficulties to contend with in doing his work than any other class of mechanics. As a rule, he is heavily handicapped in not being provided with tools and appliances enabling him to do his work quickly and economically. To a certain extent he may be compared with the pattern-maker; he has to start his work, in the first place, with nothing to guide him except a blue-print or a sketch, often one-quarter or one-eighth size. This is all that is required if the work is plain and of regular shape; but if it happens to be bent, curved, or in the least complicated, it must be laid out full size, and a templet made before the actual work can be commenced. As compared with this, the machinist, and the majority of other mechanics, have their work shaped or partly shaped before it is turned over to them, which makes it comparatively easy. The pattern-maker can do most of his work at the bench; he can turn it around, and place it in any position to suit his convenience; he can stop at any time, and think over what his next move should be; he can cut, carve, glue, and build up, handling the work with his bare hands from the time he starts until it is completed. The blacksmith, however, is confined to the anvil or the steam hammer; his material must be heated before it can be worked to shape, and he must therefore handle it with tongs and lift and turn it with a crane if it is of large size; he has to make his plans and know exactly what his next move is to be while the material is heating, so that he will be able to do the greatest amount of work while the heat lasts. Unlike other mechanics he cannot, as a rule, cut his work to shape, but draws, upsets, and bends it until it is ready for the machine shop.

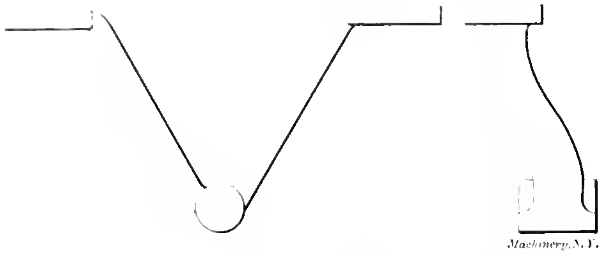


Fig. 1 Example of Forging Work which can be facilitated by using a Surface Plate.

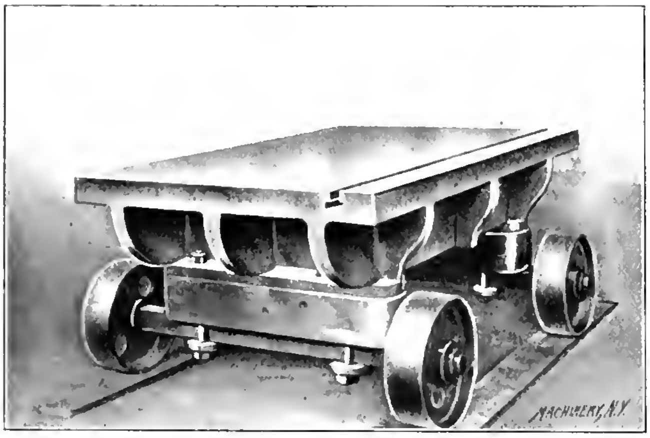


Fig. 2. Portable Surface Plate for Use in Blacksmith Shop.

To enable the blacksmith to do his work with convenience and accuracy, it would be well to supply him with some of the appliances that save time and reduce cost. In most blacksmith shops, forgings of odd and irregular shapes are, at times, made. Let us take the piece in Fig. 1, for example, which, while not complicated, would be a difficult piece to make with any degree of accuracy without a surface plate for trying the offset and the alignment of the different points. The surface plate shown in the half-tone, Fig. 2, is of a style best suited for machine blacksmithing. It was designed by a practical blacksmith and constructed so that it would meet, as far as possible, the requirements of the blacksmith shop. Being mounted on wheels, it can be moved around the shop to the place where it will be most convenient for the workman using it. The face is graduated in inches, which allows pieces being placed parallel with the plate and measured. Offsets and curves can also be gaged more accurately than would be possible if working from chalk lines. A T-slot, about four inches from one side, running the entire length, can be used for holding formers or similar tools to the surface of the plate. By using a square and a surface gage, the most complicated forgings can be made so nearly correct that there should be no trouble in machining the work.

A small surface plate of the same style should be provided for each forge. This plate need not necessarily be larger than eighteen or twenty-four inches square, with the face from 1¼ to 1½-inch thick. The plate is reinforced by ribs similar to those shown in Fig. 2. The wheels can be omitted, and a bench used to support the plate. A shelf may be placed between the plate and the base to accommodate clamps, bolts, etc., that may be used to hold work in position.

Benches with vises, attached to the walls of blacksmith shops, are not to be commended. There being no one constantly employed at the bench to keep things in shape, it is liable to be used as a place for dumping "any old thing." This not only gives the bench an untidy appearance, but makes it necessary to clear up the space every time the bench is used. With a portable vise and bench this difficulty would be overcome. Every man using the bench would be expected to clear off every tool and piece of material before returning the bench to its place in the shop. Vises attached to a porttable cast iron bench mounted on wheels can be moved around the shop to the place where they will be most convenient, saving time that would be wasted if a number of pieces had to be taken to the vise separately for some operation, especially if it happened to be located in some distant corner of the shop.

Fig.3

Fig.4

Figs. 3 and 4. Method employed for Forging Crank-shafts.

An emery wheel is a very essential piece of machinery for the blacksmith shop, as it is necessary to grind chisels and other tools quite often. If they have to be taken to another department for grinding, it means the waste of considerable time both for the blacksmith and his helper. No matter which one of them goes to do the grinding, the other generally takes a rest until the absent one comes back. Almost any type of grinder would answer the purpose, but the style known as the wet grinder is the most suitable, especially if arranged to supply the water automatically; otherwise it is liable to be used as a forging machine, which is bad practice for the blacksmith and poor usage for the wheel.

For cutting up stock and trimming the ends of forgings, such as shafts, spindles, or similar work, a power hack-saw can be used to good advantage. It requires but little attention, so little, in fact, that the blacksmith or his helper could attend to it between the heats without in the least interfering with their work at the forge. It cuts off the ends of forgings neater than is possible by hand, and the time it saves means increased production without increasing cost. It can also be used to advantage in the process of forging various pieces. Take small crank-shafts for example, as

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* For additional information on kindred subjects, see the following articles previously published in MACHINERY: The Steam Hammer and Its Use, October, 1905; Tools for the Blacksmith Shop, September, 1908; System for the Blacksmith Shop, August, 1908.

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shown in Fig. 3, which are usually forged with the crank or throw solid. The stock between the webs must be removed either by drilling small holes around it, or by using a slotting machine. By using a hack-saw, the crank can be put in shape for the lathe before it leaves the blacksmith shop. The stock intended for a crank should be wide enough for the throw on one side, the journals should then be drawn out and rounded, after which the piece between them should be laid out as shown in Fig. 4, care being taken to keep the distance between all the webs short enough to allow for drawing in rounding the bearings. A small hole should be drilled at each corner for the hack-saw to run into. When the hack-saw has cut along the dotted lines, the crank can be heated, and the pieces removed with a chisel applied where solid lines are shown in Fig. 4. When the bearings are rounded, the crank-shaft can be heated and twisted so as to bring the throws on opposite sides of the forging. Any number of throws can be made in the same manner and could be set at any angle by using a surface plate.

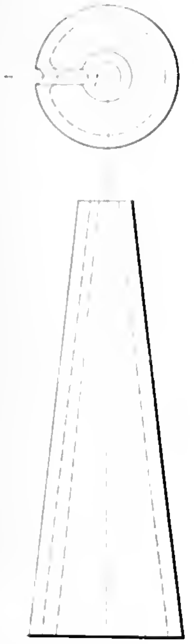


Fig. 5. Taper Cone for Forging Rings, Collars, etc.

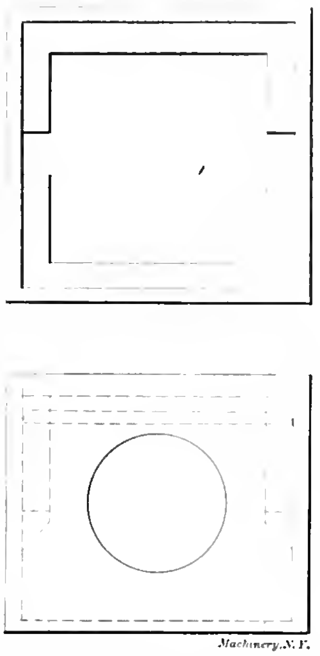
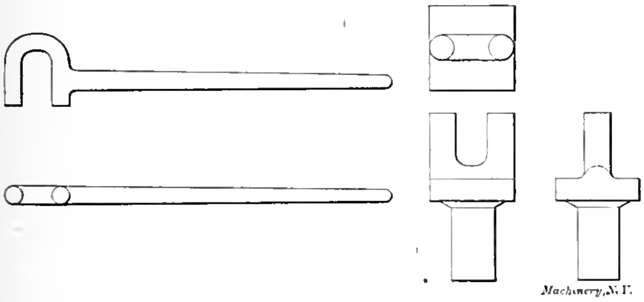


Fig. 6. Base for Swage Blocks.

The majority of up-to-date concerns manufacturing heavy machinery have a number of portable motor driven machines which can be taken to the work when it is inconvenient to take the work to the machine. These machines are usually credited with being time and labor savers, and, as a rule, cost less to manipulate on certain kinds of work than would machinery installed in a permanent position. Portable motor-driven appliances for the blacksmith do not, however, seem to have received much thought or attention up to the present time. Yet, there is no mechanic who could use portable appliances to better advantage than the blacksmith. A portable forge with a motor-driven blower attached could, perhaps, be used for a greater number of purposes than any other portable appliances. Long pieces could be welded in the majority of cases with less trouble than with an ordinary forge. Such a forge could be used for heating braces or similar work in fitting them to castings or tanks. In short, any kind of work that is done at the ordinary forge could be done at any time or place where the appliance could be connected with electric power. If mounted on small wheels or casters and fitted with a handle of the style used for small trucks, this forge could be moved around anywhere with very little trouble, and work of larger dimensions could be handled than is possible with the portable hand forge commonly used for work done outside the blacksmith shop.



Figs. 7 and 8. Tools for Bending Work.

Some shops are provided with taper cones or mandrels for truing up rings or similar work. A set of taper cones, of which there are several styles on the market, is inexpensive, and well worth a place in the blacksmith shop equipment. The kind that is most convenient to use and gives the most satisfaction is shown in Fig. 5. This style of cone has a U-shaped groove its entire length, which permits tongs to be used to remove or place work upon it more conveniently than with the unslotted kind.

Swage blocks take the place of a large number of individual tools, particularly bottom swages and heading tools. There probably is a larger variety of shapes and sizes of swage blocks than of any other blacksmith tool on the market. The style that comes nearest meeting the requirements of machine blacksmithing is the square pattern with circular, hexagon, and V-shaped impressions around the outside edges, and square and round holes of different sizes in the center; one side of these holes should be countersunk. If mounted on a cast iron base or block, such as shown in Fig. 6, the swage block can be conveniently used either for swaging or heading forgings, by standing it on its edge in the recess in the center of the block, or laying it flat in the flanged section at the top.

In bending work to curves or sweeps, dogs of the style shown in Figs. 7 and 8 will answer the purpose better than any other tool. They can be used either on hot or cold work. The tool in Fig. 7 is intended to be used by hand in combination with that in Fig. 8, which latter should fit the square hole in the anvil. In making tools of this kind, it is important that the one to be used by hand be as shown, so that its bearing upon the work will be in line with the end of the handle; this prevents twisting of flat work or slipping on round work.

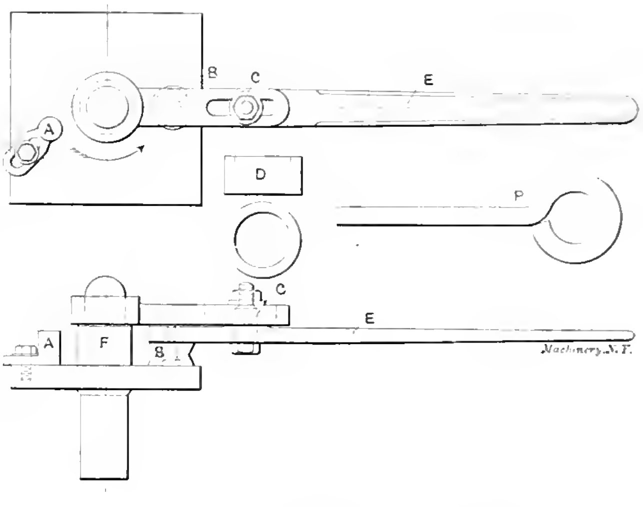


Fig. 9. Tool for Forging Open Eyebolts or Hooks

A tool for bending open eye-bolts or hooks is shown in Fig. 9. The shank of this tool is intended to fit the anvil. The part *A* is an adjustable guide for forming the first bend marked *P* on the eye-bolt shown. At *B* is shown a grooved roller which bends the eye to shape when turning the handle *E* from the left to the right as shown by the arrow. At *C* the lever is jointed, which allows adjustment for different sizes of material, and permits the roller to follow the shape of forming pin *F*, should its shape be other than round. The loose bushing shown at *D* is used to increase the size of forming pin *F* for making larger hooks or eyes. The bushings may be of any shape, but if other than round, they should be held in position by dowel pins. Tools of this kind should be fitted with an adjustable gage, so that the right amount of stock will be used for each piece. Hooks or eyes made on a tool of this type will not only be neater and more uni-

form in shape, but can be made in one-quarter of the time required if made by hand.

An appliance that would save time, trouble, and a large amount of unprintable language, is a small crane or hoist for each forge to be used only for work at the anvil. When too long or heavy for one man to handle, it is often necessary for the blacksmith to get another man to help him to handle heavy work. If trestles or "horses" are used, they must be moved or adjusted in height every time the piece is turned or moved, which often takes as much time as is used in doing the work itself. A small crane made of structural shape steel or steam pipe, properly trussed and braced, and fitted with a 1,000-pound chain hoist and snatch block, would overcome most of the difficulties. It could be easily adjusted to any height or position, would not come in the blacksmith's way, and would always be found in its place when wanted.

No blacksmith shop equipment is complete without platform scales for checking the weight of forgings and weighing stock before being used. It takes less time to weigh any kind of iron or steel than it does to figure out its cubic capacity and weight.

Machinery and tools help the blacksmith as much as any other mechanic; they make it possible for him to do more and better work, increase production and reduce cost, and thereby add to the efficiency of the blacksmith shop.

* * *

The use of denatured alcohol gas has not yet grown to the proportions confidently expected by the promoters of the industry. It was thought that when the United States government tax of $1.10 per gallon was removed, the use of denatured alcohol would soon rival that of gasoline for power purposes. The drawback to the extensive use of denatured alcohol is that so far it has not been feasible to manufacture it from vegetable products at a price that would successfully compete with gasoline. There is considerable interest now in the process of making alcohol from natural gas. Representatives of the Internal Revenue Department of the United States Government have visited Europe to study newly developed methods of manufacture of methylated or denatured alcohol from natural gas and crude petroleum. The Germans, with their characteristic enterprise for chemical research, have discovered a process which has unusual commercial possibilities. A company has been organized in the United States to promote the industry, which is being backed by Mr. Carl von Hartzfelt, Wheeling, W. Va., who also has discovered or invented a process. It is claimed that by the American process, 5,000 feet of natural gas will produce 50 gallons of alcohol, and that the cost of alcohol will be greatly reduced. Natural gas is sold to consumers in the gas fields of some localities as low as 10 cents per thousand cubic feet. At this rate the cost of gas per gallon of alcohol produced would be about one cent. Natural gas contains about 94 per cent methane, and the percentage of alcohol which may be obtained varies with the percentage of methane contained. The process is essentially as follows: The natural gas is subjected to heat in the presence of oxygen and steam which prevents complete combustion, inasmuch as the temperature is kept below the decomposing point of alcohol and destructive distillation or oxidation of the gas is induced. The action takes place in an electrically-heated German silver coil of closely woven fine wire gauze enclosed in a porcelain retainer or enamel retort. The product is a fluid containing alcohol, benzol, nitric acid and prussic acid.

* * *

It is interesting to note the low temperature obtained by Professor Onnes, when liquefying helium, to which reference was made in the September issue of MACHINERY. During his experiments, he kept helium at a temperature of 4.5 degrees K. for two hours, and finally evaporated the liquid under a pressure of about one centimeter of mercury, when the temperature is estimated to have been not far from 3 degrees K. The expression 3 degrees K. means 3 degrees centigrade above absolute zero, the expression being derived from the name of the late Lord Kelvin, who first defined the zero of the absolute temperature scale.

SYMBOLS IN MATHEMATICAL AND ENGINEERING FORMULAS.

The subject of making certain symbols, representing mathematical quantities in scientific publications, the same in all languages, has been considered for some time by the International Electrotechnical Commission, which has committees in different countries. These committees deal more especially with symbols for electrical quantities, but the system might, with advantage, be extended to embrace all important quantities in the field of engineering. The difficulties met with, are, in the first place, the difficulty of persuading a number of writers and publishers, who have become accustomed to a certain symbol for a certain quantity, to change it in favor of another, and, in the second place, that there are not enough letters in the alphabet at our disposal to give an absolutely distinct symbol to each quantity, without resorting to a combination of more than one letter to form a single symbol. There is also another objection to using letters to represent quantities in a system of universal notation, because, unless initial letters are used, there is no connection in the mind of the reader between the letter and the quantity, and the symbol is difficult to remember. We cannot always use initials, because the initial letters differ in different languages. For instance, in England R commonly stands for resistance, while in Germany the letter W is used, representing *Widerstand*; besides, the same initial occurs in a great number of different quantities. For instance, R might stand for resistance, reluctance, radius, etc.

The only way of avoiding both difficulties would be to use a number of new symbols, for which type could be made like ordinary letters, and which would represent distinct quantities in engineering formulas. In choosing a symbol a simple picture would be selected that would remind one of the quantity in question. For instance, ɭ might represent temperature. If we were told that this simple outline of a thermometer represents temperature, there would be no difficulty in remembering it. Similarly, / might represent force, and various other symbols might be derived from it. For instance, ϟ, electro-motive force (conventional representation of lightning); and ∩ magneto-motive force. Any formula expressed in symbols which have a definite meaning, would be completely self-contained, and would be an exact statement of a mathematical or physical fact. Perhaps some slight addition to the symbol, or even to the whole formula, could be used to indicate that the standard system of units is employed, and without such an addition the symbol would have a general meaning. For instance, ɭ might equal temperature, while ɭ̥ might indicate the degrees Centigrade above absolute zero. The name of the type might be the name of the physical units which it represents. For instance, ϟ might be read "volts."

The British Electrotechnical Commission invites writers and others who have some definite views as to the best method of devising an international system of symbols, to communicate with its secretary, Mr. Miles Walker, The Cottage, Leicester Road, Hale, Altrincham, England, if they wish to assist in solving some of the many difficulties which arise in connection with this matter.

The question of an adequate system of notation is really one of great importance to engineers. Everyone who has to deal with handbooks, and with formulas found in various text-books, is familiar with the annoyance of finding a formula, and having difficulty in locating the exact meaning of the various terms used to express the quantities involved. A universal system of notation, when once adopted by the engineering profession, would make it possible to make more concise and precise statements in shorter space, and at the same time misunderstandings would be largely avoided. It is to be hoped that the commission referred to above will be successful in adopting some standards of notation for the electrical quantities, and that engineering societies in various countries will also take up the matter, and, acting in unison, agree upon an international system of notation which would be adopted as the standard, thereby eliminating the present confusion.

A MODERN STEEL-HARDENING PLANT.

The illustrations, Figs. 1 and 2, show two views of a hardening plant installed by Wheelock, Lovejoy & Co. (selling agents for Firth Sterling Steel Co., McKeesport, Pa.) in the basement of their New York store at 23 Cliff St. The equipment is interesting in that it represents the latest development of gas furnace hardening and tempering baths. Fig. 1 shows a general view of the plant looking toward the street, while Fig. 2 is a view taken from the street end. The furnace in the rear, with a hood similar to the one in the foreground of Fig. 1, is for heating a chloride of barium bath, this being very successfully used for hardening "Blue Chip" steel, and the following notes relate to the practice:

The business of the company is selling tool steel, but in order to secure the best results and common satisfaction, it was found desirable to educate users to a knowledge of modern methods of heating and hardening high-speed steel. The plant was installed for this purpose and is used chiefly for hardening and tempering samples of work submitted by customers, thus demonstrating the capability of the steel for a multitude of purposes, and the best methods of treatment. An inspection of the plant gives proof of the great advance made in recent years in methods of heating, hardening and tempering. Nothing now need be left to chance or guesswork; every step can be made with absolute certainty as to the results. Thus have scientific methods and instruments practically eliminated the mystery and uncertainty attending the manipulations of the old time tool-smith who, working in his grimy dark corner, was one of the last members of ancient crafts to yield to the march of improvement.

Fig. 1. Hardening Plant, Wheelock, Lovejoy & Co., looking toward Street.

The tools to be hardened are first pre-heated, using a small American gas furnace shown next to the chloride of barium furnace. The pre-heating saves time in the barium bath, and is absolutely necessary to avoid checking or cracking the tools, as will be conceded when it is known that the temperature of the barium bath is kept at between 2,100 and 2,200 degrees F. After the tools are pre-heated, they are immersed in the barium bath, being suspended by an iron wire, or, in the case of small parts, in sheet nickel baskets. The reason for using sheet nickel for the baskets is that chloride of barium has a slight dissolving effect on iron and the exposure of a large area of sheet iron in the bath would eventually destroy the baskets. Nickel is not affected, nor is the thin iron wire used to suspend ordinary tools, to a perceptible extent.

The temperature of the barium bath is regulated by a Bristol thermo-electric pyrometer. This instrument, shown at the left in Fig. 3, is similar to a Weston ammeter or voltmeter, and the fire end is a thermo-electric couple. The heat of the bath effects the thermo-electric couple and generates a current that deflects the indicator of the indicating instrument to correspond with the temperature. For convenience of operation, the indicating instrument is provided with a double hand, one hand, *A*, being controlled by the temperature of the bath, while the other, *B*, is a marker set by the operator to indicate the temperature which he desires to carry. This marker is made with a disk at the end that covers a hole in the indicating hand when the two coincide, as they do when the temperature has reached the predetermined point. Thus, an operator whose eyes are dazzled by the heat of the bath does not have to painfully study the graduations to see whether the pointer has reached the correct position, but by glancing at the instrument he can readily determine when the indicator is directly beneath the marker referred to.

The immersion of a piece pre-heated to a dull red immediately causes the indicator to drop, the temperature of the bath falling perhaps 30, 40 or even 50 degrees. The fall in temperature is due to absorption of heat by the piece, being the same as the refrigerating effect of a lump of ice thrown into a pot of boiling water, and several minutes may be required to raise the temperature of a large piece to the temperature that is required. For hardening "Blue Chip" steel, a temperature of 2,120 to 2,140 degrees F. has been found most suitable. After this temperature is attained, the part is allowed to soak for a few moments, then is lifted out and dipped into the cooling bath shown at the right, Fig. 1, and left in Fig. 2, which consists of cotton-seed oil agitated by compressed air admitted at the bottom. The cotton-seed oil is contained in a large iron barrel surrounded by water in a wooden tub. The part hardened is allowed to remain in the bath until it is quite cold. In practice, the operator hardens a batch and then removes the pieces by means of a wire basket hanging immersed in the oil. It is recommended that milling cutters, end mills, slitting saws, etc., made of "Blue Chip" steel, be used, in general, without drawing the temper. They will have the requisite hardness and toughness to stand up to the majority of work. However, an oil bath heated by gas and regulated by a thermometer is provided for tempering such tools as require it.

Fig. 2. View of Hardening Plant, taken from Street End, shown in Fig. 1

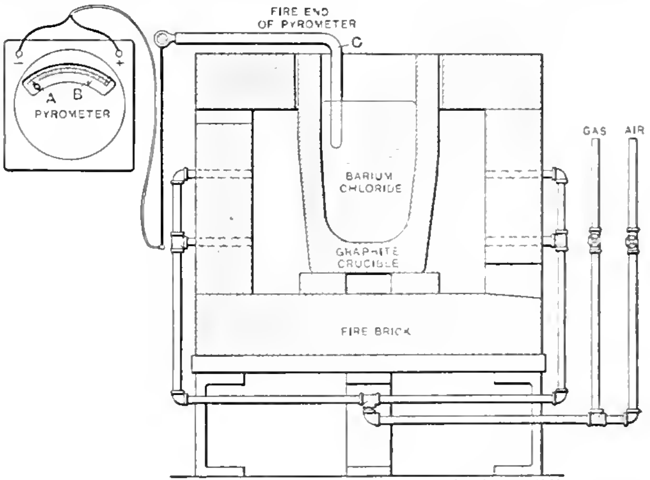


Fig. 3. Vertical Cross-section of Chloride of Barium Furnace.

Chloride of barium is a white transparent salt ($BaCl_2OH_2$) which melts at a temperature of about 1,700 degrees, the

water of crystallization being driven off at a much lower heat. The salt volatilizes at an extremely high temperature, the loss at the temperature required for heating high-speed steel being negligible. The waste because of volatilization is, say, two pounds from a mass of barium weighing 75 pounds when held at a temperature between 2,000 and 2,300 degrees for five hours. This property of the chloride of barium bath of standing high temperatures without rapid volatilization is joined with others equally important. The piece heated is protected from the atmosphere during the heating period by the bath, of course, but the protective influence extends still further. A thin coating of barium clings to the piece when it is lifted out for immersion in the cooling bath, thus preventing oxidation. The effect of the barium on the steel seems to be limited to a slight mottling that quickly disappears under the action of cleaning and buffing wheels. The coating of barium remaining when dipped, prevents the coating of burned oil so troublesome to remove, so that on the whole the process probably produces the cleanest work of any bath known.

Wheelock, Lovejoy & Co. have improved the furnace and crucible used for the chloride of barium bath. The common form of furnace and crucible in use employs a comparatively shallow crucible, which necessitates making a joint between the top of the crucible and the fire-brick cover. This gives trouble by loosening and permitting the hot gases to escape around the edge of the crucible. The improved construction illustrated in Fig. 3 utilizes a deeper crucible, the top of which comes flush with the fire-brick cover and simplifies the construction. The deep crucible also gives a greater volume of chloride of barium, consequently the refrigerating effect of the pre-heated steel parts when immersed in the bath is not so great. This illustration also shows the fire end, C, of the pyrometer immersed in the bath. It has been found advisable to employ crucibles made for steel melting, the ordinary graphite crucible used for brass melting giving trouble by flaking off into the barium.

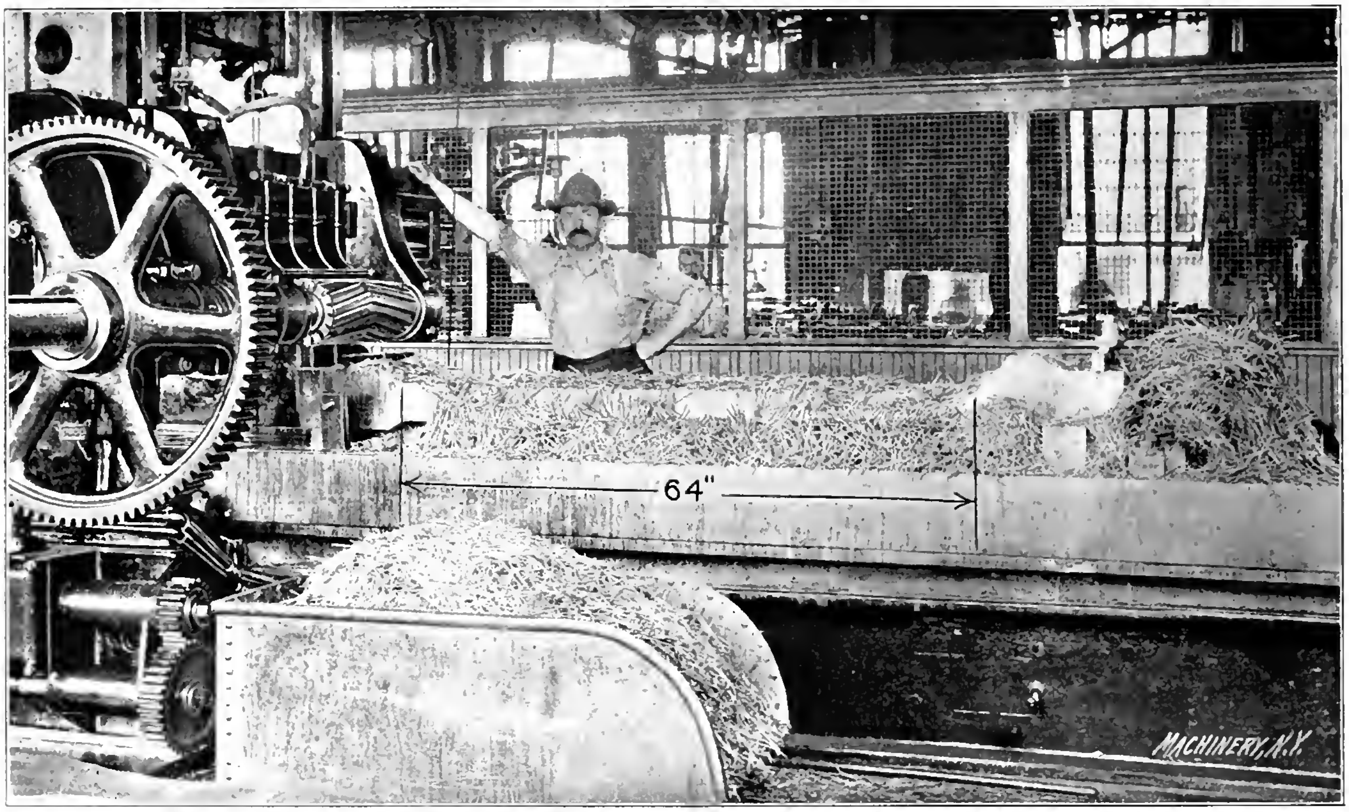
The equipment of the plant includes an air compressor and exhauster, the former being required for the air blast in the furnaces and for agitating the oil bath, while the exhauster connected with the smoke pipes and hood, draws off the hot air and gases, thus keeping the working conditions fairly comfortable, even in the hottest weather. An efficient ventilating system is a prime requirement, inasmuch as the fumes of the barium are somewhat noxious and besides would have a serious rusting effect on the steel stock if permitted to pervade the basement where it is stored. The chloride of barium process is used by the Boston and Chicago selling agents of the Firth-Sterling Steel Co., also.

* * *

HIGH-SPEED MILLING ON LOCOMOTIVE PARALLEL RODS.

The illustration does not show a hay-cutter nor a tooth-pick machine; it is a Bement-Miles milling machine, milling four heavy locomotive parallel rods, in a well-known locomotive works. These parallel rods, as well as many other locomotive forgings, are only roughly forged, it having been demonstrated long ago that it is cheaper to rough forge in the blacksmith shop to approximate shape and dimensions, leaving plenty of stock to finish up on the machines. The labor and fuel in the blacksmith shop are much more expensive than the labor and machine service in a well-equipped modern machine shop. It is on forgings of this and heavier types that high-speed steel has made its greatest records.

The rate of traverse on the middle portion of the rods was 5 inches per minute, 13 minutes being required to mill the straight part, which is 64 inches long between the end bosses. The bosses or end sections of the rod, which are enlarged for the reception of the crank-pin, are about 17 inches long and the profile is a combination of curves and straight surfaces. These sections were milled in 28 minutes each, the additional time per lineal inch of traverse being due, of course, to the greater amount of material removed and the repeated settings of the cutters required for the forming operations.



An Example of High-speed Milling on Locomotive Parallel Rods.

The milling cutter is composed of two parts having straight teeth set at an angle with the axis, the teeth being high-speed steel. The parallel rods shown in the illustration are 54 points carbon. The quantity of chips shown on the table gives a hint of the amount of metal removed from the top surface of the rods. Repeated tests made on heavy milling machines of the type shown, indicate that from 1½ to 2¼ horse-power is required for one cubic inch of steel removed per minute.

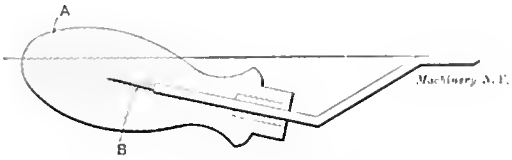
* * *

An ill-natured reprimand, an unexplained promotion, a summary dismissal—all these put emery powder in the grease-cups.—*The Silent Partner.*

ITEMS OF MECHANICAL INTEREST.

A HANDY SCREW-DRIVER.

A contributor to *Wood Craft* calls attention to a simple little tool which is handier than the ordinary screw-driver, particularly for putting in small long screws. It consists of a handle *A* in which is drilled a hole, so that a wire, say 3 inches long, will revolve in it without much friction. Into the bottom of the hole is driven a small brad *B* which is used as a bearing for the end of the rod constituting the screw-driver proper.

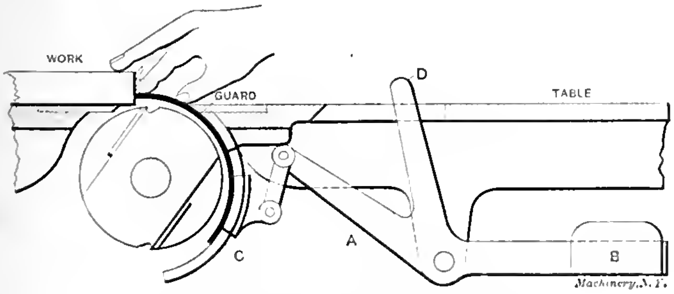


Screw-driver for Rapid Action.

The outer end, of course, is flattened to suitable dimensions. It will be seen that the tool constitutes a very neat little screw-driver, which will sink small screws very rapidly by simply revolving the handle like a crank, in the proper direction. A number of wires with different sized ends can be kept on hand, and interchanged as conditions require.

SAFETY DEVICE FOR BUZZ-PLANERS.

An interesting and effective safety device for buzz-planers has been patented by Mr. Lundberg, of Wernamo Mekaniska Verkstad, Wernamo, Sweden. The general arrangement of this device is illustrated in the accompanying line engraving. The principle of the device is that plates or guards *C*, of a semi-circular form, are held up against the end of the work when it passes over the cutter, by a weight *B* on the end of lever *A*, suitable linkage connections being provided between the lever and the guard. A number of these guard plates are placed side by side across the full width of the planer. It will be noticed that one arm *D* of lever *A* extends up through the table of the machine when the guard is in action, but when the work entirely covers the opening over the cutter, having pushed the guard clear back, this end of the lever is turned below the surface of the table. The handle of the lever serves the purpose of hand adjustment of the guards. It will be noticed that the cutter is covered at all times, either by the work, the work and guard in combination, or by the guard alone, so that at no time is any part of the cutter exposed. The weight *B* on the end of the lever makes the action automatic.



A Swedish Safety Appliance for Buzz-planers.

This guard fills also some of the very most important requirements of safety devices for machines of any type. In the first place, it is unobstructive to the working of the machine, and for that reason there is no incentive for the workman to remove it. Not only is there no incentive for the workman to remove it, but it is also very difficult to remove, and practically impossible to keep inoperative while in place. As the guard is made in sections, each of which covers a part of the full width of the table, it covers the cutter not only in line with the work, but completely on each side of the work as well. The simplicity of this construction, the ease with which it can be temporarily withdrawn for the changing of cutters, and the way in which it prevents dust and chips from entering into and obstructing the working of its own mechanism, are all factors which indicate the thoroughness of design, and that all the requirements have been well taken care of.

A SLIDE RULE FOR TRIGONOMETRICAL PROBLEMS.

A slide rule which is specially graduated for convenience in solving trionometrical problems is illustrated in the accompanying half-tone engraving. It is the invention of Mr. M. J. Eichhorn, 5759 Aberdeen St., Chicago. As seen from the engraving, this slide rule is constructed in the same manner as an ordinary calculating rule, but it is graduated in an entirely different manner, so as to be especially adapted for the solution of the formula

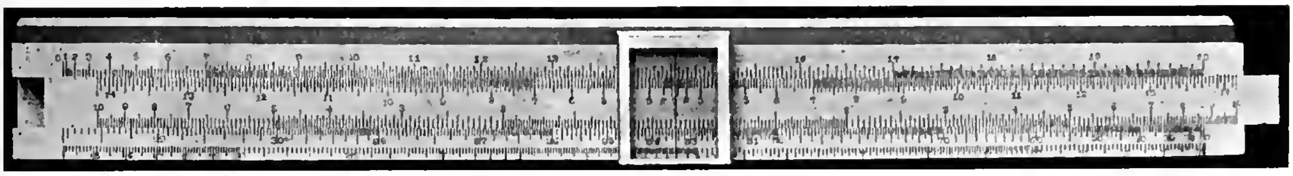
$$C^2 = A^2 + B^2 + 2AB \cos c$$

which is the well-known expression for the value of the third side in any triangle, when the two other sides and the angle between them are given. It is clear that this formula can be transformed so as to give an expression for practically the entire range of plane trigonometry, as either *A*, *B*, *C*, or *c* can be considered as the unknown quantity, and the equation can be solved for the same, thus giving a solution for any of the four basic classes of trigonometrical problems. Of course, the main reason why the formula is not used ordinarily for the sides *A* and *B* when transformed for solving either of these, is because it becomes rather cumbersome, and is not adapted for direct use of logarithms, thereby involving a considerable amount of ordinary figuring. When triangles are to be solved, however, and an approximation of three or four figures is sufficient, such as may be obtained within the length of a slide rule, the formula above can be so transposed as to permit of an easy solution on a slide rule specially graduated for the purpose and as shown in the illustration. For this purpose, we substitute as follows in our equation:

$$X^2 = 2AB \cos c$$

and

$$C^2 = A^2 + B^2 - X^2$$



A Slide Rule for solving Trigonometrical Problems.

The latter formula gives an expression which permits of solution on the trigonometrical slide rule. The slide is set in relation to the scales on the main body of the rule so that the known values of *A*, *B*, and *X* are taken care of, and *C* can be read off directly on the rule.

To permit of solving so complicated a problem, the instrument is, of course, provided with a rather ingenious system of graduation, and it suggests the idea that special slide rules can be constructed for the solution of rather complicated formulas, which are used very frequently in certain classes of work. The relation that such slide rules would have to the ordinary slide rule would be the same as that of special machinery to more or less universal machines. The ordinary slide rule, like the universal machine, is adapted for a great number of different operations, but is not adapted to carry out any one of them with particular speed, while a special slide rule, like a special automatic machine, would be suited to one particular operation only, which, however, could be carried out accurately, easily and rapidly.

* * *

Some concerns are so busy getting new customers that they have no time to take care of their old ones. Somebody ought to call around and recite that old saying about the value of a bird in the hand.—*The Silent Partner.*

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SYSTEMATIC STUDY.

From time to time we receive letters from subscribers asking for advice in regard to the best methods of increasing their knowledge along mechanical lines. It would be difficult to give an absolute rule to be followed for self-education, or to say which subjects are of the greatest importance, and which should be studied in preference to others. It all depends upon the work in which the person asking for advice is engaged, or for which he intends to fit himself, and upon his own mental make-up. There is, however, one rule that can be given without qualification or limitation, to everyone, and that is, *study systematically*. Do not take a book and read one chapter, and then turn to another and study up a different question, unless the foundation on which you build is already of such proportions as to permit adding to the structure in this haphazard manner. Start with some good book on the fundamental principles of the work you are engaged in, or of the work for which you intend to fit yourself, and study systematically and earnestly. Do not jump certain parts, because they do not, at the time, directly interest you. Make it a point to have certain hours which you devote to study, and certain hours to recreation. If this general advice is followed, at the end of each year you will find that you have stored up a great amount of knowledge which you would not have been in possession of had you not followed a method in your study. After a while systematic study will become a habit, and then your mental capacity will increase, and your ability to grasp and understand will be so developed that study is no longer an effort, but largely becomes a diversion.

* * *

RELATION OF EMPLOYES TO TRADE SECRETS.

The question of trade secrets has of late attracted some attention, particularly on account of the recent petition for an injunction brought by a well-known manufacturing company against two of its former officials. Another litigation, which merits attention by both employers and employes, is that in which a recent decision has been rendered by a New Jersey court. The complaining company had been engaged in making a special alloy steel, and a person in the employ of the company had made a contract that he would not at any time, directly or indirectly, during the term of the agreement or afterwards, divulge to any person, firm or corporation, except to officers of the firm with which he was employed, any information of any nature, known to him or thereafter acquired by him during the term of the agreement, relating to or regarding any process of steel making, or molding or treating steel, that may have been, is, or might be, during the term of the agreement, used by the company. The court, however, ruled that a contract of this form cannot be enforced, as it not only forbids the defendant to disclose any secret of the complainant, but also any knowledge that he may have relating to steel making in general. The necessary results of the enforcement of the contract would be that the defendant must either work for the complainant or remain idle, and since the restraint is unlimited as to time and place, he might at the option of the complainant, after the expiration of the term of the contract, be without employment for the rest of his life at the only calling he knows. Such a restraint, the court said, savors of servitude, unrelieved by an obligation of support on the part of the master. Comment seems unnecessary. Any reasonable minded man, whether employer or employe, will grant that contracts of this kind are disgraceful to the party demanding them.

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MECHANICAL FLIGHT.

The year 1908 will be remembered for the extraordinary progress made in mechanical flight. The present stage of development of the aeroplane by the Wright brothers, Farman, Delagrange, Curtiss, and others is such that we may truthfully say that the possibility of mechanical flight has been conclusively demonstrated. The step from the ignorance of centuries to the present knowledge of the laws of flight and the structural requirements of the flying machine doubtless is greater than for all future knowledge that will be acquired in the complete mastery of aviation. The conquest of the air is a matter of satisfaction for the machinist and machine designer. The Wright brothers' experiments which, doubtless, have been more thorough and comprehensive, than those of anyone working on the problem of aeroplane navigation, were made with a skill and insight into mechanical principles derived from their experience as bicycle builders. The design of the extraordinarily light and powerful gasoline motors that develop a horse-power for each three pounds of dead weight, or even less, is in itself a great achievement, and is one that has contributed in no small degree to the success of the heavier-than-air machines. It is to the machine designer that we owe thanks for this wonderful motor construction.

The mechanic has had a greater part in the present triumph than the theorists who have attempted to formulate laws of flight by mathematical analysis and deduction. The experience of the Wright brothers shows that practically nothing was known of the action of the atmosphere on moving planes, especially when these moving planes were propelled by motors. Experiments with kites, while useful, have led to many wrong deductions. The tables of wind pressures per unit of area for various velocities appear to be all wrong when it comes to bodies standing at angles in the air. The unit wind pressures vary according to the size and shape of the wings. The Wright brothers say, in their article in the September *Century*, that the wind pressures on squares are different from those on rectangles, circles, triangles, or ellipses; arched surfaces differ from planes, etc. They found, "contrary to the teachings of the books, that the center of pressure on a curved surface travels backward when the surface was inclined, at small angles, more and more edgewise to the wind." A great many other confusing and contradictory facts were discovered in their experiments at Kitty Hawk, N. C., which demonstrated how little really was known about the mechanics of the atmosphere. It is gratifying, however, to learn that the theories advanced were of value to experimenters, although in many cases, wrong. The theories served at least as something to grasp at and thus in a degree did illumine the dark way of the youthful investigators. The problem of aerial navigation is tremendously complicated by many unknown factors, and it is no wonder that mathematical analysis and deduction were found at fault in many vital respects.

AN ABUSE OF PATENT RIGHTS.

Some time ago an infringement suit was brought by an Eastern company against another firm manufacturing a like product, in which the court had to decide the question: Can a manufacturer buy a patent, never make use of it, and still sue for infringement? The decision, as rendered by the Supreme Court of the United States, was to the effect that the owner of a patent, after having bought it, has an absolute property right in it whether he uses it or not, and has a right to withhold from the public the benefits derived from the invention. This decision, no doubt, conforms with our present patent laws, but it is safe to say that laws so enacted and interpreted do not carry out the original purpose of patent protection, which was simply to insure to the inventor the right of deriving full benefit from the invention, by exclusive privilege to use or manufacture for a certain number of years, and by no means included the right to prevent others from deriving a benefit from something which he did not care to use himself. The present patent law appears to operate merely to restrain others from making and using for a limited period a certain device covered by a patent, whereas it is clear that patent laws were originally framed with an entirely different conception of the rights of the inventor. The question of patent right has an entirely different aspect whether we examine it from the point of view of exclusive right to make or use for a number of years, or of a right not to use it but at the same time prevent the whole world from using and deriving benefits from the invention as well. The inventor is given a monopoly by patent with the idea of encouraging him to expend energy and capital in its perfection, and to benefit the public by his invention, he himself being assured a reasonable profit for a reasonable number of years. The idea of permitting an absolute monopoly of a patent, even though the patentee or owner of the patent refuses to make any use of it whatsoever, is very similar to our harmful and vicious policy of legalizing monopolies in natural resources with the result of benefiting a few who render no service to the community at the expense of the community itself. From a moral point of view there can be no exclusive right to a patent, excepting if it be used, any more than there can be exclusive right to the bounties of nature, excepting if they be put to their best use, so that they benefit the community at large.

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AUTOGENOUS WELDING.

During the last ten years several interesting and valuable processes for joining metal parts have been developed. The processes of welding, soldering, and brazing are very old, having been used from time immemorial. Welding is applicable only to the joining of wrought iron, low carbon steel and a few alloys. For the sake of accuracy we must except gold which in the pure, clean, annealed state has the curious property of welding cold under pressure; but commercially speaking, welding is limited to wrought iron and mild steel. Soldering can be used only on small, light work for joints which are exposed to ordinary temperatures and those slightly above the boiling point of water, inasmuch as the melting point of solder is about 400 degrees F. Brazing, that is, the joining of parts by the fusion of a spelter, is applicable to iron, steel, copper, brass, and other metals. On many kinds of work it is a process rather uncertain in results, even in the hands of experts, unless a good equipment is provided for controlling the heat and manipulating the work.

Until within a few years, cast iron could not be brazed successfully because of the presence of the free carbon in the iron. The brazing of cast iron was made possible by the "ferrofix" process, which first decarbonizes the joint, placing the metal in much the same condition as wrought iron, so far as the action of brazing is concerned, and then brazing follows in the usual manner. Prior to this discovery had been developed the Thompson electric welding process, by which almost all commercial metals except cast iron are quickly and homogeneously welded together, the joint being raised to incandescence by the flow of the electric current. This process has had a very successful commercial development, and now is used for making thousands of welds daily. It and the other electric welding processes are essentially autogenous, as will be explained further on.

The thermit process developed by Goldschmidt was unique. Intense heat is produced by the chemical reaction of pure aluminum and iron oxide in a finely divided state, the temperature rising as high as 5,400 degrees F. One product of the reaction is pure molten iron or mild steel so hot that when poured upon the broken ends of a forging, surrounded by a suitable mold, the parts are instantly melted, and the whole fused together with a mass of hot metal which, as it cools, binds the joint together with a perfectly homogeneous union.

The latest development in the joining of metals, which is now assuming important commercial development, is the so-called autogenous gas flame process. The term autogenous welding is in some danger of becoming applied exclusively to various systems of gas flame welding. The flame produced by the combustion of hydrogen and oxygen, or acetylene and oxygen, is so hot that the parts adjacent to the metal joint are quickly melted together, forming a perfect union. But the meaning of autogenous welding is simply a welding of its own kind, the parts being joined together without the introduction of spelter, solder or any foreign material. Hence any method of joining metals by fusion of the joint which does not require the introduction of foreign material to make the weld, is autogenous. Right here it may be said that the autogenous weld is the only reliable joining of aluminum parts that has been discovered.

An autogenous joint, when properly made, must be as strong as the adjacent metal, provided no change has been made in the characteristics of the metal because of the heat. A broken forging that has been subjected to special heat treatment to improve its physical characteristics could not be autogenously welded and made as strong in the joint as before, without, of course, again being heat treated.

The importance of gas flame autogenous welding in jointing of boilers, drums, receivers and thousands of other manufactured articles, which are now brazed, riveted or bolted together, is obvious. It would seem that a revolution would be worked in the manufacture of steam boilers. The weakness of joints in boilers is more than that of simple reduction of tensile strength. A riveted joint is a section subject to deterioration, because of localized stresses through bending, corrosion and the action of the fire. The ideal boiler shell is that in which every part is as strong as another part, and which is of uniform thickness throughout. The autogenous process bids fair to make the realization of this ideal possible.

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It is stated on good authority that more than a hundred cylinders for the engines ordered in Germany some time ago for the East Indian and the Assam-Bengal Railways were condemned because of faults. Of these, eighty-eight were condemned in one day by the English inspecting engineer at the works. Further, after all the engines were finished, it was found that the transverse framing, a steel casting, ordered outside, would not permit the rocker-arms to work, hence must be replaced. These engines were promised, under fine for delay, to be delivered in May, but were delivered about a year late. The fault in the cylinders was mainly one of the method of casting. It would have been by far better to have cast only one pair of cylinders and tested these both before and after machining, to see if the metal was sound, the coring accurate, and the dimensions correctly given and worked to; then if a fault in any one of these particulars had been discovered, it could have been remedied on the next pair, or if not, at least there would have been less loss on the two trials together than on the eighty-eight. The trouble with the cross-girts was one either of the drawing-room, of the foundry, or of the machine shop; and would have been readily traceable; and in any case a little careful inspection would have revealed that the motion work would not clear, and the engine, consequently, could not make a single turn.

On the same set of engines the safety-valve springs were not of the right length, and a batch of six hundred bolts did not fit their nuts.

All these things reveal the desirability—indeed the necessity—of careful inspection all along the line.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

The increase in the lumber cut in the United States in 1907, over that cut in 1906 was over 7 per cent. The average lumber cut in the United States has increased from 250 feet per capita in 1850, to 480 feet per capita in 1907. There are nearly 30,000 saw mills in the United States.

One of the causes of pin-holes in aluminum castings is, according to the *Brass World*, that the metal is allowed to remain in the fire for some time after it has melted. Aluminum should never be allowed to remain in the fire more than the time required for melting, and overheating should be carefully guarded against if a good casting is expected.

That the aeroplane has been developed to the point of commercial importance is indicated by a cablegram from Le Mans, France, stating that a French syndicate has offered Wilbur Wright $100,000 for the sole right to construct the Wright type of aeroplane in France and the French colonies. It is also alleged that fifty aeroplanes of the Wright model have been ordered and that construction will be begun soon.

A patent has been granted to Henry V. Draper, of Springfield, Mo., for a process of hardening copper. The copper is melted in a crucible, and one pound of alum and four ounces of arsenic are introduced for every 20 pounds of copper. After stirring for some time, the copper is poured. It is claimed that copper thus treated is of great density, toughness and hardness, and that the copper may be melted a number of times without injury.

In the March issue of MACHINERY reference was made to the construction of boats and barges of reinforced concrete in Italy. According to *Engineering News*, reinforced concrete boats similar to these in use in Italy are to be manufactured for use on the Missouri river by Moechel & Lowther Engineering Co., of Kansas City, Mo. This firm has made a model of a 300-ton boat in 1/60 size, and of a 300-ton barge in 1/45 size, each to draw 3½ feet of water for the full-sized boat. Tests made on the models have shown very favorable results, but as yet the large vessels have not been built.

On October 3 the nine-hundred thousandth patent was issued from the U. S. Patent Office. It was an improvement on traveling stairs, such as are used in hotels and other large buildings. Patent Commissioner Moore estimates that the one millionth patent will be issued in the year 1911, and he calls attention to the fact that the total number of patents issued by the United States, is not very far below the total number for all other countries for all time. The issuance of foreign patents up to the date of the last report, was 1.135,000, or only 235,000 in excess of the total for this country.

The construction of the two new White Star liners, previously referred to in MACHINERY, is, we understand, to be commenced in January by Messrs. Harland & Wolff. The definite plans are now laid down. The steamers are to be 860 feet long and of a gross tonnage which is 8,000 tons in excess of that of the *Lusitania* and *Mauretania*. The names of the two vessels will be the *Titanie* and the *Olympic*. There speed is to be practically that of the *Oceanic*, or 21 knots. The first of the two vessels is expected to be ready in about two years, and the second in somewhat less than three years.

The shop structure of the Lucas Machine Tool Co., of Cleveland, Ohio, is built with a saw-tooth roof, and extensions have been made from time to time by adding saw-tooth roof units as the business has grown. To reduce the fire risk, the roof of the last section erected is made of 12 × 18-inch hollow tile, supported by structural steel, and covered with asbestos roofing. The floor is made of cinder concrete about 4 inches in thickness, laid on the natural sand foundation. Two-inch planks are spiked to the concrete, and ⅞-inch maple boards are laid on the planking. This combination makes a shop floor which is believed to be superior to any other construction of equal cost.

The effects of the new British patent law, which provides for the actual working of all British patents within the British Islands, are now commencing to be visible. The law became operative on August 28, 1908. It is stated that 30 foreign firms have completed arrangements to open factories in Great Britain for the working of their patents, and that a number of these are American concerns. Still other firms in the United States and in Germany are negotiating for factories or sites for plants. The principal articles which American firms will manufacture in England are telephones, typewriters, phonographic records, and shoe machinery. It is estimated that about 2,000 patents are now within the scope of the law, and that the effect of the law will be to give employment to from 30,000 to 40,000 people.

The development of scientific instruments, such as the scleroscope and Brinell machine for testing the hardness of metals, may lead to some astonishing and highly desirable discoveries. In an address delivered before the Institution of Civil Engineers, London, Prof. Henry Louis said that one of the greatest needs of the present time in mining is a strong tough metal considerably harder than quartz, which can be used as a substitute for black diamonds or bort for cutting hard rock. It is not impossible, so far as we know, that such a metal will be developed or discovered. Hardness of steel is a quality not fully understood. Manganese steel, for example, resists all steel cutting tools, yet it seemingly is not "hard." It can be bent without fracture and even twisted into corkscrew form. Scientific testing methods may lead to the discovery of steels having as surprisingly superior qualities over those now known as high-speed steel had above the carbon and tungsten steels of a decade ago.

On September 17th, Mr. Orville Wright, who had previously broken the world's records for flights with a heavier-than-air machine, while making a trial flight at Fort Myer, met with an accident which resulted in serious injuries to himself, and the death of Lieut. Selfridge, of the U. S. Signal Corps. The aeroplane was about 75 feet high, when one of the propeller blades broke. Mr. Wright lost control of the machine, which rapidly descended, striking the earth with terrific impact and burying the two men beneath the debris. A few days after the accident the broken blade was brought to Mr. Wright and he discovered an indentation in it which proved conclusively that the accident was due to the propeller coming in contact with a steel stay which was near it, but which was not supposed to be close enough to interfere with its movement. At the time the blade broke the aeroplane was on a curve, and the cause of the tragedy is attributed to this fact, as the machine cannot glide in a curve or spiral.

A paper was presented before the Franklin Institute April 15, 1908, on the theory of shooting, and the evolution of the Spitzer bullet, by L. H. Hartmann. The author briefly traced the evolution of the shoulder arms, mentioning how important is a flat trajectory on the accuracy of shooting. The introduction of smokeless powder by Noble made possible very flat trajectories for long ranges. A further improvement has been made by the Spitzer bullet, which is made with a sharp, approximately conical point, instead of the well known rounded point in common use. So marked is the difference between a round-nose bullet and a Spitzer bullet that the muzzle velocity produced at the same charge in present government rifles is 2,000 feet in the first second with a round-nosed bullet and 2,800 feet with a Spitzer bullet, the gas pressure being 42,000 pounds per square inch. The shape of the point of the Spitzer

bullet in longitudinal section is a sharp ogive. Tests made by the United States government, at Springfield, Mass., confirmed the results that have been experienced abroad.

Lieutenant-Commander Davis, of the United States Navy, has invented a new type of torpedo, which, judging from experiments, will prove very destructive. The torpedo contains a tube of vanadium steel, weighing about 40 pounds, and when the torpedo strikes the side of the vessel a shell is discharged from this tube, through the opening made in the vessel, with a velocity of 600 feet per second. The shell is charged with high explosive and equipped with a time fuse so that when it reaches the interior of the vessel it will explode, doing the greatest possible damage. In this way the protection now given by the water tight compartments, bulkheads and layers of coal will be overcome, and the vessel damaged very much more than when the explosion takes place on or near the exterior. In a trial at Sheep Island in Massachusetts Bay, a torpedo of this type was sent 120 feet to a steel tank 15 feet in diameter, with three bulkheads of ⅝-inch plate, and the torpedo shell passed entirely through the tank and bulkheads, going 100 feet beyond. There was no explosive in the shell used in this trial.

It has been stated by newspaper reports that Professor Wood, of Johns Hopkins University, has designed a new type of astronomical telescope, by means of which he expects to obtain results far in advance of any obtained by telescopes of ordinary construction. The principal feature of Professor Wood's telescope is the mirror, which consists of a basin of mercury set spinning by means of an electric motor. The mercury in the basin assumes a concave surface when the basin is rotated, the concavity being proportional to the speed. The surface obtained is theoretically more correct and brighter than that of any ordinary reflector. By varying the speed of the basin it is possible to alter the focal length of the instrument at will. The only difficulty, so far, has been the impossibility of eliminating slight vibrations of the machine, so as to preserve an absolutely perfect surface of the mercury. At the present time Professor Wood is having a telescope constructed with a 7-inch reflector, and if the instrument fulfils his expectations, it is stated that he will proceed to construct a giant telescope along the same lines.

The beneficial effect of reforestation on water power is vividly illustrated in the case of Miller's River, Mass. A number of concerns, including the L. S. Starrett Co. and the Union Twist Drill Co., of Athol, Mass., have water power derived from this river, and both concerns have auxiliary steam power to help out during the dry season. A few years ago the water would fail almost entirely in July and August, requiring the maximum capacity of the steam plants to run the works, but during the last two or three years the volume of flow has been almost equal to the normal demand for power during the whole summer, and the steam power has been required for a minimum period. The reforestation of the uplands of the drainage area that has been going on rapidly during the last twenty or twenty-five years has restored the old conditions, and now the rain-fall is held back by the trees, shrubbery, leaves and moss, the whole acting like a huge sponge to absorb and feed out the water instead of precipitating it at once into the water courses. In our generation it is common experience that water power, except on large rivers, is very uncertain and unreliable, but with reforestation of the upland areas we may see our streams in a few years restored to the equable flow all the year round that existed in the days of the early settlers. The benefit of conserving forests on the uplands and replanting lumber areas cannot be over-estimated from almost any point of view.

An electric recording target, designed by Mr. Sydney A. M. Rose, A.M., I.E.E., which records each shot, or series of shots, accurately and automatically, is, according to *Engineering*, being introduced by the Rose Recording Target Co., Ltd., 14 Abchurch-lane, E. C. It consists of a traveling target of the usual size, in conjunction with a miniature recording replica of same, located at the firing-point; the motions of both the target and replica synchronize, and when the former is hit, a mark is recorded on the corresponding part of the replica. The target consists of a paper or paper-covered canvas band, marked with the required aims, and is actuated by an electric device which unrolls the band on one side and winds it up on the other. The endless series of targets can travel in either direction and operates synchonously a roll of paper at the firing-point on which the records are made. Across this paper, and at right angles to the direction in which it travels, is arranged a set of contact-making devices placed 1/16 inch apart, and for individual firing connected through a resistance and a line-wire to the marking mechanism of the recorder. An auxiliary line-wire is provided for synchronizing purposes. For volley firing the contact-levers are each connected by a separate wire to a corresponding pencil or marker. When the target is being used, any hole passing under the contact devices immediately closes a circuit, thus transmitting and reproducing the hits.

As we mentioned in the September issue of MACHINERY, the state of New York has organized a new division of trade schools in the Education Department, and Mr. Arthur D. Dean has been made chief of this division. This new inauguration in the Education Department of the state is intended to further the organization of two classes of schools: in the first place, factory or apprenticeship schools, which will train men in factories for the various trades; and in the second place, trade schools of the ordinary type. The new schools will be a part of the regular school system, and subject to its management, but the work will not be mingled or confused with the work of the ordinary public schools. The state will make an allotment of $500 to the Board of Education for each of such schools giving instruction to not less than 25 pupils, provided the school is maintained for a minimum period of 40 weeks in one school-year. The state will also contribute an additional $200 for each teacher, after the first, employed in such a school for the same period. Among the rules laid down by the Department of Education is that for these schools no teacher will be approved of who is not a recognized mechanic. It is advised that the system be organized upon an economical footing, it being suggested that often an idle building, erected for a factory, or some other purpose, may be used. All correspondence regarding this new departure will be welcomed by Mr. Dean; address Division of Trade Schools, Education Department, Albany, N. Y.

A test was made August 24 at the Springfield Armory of the noiseless rifle invented by Hiram Percy Maxim. The test demonstrated that the report of a service army rifle was so reduced by the device as to be inaudible at a distance of 150 feet from the person firing. The invention is of a nature similar to the muffler of a gas engine. Its essential parts are a valve that closes the bore of the gun immediately after the projectile has passed the valve. This closure of the valve prevents the sudden expansion of the gases, the gases being emitted slowly. The result is that the characteristic report of a rifle is reduced three-fourths in loudness, it being judged by the officials who were present that the efficiency of the apparatus was about 74 per cent. In the report of the test it is stated that upon firing, the report was like the snapping of one's fingers accompanied by a slight hissing as the gases escaped. The sound of the hammer striking the firing pin was much sharper than the report of the piece. The invention appears to be entirely practicable and it is thought that it will work a revolution in warfare. The firing line of an army equipped with noiseless and smokeless rifles will be very hard to locate, as there will be neither noise nor smoke to guide the observer as to the position of the enemy. A dangerous feature of the new weapon is that it lends itself admirably to the cowardly assassin. With a noiseless gun it will be possible to shoot down a man in the street without alarming the police. On the other hand, as a game gun the new rifle will be highly prized, it being possible with it to shoot an animal without scaring the remainder of the herd, but even that has its drawback as it will tend to make the business of pot-hunting more successful.

MAKING CONCRETE TELEGRAPH POLES.

An interesting process has lately been adopted by an English firm for manufacturing hollow, tapering, concrete telegraph poles as well as pipes for conveying water, gas, oil, etc., under pressure. It has been customary to regard concrete as a material which has to be cast in a mold, but this machine uses the concrete as a plastic material, somewhat like clay, and the poles and pipes are not cast in a mold. In general, the process of manufacturing concrete poles, as described by *Page's Weekly*, is as follows:

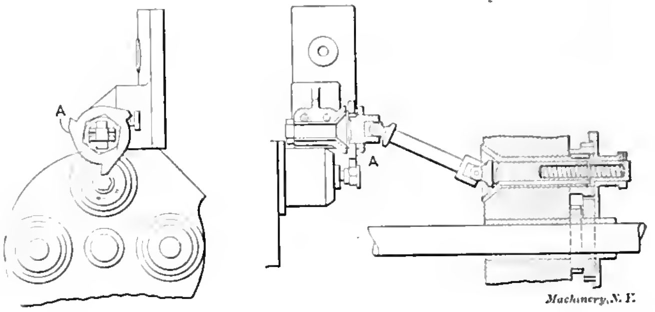
A long core of sheet iron is mounted on two trestles running on rails so as to be capable of rotation and longitudinal movement. Upon this sheet-iron core longitudinal steel rods of small size are fixed. This core is drawn through the machine employed, which is stationary. Concrete made of clean screened grit and Portland cement is discharged into a hopper or drum, in which rotating paddle wheels regularly discharge the concrete upon a bandage of coarse cloth webbing laid on a conveyor belt that takes one lap round the core. This continuous traveling conveyor belt is stretched so that it wraps the concrete round the core under great pressure. As the core issues beyond the conveyor belt, steel wire is fed spirally round it so as to press into the concrete wrapping, and small rollers then apply great pressure by working on the webbing, the slack of which, produced by the reduction in circumference and external diameter resulting from this pressure, is taken up by another contrivance. The core, therefore, as it issues from the machine is wrapped round spirally with a bandage of cloth containing the concrete. The machine pulls the trestles with the suspended core regularly forward, so that the core passes through it as the concrete is wrapped round it, and when the core has passed completely through the machine, it is lifted by an overhead traveling crane and placed on one side for the concrete to harden. In about twelve hours the interior sheet metal core is reduced in diameter by a screw attachment inside and withdrawn from the pole. After hardening for about six days, the bandage of webbing is removed and the pole is then complete. The thickness of the shell of the pole is from one to two inches, according to the height and the strength required, and the reinforcement is likewise varied according to circumstances. Poles are made by the machine above referred to up to 39 feet long, and pipes up to 20 feet long and 2 feet in diameter. Pipes are manufactured in the same way as poles, the smaller pipes withstanding pressures up to twelve atmospheres, and the larger pipes up to six atmospheres.

ATTACHMENT FOR CUTTING SQUARES AND HEXAGONS IN AUTOMATIC SCREW MACHINES.

Practical Engineer, August 7, 1908.

A device has just been patented by Messrs. J. H. Hopkins and H. J. Smith, of Manchester, England, consisting of an attachment for automatic screw machines for cutting flat surfaces, such as squares and hexagons or other polygons, on work produced from a bar, directly in place, so as to save a second handling of the work after leaving the automatic machine. The attachment, as designed, is particularly intended to be applied to a 4-spindle automatic screw machine, and provisions are included for driving a milling cutter of special design, as described later, by means of which flat surfaces are cut, and also for feeding this cutter past the revolving work. It should be understood that the work revolves while the flat surfaces are cut, to provide for which, of course, required some ingenuity in the design. As shown in the illustration, a hexagon is cut on the end of one of the bars in the machine, the cutting tool being the cutter *A*, provided with three teeth. This cutter is placed on a supplementary slide, mounted on the work-carrying head of the machine, and fed by the work by means of a leverage system adjustable to suit the requirements of different work. When the device is in operation, the work and the cutter revolve in the same direction in relation to their axes, so that at the cutting point the directions of the surfaces which are in contact are opposite, but the cutter is geared to revolve at twice the speed of the work to be provided with the hexagon, and as the cutter has three cutting points and revolves very rapidly, it produces a polygon with six equal sides when it has traversed the full width of the flat. If the cutter had only two points, it is clear that a square would be produced. Were a cutter having only one point used, the gearing being the same, two flats only would be produced, and the remaining portion of the circular surface would remain curved. It is clear that the same results can be obtained by gearing of other ratios than two to one, provided the number of teeth in the cutter is selected to suit the ratio of revolutions. The sectional view shows how the drive is transmitted to the cutter from the main drive of the machine.

It may well be remarked in this connection that when any devices are applied to automatic machines which in a certain sense belong outside of the original territory of the machine, it is very important to take into consideration whether these devices require a stoppage of the regular functions of the machine, and thereby rob the machine itself of the efficiency of which it is capable, or whether these extra devices perform their work simultaneously with the performance of certain of the legitimate functions of the tool. In the former case it is often doubtful whether the introduction of such devices is economical. Tying up an automatic machine for such operations as screw slotting, milling, etc., which prevent the continuous working of the machine, is sometimes questionable economy. On the other hand, if the devices are so designed that operations which of necessity must be performed on the machine can still be carried on while the device performs its own functions, then the introduction of such devices is of distinct advantage. If we analyze the conditions attending the device just described we will find that one of its strong features consists in the fact that the work is provided with its flat surfaces while it still continues its rotary motion, thus permitting other cutting tools to perform their functions without interference. There is no stoppage of the machine whatever required. Of course, in the present case another very important fact to consider is that a second handling of the work for milling purposes is saved, and it is often the handling of the work for the performing of various operations, rather than the time occupied by the operations themselves, that determines the cost of the product.



Attachment for Milling Squares and Hexagons while Work is revolving for Other Machining Operations.

RELATIVE ECONOMY OF STEAM AND GAS POWER WHEN EXHAUST STEAM IS USED FOR HEATING.

F. W. Ballard in the *Engineering News*, August 15, 1907.

The present time offers a good opportunity for making a comparison between the cost of power generated by the gas engine and the cost of power from steam when the conditions are such that either the heating of the building, or the carrying on of some of the processes of manufacture, can be accomplished by the use of exhaust steam from the steam engine. It is generally conceded that when the power alone can be used, and the waste heat from the steam engine and gas engine is not utilized, doubtless the gas engine is the more economical power producer. This can hardly be disputed because not only is the gas engine cheaper as far as fuel consumption is concerned, but in a well-designed gas engine plant the cost of maintenance need not be more than one-half the cost of repairs in a steam power plant of the same capacity, and the total cost of labor for the running of the plant would probably not run very much over one-half what the service would cost in a steam plant. The feature, however, which

gives the steam plant a decided advantage over the gas plant in economy is the possibility of using the exhaust steam from the steam engine for heating. This precludes, of course, the use of the condensing apparatus in connection with the engine, and consequently lowers the economy of the steam plant itself, but since the latent heat contained in exhaust steam amounts to about 80 per cent of the total heat of the steam when going to the engine, the lowering of the efficiency incident to running the engine non-condensing becomes of minor importance. Not only can the exhaust steam be used for heating the whole manufacturing plant, but in addition to the heating of buildings, a great many manufacturing concerns can make use of the heat of the exhaust steam for the carrying on of certain processes necessary in the work, thus saving the use of live steam; and, in cases where the temperature necessary is higher than that of the exhaust steam, it is not only possible, but perfectly feasible, to use the exhaust steam for bringing the temperature up to a certain point, and then to supplement by the use of live steam, thus effecting a great saving of what might otherwise be a very expensive operation.

As examples of uses for exhaust steam, we may mention drying ovens for various kinds of manufacture. If in such cases gas engines were used for power, it would be necessary to operate a special boiler plant to generate steam for drying purposes and for heating. There are also great possibilities along the line of using high-pressure compound engines for power, which can be operated condensing or non-condensing, so that they can be run condensing in the summer time or whenever the exhaust steam is not needed for heating, and operated non-condensing the balance of the time. Of course, there is a possibility of using the exhaust gases from the gas engine for the heating of buildings, but its possibility is very limited, first, because of the low fuel consumption of the gas engine per horse-power hour, and second, because of the large percentage of the heat units contained in the fuel which are converted into power. In a simple non-condensing steam engine we may say that there are about 30,000 heat units contained in the exhaust steam for each horse-power hour, while the waste heat in exhaust gases from the average gas engine would contain only about 6,000 heat units per horse-power hour. In conclusion, therefore, in any comparison between the relative economy of steam and gas power, due consideration must be given to the fact whether or not the exhaust steam from steam engines can be used for heating or other purposes. If it can be so used, the steam engine is likely to be the more economical of the two power producers.

CLUTCHES FOR POWER PRESSES.

Mr. Frank Mossberg, at the June Meeting of the American Society of Mechanical Engineers.

Clutches for power presses must be so constructed as to disengage from the driving wheel and allow the driven shaft to stop in the same fixed position whenever disengagements are made. For quick running presses the clutch parts must be light enough to respond promptly when the trip lever is actuated, otherwise their inertia will so retard the action that the clutch will not properly engage with the driving wheel.

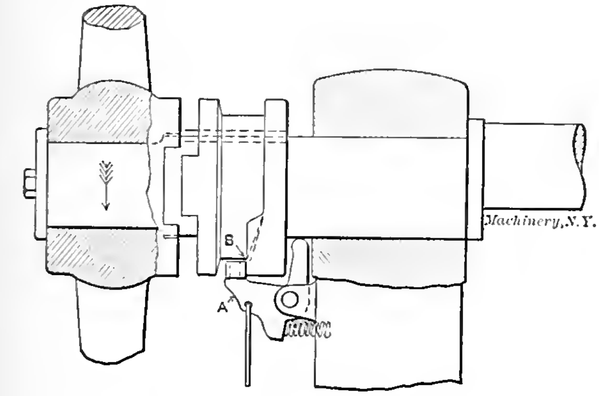


Fig. 1. Plain Jaw Clutch.

Perhaps the oldest clutch used for power presses is the simple jaw clutch illustrated in Fig. 1, in which the construction is so fully shown that no explanation is necessary. This clutch, while it may have proved useful for comparatively slow power presses and for light work, has been largely superseded by more improved types. The principal objection to this clutch is its heavy parts, which make it slow to respond, and sometimes when the speed is up to 100 revolutions, difficulty is found in making the clutch jaws enter the driving recesses in the wheel.

Fig. 2 shows a form of clutch used largely by several Connecticut press manufacturers. This consists of a sliding key *B* fitted to move freely in a slot or pocket in the crank-shaft, and controlled by a wedge shaped cam *A* connected to a treadle or hand lever. To lock the clutch to the driving wheel, the cam is released and the spring forces the key into engagement. Simplicity and low manufacturing cost are points in favor of this clutch, but it requires considerable repairs.

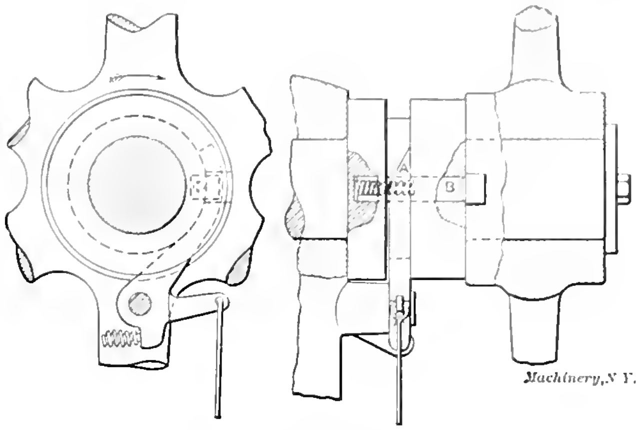


Fig. 2. Sliding Key Clutch.

Fig. 3 illustrates a form of clutch used extensively by the Stiles & Parker Press Company, and probably originated by Mr. Stiles. It was developed some thirty years ago, and yet is still used on a large number of presses where it appears to work satisfactorily. In this clutch the locking pins *A* are located in the driving wheel, and held in position by the trigger block *B*. To operate the clutch the cam segment *C* is slightly depressed. When held in this position the trigger block located in the driving wheel will come in contact with the cam lever, releasing the clutch pin, which in turn drops into recess *D* in the crank shaft. The cam lever is now returned to its normal position, and when the shaft revolves, the clutch pin *A* will be drawn out of the recess of the crank shaft by this same cam, thus stopping the driving shaft in its original position.

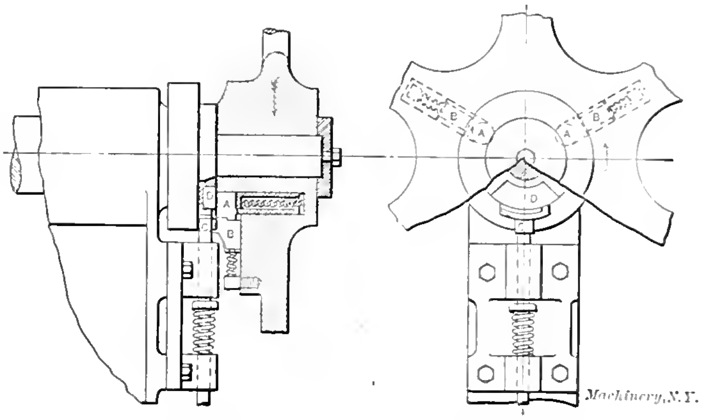


Fig. 3. Stiles & Parker Press Co.'s Clutch.

Fig. 4 shows a clutch used by one of the large press manufacturers, which commends itself for its simplicity. Owing to the peculiar construction, however, whereby a considerable part of the bearing in the hub of the driving wheel is cut away, the bearing is liable to wear rapidly. Its operation is as follows: The lever *B* is swung out of contact with clutch arm *C*, allowing clutch arm and key to be acted upon by the spiral spring shown in dotted lines. The continual revolution of the driving wheel will promptly bring one of the recesses

E in front of the half round locking key, allowing this key to make one-fourth turn in its socket and thus lock the driving wheel to the shaft. When the shaft reaches the original point of starting, the clutch lever *B* being in its normal position will obstruct the clutch lever *C* and cause the clutch key to return to its original position, allowing the driving wheel to pass over it freely.

Fig. 5 shows a form of clutch used on presses made by the Stiles & Fladd Press Company. The clutch pin *B* in this construction is placed in a pocket in the driving shaft in which it moves radially. A spring forces this pin outward to engage with a lug in the driving wheel when the release lever is actuated. This actuating mechanism will also cause the clutch pin to recede into the pocket in which it is held by the releasing cam out of contact with the driving wheels. This clutch, having two or more contact points in the driving wheels, is a very satisfactory working mechanism, and has proved very durable.

Fig. 6 shows a form of clutch used by the Ferracute Machine Co., and designed by Mr. Oberlin Smith. This clutch is used to a large extent on punching presses. It is rather complicated, especially in the form applied to larger presses. A desirable feature is that it is usually made with several contact points in the driving wheel which are of tempered tool steel. These contact points are so constructed that when the clutch is engaged, the wheel is locked in both directions. The illustration shows the working of this clutch.

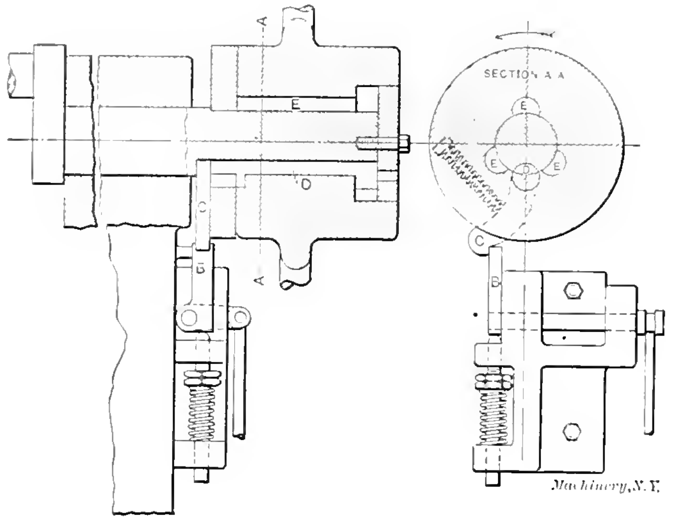


Fig. 4. Bliss Clutch.

Fig. 7 shows a form of clutch designed by the author and intended especially for large presses. It has two large engaging pins of tempered tool steel, which act together. These are located radially opposite each other and far enough from the center for good leverage. This clutch can be made to connect at each half revolution of the driving wheel. It is one of the strongest made and has proved serviceable in practice, requiring very little repairs. The clutch pins *G* connected with sliding collar *C* are mounted to move freely, and revolve with the driving wheel at all times. To operate the clutch, the locking pin *E* is pulled out off the cam *D*, allowing the collar *C* and pins *G* to move into engagement with the clutch lugs *H*, which lock the driving wheel and the shaft together. When the shaft returns to its original position the clutch pins are withdrawn by the action of the cam *D*.

A total departure from all the clutches previously described is a clutch invented by Mr. James A. Horton, of Boston, some years ago. Fig. 9 shows this clutch, which consists mainly of a hardened steel cam *A* keyed to the crank-shaft; a clutch ring *C* mounted to turn slightly on the shaft; a series of rollers *B* held loosely in slots in the ring, and a spring *G* acting on the clutch ring and causing the same to turn, carrying with it the rollers *B* towards the high point of the clutch cam *A*. The balance wheel is recessed to receive this clutch mechanism, this recess being lined with a hardened tool steel ring *D*. The diameter of the recess is such that when the rollers *B* reach a point about half way between the lowest and highest point of the cam they come in contact with the clutch ring *D*, and act as wedges to lock the clutch. Release of the clutch is made when the lug *F*, fastened to the clutch ring, strikes against the stop lever *E*. This will throw the clutch rollers out of engagement and allow the wheel to pass freely. This clutch we may term as a positive friction clutch. It is instantaneous in its action and can readily be disengaged at any predetermined position on the shaft.

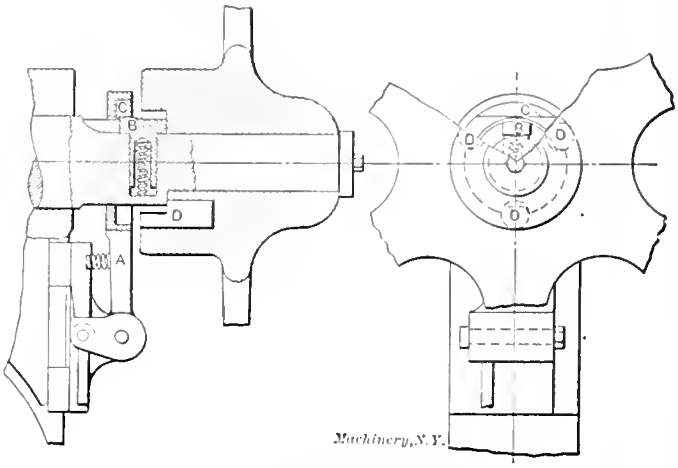


Fig. 5. Stiles & Fladd Clutch.

A desirable feature peculiar to this clutch is that it can be released with ease under full load. In other words, with this clutch it is possible to cause the slide of the press to descend on the work such as in embossing; release the clutch when the embossing dies act on the work; and then when the desired time has elapsed for the embossing tools to act, again engage the clutch and cause the press slide to return to its normal or up position.

This clutch has been extensively used for power presses by the Standard Machinery Company of Providence, R. I., and is one of the most durable forms yet produced for this purpose. It is suitable for the lightest as well as the heaviest press made and works well for speeds from the slowest to 500 R.P.M. The instantaneous action of this clutch when the trip lever is actuated enables the operator to run a press fitted with it faster and keep more perfect time than with any other. In the ordinary clutch, the operator presses the treadle which actuates the fixed locking or catching key. The balance wheel is revolving around the shaft and may be just past the locking point, requiring almost an entire revolution to return to the fixed point in the wheel, while at another time the fixed point in the wheel is in such a position as to engage the locking point instantly; thus we have a stroke of the press taking practically two revolutions of the wheel in one case and only one in the next, this variation making it impossible to perform operations in unison with the ordinary clutch. These clutches are made in various sizes to transmit from ½ horse-power up to 1,000 horse-power

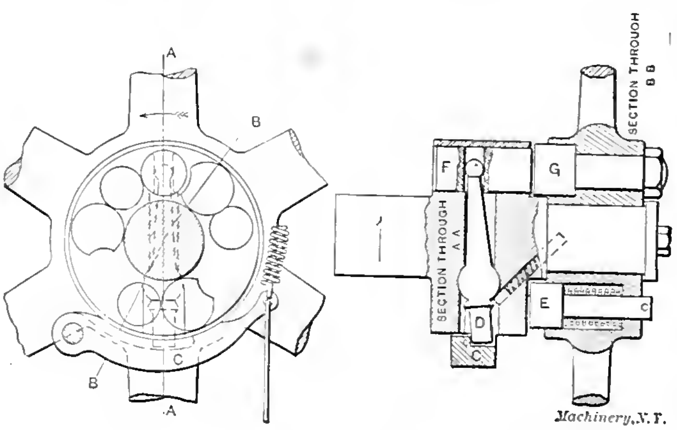


Fig. 6. Ferracute Clutch.

Fig. 8 shows the Horton clutch applied to a punching press. It also shows the tripping levers and automatic safety device which guard against the press making more than one stroke at a time, excepting by tripping the starting lever

for each stroke. To make the press run continuously, the clamp *D* is raised to the top of the vertical rod shown and fastened with a thumb screw. The operation and function of the mechanism is so plain that detailed explanation is unnecessary. The safety device described is only one of many for use in connection with a press and a press clutch and by no means confined to the Horton clutch. The high speed at which small hand operated presses are run makes such a device very desirable for the protection of the operator's hands and fingers. Without it a press will frequently make a second stroke unexpectedly, when the operator is putting in or removing from the dies the piece which has been operated upon, and this is the time when accidents usually happen. Small presses run at a high speed, and fed by hand, especially, should be provided with clutches that will not start the press until the operating lever is tripped.

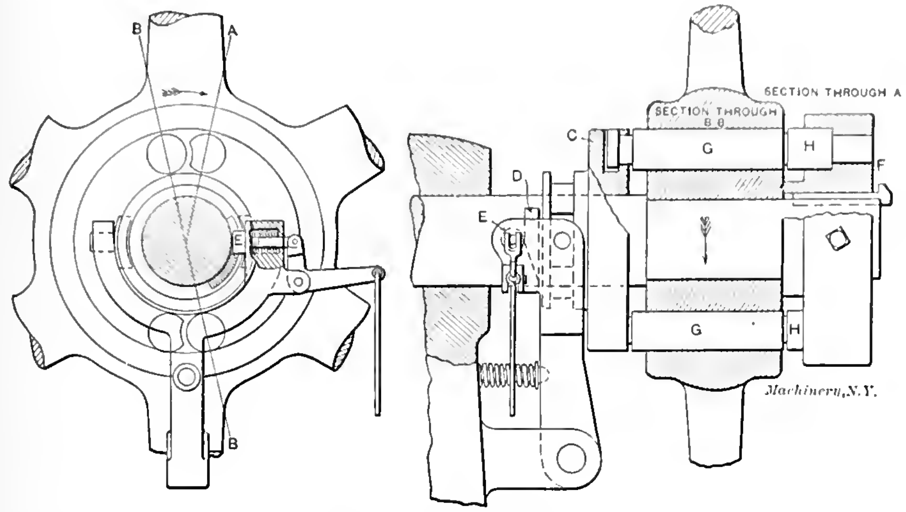


Fig. 7. Mossberg Clutch.

Press clutches must endure exceptional strain and abuse. Often a press with its heavy fly wheel will be brought to a standstill by the operator's placing the work in the die in such a way that the press cannot make the full stroke. With a fly wheel weighing seven or eight hundred pounds and 30 to 40 inches in diameter, the strain on the clutch is enormous; but a clutch that will not stand this abuse occasionally, without breaking, is not considered desirable or practicable. Several of the clutches described are capable of meeting these conditions.

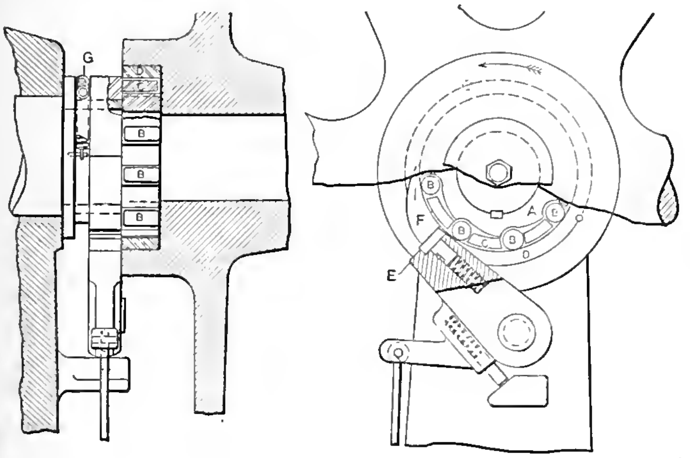


Fig. 9. Design of Horton Clutch.

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Reference was made some time ago in MACHINERY to the trackless trolleys in operation in several places in Europe. Such a trolley line has now been projected from Chattanooga, Tenn., to the top of Walden's Ridge, a distance of about fifteen miles. It is stated in the *Engineering News* that the cars will carry thirty passengers, and each have starting arrangements similar to that of an ordinary automobile.

CALCULATIONS FOR CONE DRIVE AND BACK-GEAR DESIGN.

ALBERT CLEGG [*]

One of the first problems met with in the design of a machine tool is that of determining suitable spindle speeds. In a correct design the various speeds must have a fixed relation to each other, this relation being that of geometrical progression, and the problem is to find the intermediate speeds, the various diameters of the cone steps, and the back-gear ratio, when the slowest and fastest speed and the diameter of one of the cone steps are given. The calculations for finding these speeds are rather lengthy, and the machine designer will no doubt appreciate any method which permits him to save time and work in the laying out of his drive. The table given in the current Supplement will be found to be very valuable for this kind of work. This table gives a number of geometrical progressions ranging from speeds decreasing by 15 per cent to speeds decreasing by 50 per cent.

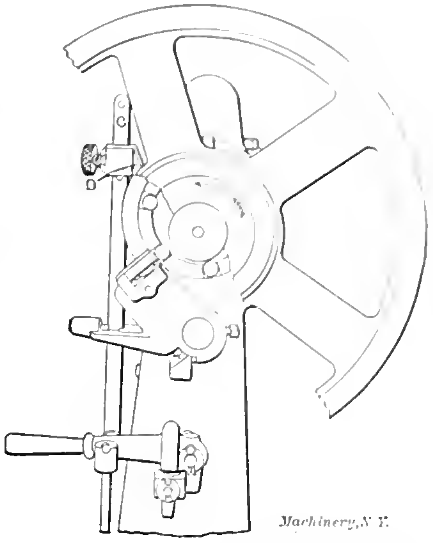

Fig. 8. Horton Clutch applied to Power Press.

The simplest way to describe the advantages of this table will be by a practical example. Assume that the spindle of a lathe requires 18 speed changes, varying from 6 to 250 R. P. M., that the cone has three steps, the largest step being 15 inches in diameter, that the lathe is double back-geared, and that a two-speed counter-shaft is provided. The questions to be answered are then: What are the intermediate speeds between 6 and 250 R. P. M.? What are the diameters of the two remaining cone steps? What are the back-gear ratios? and what should be the counter-shaft speeds?

If we turn to the table given in the Supplement, we will find that the maximum speed in every case is given as 1,000, which, in the case of the lathe we are to design, is four times greater than the maximum speed of the spindle. In order to reduce the figures given in the table to correspond with those of our example, we must divide the speeds given in the table by 4 ($1,000 \div 4 = 250$); our slowest speed, given as 6 R. P. M., will then correspond to a speed given in the table equal to 24 R. P. M. ($24 \div 4 = 6$). It will be seen that 24 and 1,000 are in exactly the same ratio as 6 and 250. The number of spindle speeds being 18, we now follow the horizontal line from the figure 18 in the left-hand column of the table, until we reach the number nearest to 24, this number in this case being 22.5 in the 20 per cent column. The figures in this column, divided by 4, will give us the range of the speeds desired, these speeds being as follows:

250	65.5	17.17
200	52.5	13.7
160	42	11
128	33.5	8.8
102.5	26.75	7.04
82	21.5	5.62

The speed ratio for the first back-gears is obtained by dividing 250, the fastest open belt speed, by 65.5, the fastest first

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back-gear speed and the second back-gear ratio is found by dividing 250 the fastest open belt speed, by 17.17, the fastest second back-gear speed. These two ratios are then found to be 3.82 to 1, and 14.6 to 1, respectively. The counter-shaft speeds will be found to be 200 and 102.5 (the speeds of the middle cone steps), if consecutive spindle speeds are obtained by moving the belt from one step on the cone to another; but if consecutive speeds are obtained by shifting the counter-shaft, then this latter would be required to run at 160 and 128 R. P. M., which would then be the speeds of the middle cone steps. The diameter of the smallest cone step, if consecutive speeds are obtained by changing the counter-shaft speed, will equal $\frac{15 \times 160}{250} = 9.6$ inches. The diameter of the middle step would then be 12.3 inches. It will be seen that the table in the Supplement diminishes the actual work required for calculating geometrical speed progressions to a large extent, and that the various quantities to be settled upon can be determined with very little arithmetical work.

If it be required to lay out a drive with four cone steps instead of three, the calculations for the counter-shaft speeds, of course, become a little more complicated, as there is then no middle cone step, but the use of the table for finding spindle speeds, and back-gear ratios will eliminate a great amount of work even in this case.

* * *

COMPUTATION TABLE FOR REGULAR POLYGONS.

W. L. BENITZ *

The object of the two tables relating to regular polygons, in the Supplement, is to simplify the necessary calculations for any required dimensions of polygons. If the area, or any dimension of a regular polygon of a specified number of sides, is given, all the other dimensions are thereby determined in amount, and the proportion which the known part bears to each of the unknown parts will vary with the number of sides of the polygon. A knowledge of trigonometry is a requisite in determining the required proportions of these parts, and the accompanying tables were prepared not only to facilitate the trigonometrical work, but, at the same time, to simplify the process down to plain multiplication, or, where the area is the given dimension, to the extraction of a square root. The case in which the number of sides is required cannot be directly solved by elementary trigonometry, but is easily found by means of the tables.

Table I in the Supplement gives the symbols by which the various parts are designated, as well as all the necessary formulas needed for any computation. In addition to the symbols indicated at the top of Table I, there appear the letters B, F, M, K, and H, which are calculated in Table II for the proper value of N, the number of sides of the polygon, which heads the first column. These letters represent the following quantities: $F = N \tan \frac{180°}{N}$; $M = 2N \sin \frac{180°}{N}$; $B = \frac{1}{N} \operatorname{cosec} \frac{180°}{N}$; $K = \frac{N}{4} \cot \frac{180°}{N}$; $H = \frac{N}{8} \sin \frac{360°}{N}$. The logarithms of these quantities are given in each succeeding column for convenience in logarithmic calculation. The use of the tables may be partly illustrated by the following simple applications.

Example 1.—What size octagon steel will have a sectional area of 2 square inches?

We know $A = 2$, $N = 8$, and must find d. In Table I and in the column headed A, we run down the column until we find d on the left-hand side of the equation, giving the formula $d = \frac{4\sqrt{AK}}{N}$. The value of K is taken from Table II in the line beginning with $N = 8$, giving us $K = 4.82843$. Substituting these values of A, K, and N in the formula gives:

$$d = \frac{4\sqrt{2 \times 4.82843}}{8} = \frac{\sqrt{9.65686}}{2} = 1.554 \text{ inch, which is the}$$

proper distance across the flats to give a sectional area of 2 square inches.

Example 2.—What is the size of the round bar from which the octagon bar of the preceding example could be milled?

It is now required to find D, with $N = 8$, as before, and $A = 2$, or we may use $d = 1.554$, as already found. If the latter is selected we know d, and selecting the last formula in the column headed d from Table I gives $D = BFd$. B and F are selected as before, but if we use logarithms this time we will take our values from the tabulated logarithms of those quantities, giving us in the line for $N = 8$, Table II, log. $B = \bar{1}.51407$; log. $F = 0.52031$; and log. $1.554 = 0.19145$, from table of logarithms.

Then log. $D =$ log. B + log. F + log. $d = \bar{1}.51407 + 0.52031 + 0.19145 = 0.22583$, and $D = 1.682$ inch.

Example 3.—What is the area of a segment of a circle, 66 inches in diameter, lying between the circumference and one side of an inscribed polygon of 5 sides? The area required, which is similar to the shaded area in the figure of Table I in the Supplement, will be one-fifth of the difference in areas between the circle and the inscribed polygon. Knowing D, we find the area of the polygon from the formula $A = HD^2$, using the value of H for $N = 5$, which is 0.59441. The area of the polygon is then $A = (66)^2\ 0.59441 = 2589.3$ square inches. The area of the circle is $\frac{\pi}{4}(66)^2 = 3421.2$ square inches. Taking one-fifth of the difference we have

$$\text{Area of segment} = \frac{3421.2 - 2589.3}{5} = 166.38 \text{ square inches.}$$

Example 4.—If each side of a polygon is 4 inches long, how many sides must it have to make the area 99 square inches?

In this case both C and A are known and N is to be determined. Selecting the formula for A when C is known, we have $A = KC^2$, and solving for K gives $K = \frac{A}{C^2}$. Substituting the known values of A and C we have $K = \frac{99}{(4)^2} = \frac{99}{16} = 6.1875$. Running down the column headed K in Table II, we find the nearest value to this is 6.18182, which corresponds to the value 9 for N. The figure would then have 9 sides.

These are only a few of the many applications that may be made of the tables, and as indicated by the number of formulas, there may be twenty different problems stated, all of which are taken care of. These formulas and tables are also adapted to the solution of isosceles triangles in which the vertical angle approximates that in column Z, Table II.

* * *

TWO-CYCLE AND FOUR-CYCLE GAS ENGINES.

The growing importance of the gas engine as a motive power for all services makes the application of the terms "two-cycle" and "four-cycle" peculiarly aggravating misnomers. The word "cycle" means a chain of events that follow one after another until completion, when the same chain of events is repeated. In the action of the so-called four-cycle engine, the mixture of atmosphere and combustible gas is drawn into the cylinder by the induction stroke. The next stroke of the piston compresses the mixture of combustible gas and air into the clearance space of the cylinder, where it is exploded by a spark. The next stroke is the power stroke, following which is the stroke which exhausts the spent gases from the cylinder. Following this stroke is the induction stroke again. Thus four strokes of the pistons are required to complete the cycle.

In the two-cycle engine there is the induction stroke and the firing stroke, only two strokes being required to complete the cycle, the exhaust gases being expelled at the same time that a new charge is forced into the cylinder. The particular descriptive terms which apply to the two types of internal combustion motors and which are coming into use to some extent are "two-stroke cycle" and "four-stroke cycle," these terms clearly describing the action of the respective types.

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GRINDING THREADING CHASERS FOR BRASS WORK.

ETHAN VIALL *

From time to time a correspondent will tell of his trouble in obtaining a smooth thread on machine or tool steel when using the self-opening type of die heads; but when a person has been working with tools of this description on brass of varying grades of hardness he comes to the conclusion that dealing with machine or tool steel is what might be called a "soft snap." When the brass worked upon is reasonably uniform, the difficulty of grinding threading dies to suit the work is not so pronounced. But when all kinds of brass, scrap as well as new brass, is used, only long experience will enable a man to sharpen the thread cutting chasers so that they will give satisfaction. Definite rules that will cover all cases cannot be laid down, but a few general principles applying to the grinding of these tools may be of value.

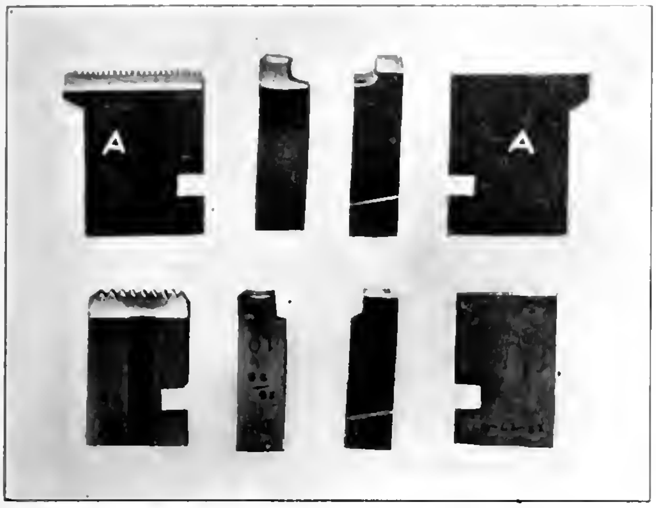
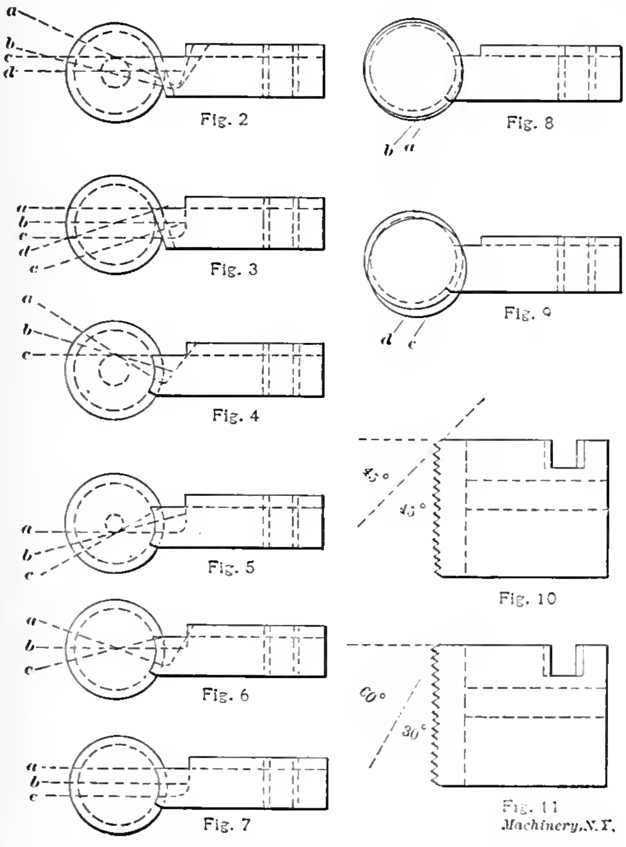


Fig. 1. Threading Die Chasers used for Brass Work.



Figs. 2 to 11. Different Ways of Grinding Rake and Chamfer on Threading Die Chasers.

That difficulties will arise on account of ununiformity in the texture of the brass to be worked upon is, of course, evident. Another difficulty to be contended with is the wear of the die heads. When the die heads are new the chasers are held reasonably solid, but when the heads wear, the chasers become loose and must be ground so that they will not dig into the brass and produce a torn or imperfect thread. In the following the writer will describe the practice of grinding chasers in a certain shop where a great deal of this work is done. All chasers used in this shop are made in the toolroom from Jessop steel, and the threads are cut and relieved on Hendey-Norton lathes. They are then hardened and sent to the grinding room to be sharpened. The first cost of the chasers is higher than that for which they could be bought from firms making a business of die making, but these chasers give better satisfaction than any that could be obtained in the market, and besides, any faults discovered in actual use may be corrected in the next lot, which is not the case when the chasers are purchased.

In making brass chasers it is absolutely necessary that the threads be relieved; otherwise clogging will result. In the class of work just referred to, most of the threads are run up close to a shoulder, and, as a consequence, a very sharp chamfer must be ground on the chasers. It is not good policy to grind the chamfer any oftener than is absolutely necessary, because each grinding of the chamfer will shorten the life of the chasers in those cases where the die cuts close to a shoulder. When chasers show a tendency to break off at the chamfer or to get dull quickly at this place, they may be made with an extension as shown at *A* in Fig. 1. When made in this way the chasers are usually worn out by the time the extensions are ground off flush with the face of the body.

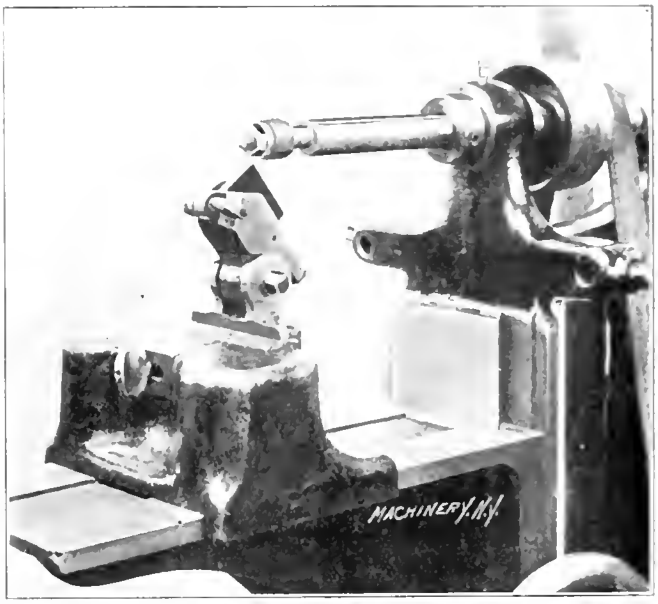


Fig. 12. Grinding the Chamfer on the Chaser.

Referring now to the principle of grinding thread chasers, a number of conditions are shown in Figs. 2 to 11. Our discussion will probably be clearer if for the time being we consider the chasers as lathe tools. In Fig. 2 is shown a chaser with milled threads. This is extremely difficult to use on brass work. When ground as shown at *c* it will dig into the work; when ground down still further as at *d* it still has the same tendency. To grind it as shown at *a* and *b* would produce impossible angles for brass work. In Fig. 3, *a*, *b*, and *c* are the same angles as *c* and *d* in Fig. 2, and *d* and *e* show the teeth ground without rake. When ground as shown at *d*, the cutting edge being on the center line, the tool has still a tendency to dig in. If ground as at *e*, it is obvious that this angle is undesirable. The writer's experience points toward the fact that it is useless to experiment with this kind of chaser on brass work, as it is impossible to grind it so as to be able to use it any great length of time.

Fig. 4 shows a chaser ground to angles advantageous for very hard brass. The angle is so determined that the face of the cutting edge is 1/16 inch ahead of the center at the successive grindings. In Fig. 5 the chaser is ground with a negative rake, the cutting edge being 1-16 below the center. This

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is used occasionally for certain classes of work, such as very soft "greasy" brass. In Fig. 6 is shown a chaser ground in a way to give the best satisfaction for all-around work. The cutting edge is ground so that a line passing through the face also passes through the center of the work. Finally, in Fig. 7 is shown a very poor way to grind a chaser whether for brass or steel, as the angle of the cutting point changes with each successive grinding, and while such a chaser may cut satisfactorily on some work when nearly new, it is not likely to do so after one or two grindings.

In grinding the chamfer on a brass cutting chaser a wheel about the size of, or very slightly larger than, the piece which the chaser is intended to cut, should be used. The relation of the wheel to the chaser when grinding the chamfer is indicated in Figs. 8 and 9. In Fig. 8, *b* represents the stock to be cut, and *a* the emery wheel used for grinding the relief of the chamfer. As will be seen, the center of the emery wheel is a trifle below the center of the stock, and somewhat toward the right. In Fig. 9 is shown the relation when grinding a chaser for hard brass, such as shown in Fig. 4. Extreme care must be taken, in grinding, not to draw the cutting edge or chamfer of the teeth.

In Fig. 10 is indicated the angle at which the chaser should be set in the fixture when grinding the chamfer for a uniform run of thread cutting. Fig. 11 gives a little more bevel or angle of chamfer. As a general rule, except for the very hardest brass, as little relief as possible back of the cutting edge of the chamfer should be used, as it steadies the chasers when starting the thread. It is of advantage when grinding new chasers to set the chaser well over to the left of the wheel, using a fixture such as shown in Fig. 12, and just touch the edge of the chamfer furthest away from the cutting edge, with the wheel; then gradually move the wheel over until there is a slight relief all the way up to the cutting edge. A fixture or jig used for grinding the faces of chasers is shown in Fig. 13. Both of these fixtures are made by an outside company (The Modern Tool Co., Erie., Pa.) especially for this purpose. It is necessary to use some kind of a fixture, as it is impossible to get good results when chasers are ground by hand.

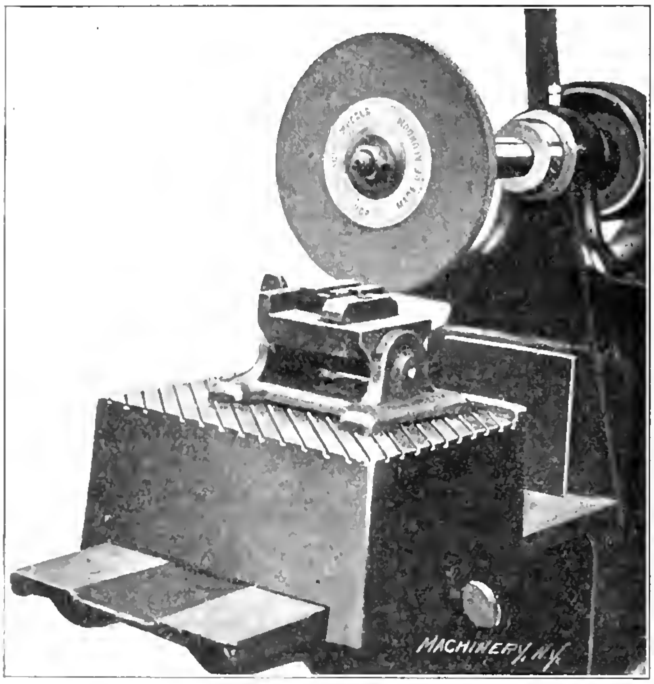
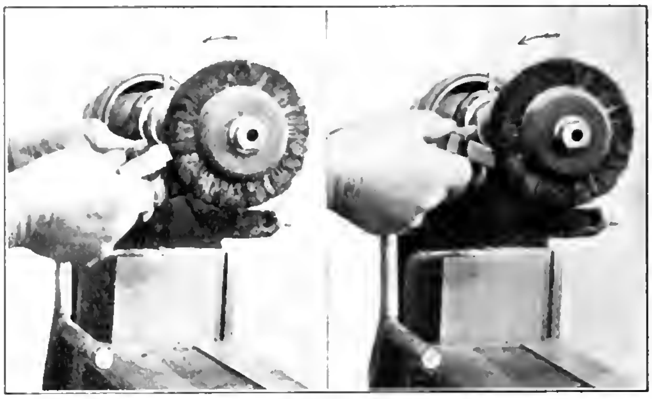


Fig. 13. Grinding the Cutting Edge of the Chaser.

Alundum wheels of rather fine grade and known as elastic bond, have given better satisfaction for grinding chasers than any other wheels, but no matter what wheel is used there is a fin left on the cutting edges of the tool, which is a source of trouble if not removed. Lapping in various ways was tried for removing this fin, but the most satisfactory, as well as the quickest way, is to use a very fine three-cornered file and just draw it lightly down each V-groove of the thread at an angle of about 45 degrees, not pressing hard enough to more than take away the fin and slightly dull the cutting edge. An oil stone should then be run lightly over the edge of the chamfer to dull it just enough, so that it is not entirely sharp. The chaser threads are then dipped in a little flour of emery and oil, and brought up against a wire brush, as shown in Fig. 14. They are then turned over and brought up against the wire brush as shown in Fig. 15. This should be done very lightly, and has the effect of smoothing the edges the right amount. A little practice soon enables one to determine the proper amount for this. The wire brush is 6 inches in diameter, made of fine wire, and runs 3,400 revolutions per minute.

As a rule, a brass cutting chaser will chatter when too sharp. When the thread cut becomes torn, it is evidence that the chasers are dull, or that they feed too fast. Burrs in the thread tend to have the same effect as increasing the pitch in many cases. Chasers generally tend to feed too fast rather than too slow, and the remedy is the judicious removal of burrs or dulling of the cutting edges, provided, of course, that the teeth are already ground to the right cutting angle. When a set of chasers feed too slow the cause is usually that there is not enough clearance back of the cutting edges of the chamfer. Whether chasers feed too fast or too slow is easily determined by examining the thread cut. If the side of the thread next to the turret is smooth, and the side next to the chuck is torn or ragged, the chasers feed too fast, and vice versa.



Figs. 14 and 15. Revolving Wire Brushes which smooth the Cutting Edges of the Chaser.

* * *

At the October 13 meeting of the gas power section of the American Society of Mechanical Engineers in New York, a plan of action was presented in a paper by Mr. H. L. Doherty. It briefly reviewed the subject of gas power and pointed out some of the fields of activity that are now in embryonic state. He warned the members of the section in regard to unpromising fields and unnecessary duplication of work. Much duplicate work could be avoided if the present state of the gas power art could be quickly brought before the membership and provision made whereby all progress in the state of the art would be quickly reported. As an example of an unpromising field of experiment and invention, Mr. Doherty quoted the so-called gas turbine as distinguished from the mixed turbine, that is, a turbine using both gas and steam. To construct an actual gas turbine on ordinary lines requires the transformation of heat energy to work energy at a temperature and blade velocity beyond the strength of any material now known. In spite of this fact, however, thousands of dollars have been wasted in the vain attempt to solve the problem.

* * *

The general development of the gas engine has taken little account of the heat of the exhaust, the exhaust generally being allowed to go to waste. However, there is a growing disposition now to utilize the exhaust heat for water heating and steam generation. Experiments made abroad indicate that the heat of the exhaust will evaporate from 1.1 to about 1.5 pound of steam per horse-power per hour, or it will raise from 600 to 820 pounds of water from 32 degrees F. to the boiling point. The value of this heat from a large gas engine is apparent.

A PROPELLER PLANING MACHINE.

NOSMOT.

The accompanying half-tones and line engraving illustrate a machine designed to dispense with considerable hand labor in the finishing of large propeller blades. Up to the time that this machine was put in operation, all blades were finished by chipping, grinding with a flexible shaft grinder, scraping and filing, and the time consumed was considerable. The blades were not uniform when thus finished, and consequently did not balance when under pressure.

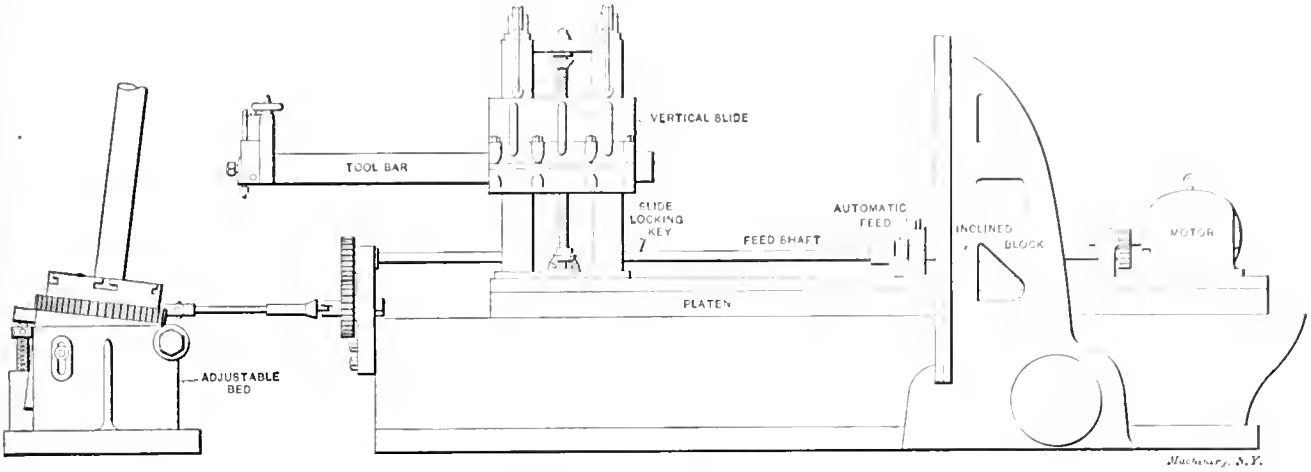


Fig. 1. General Arrangement of Propeller Planing Machine.

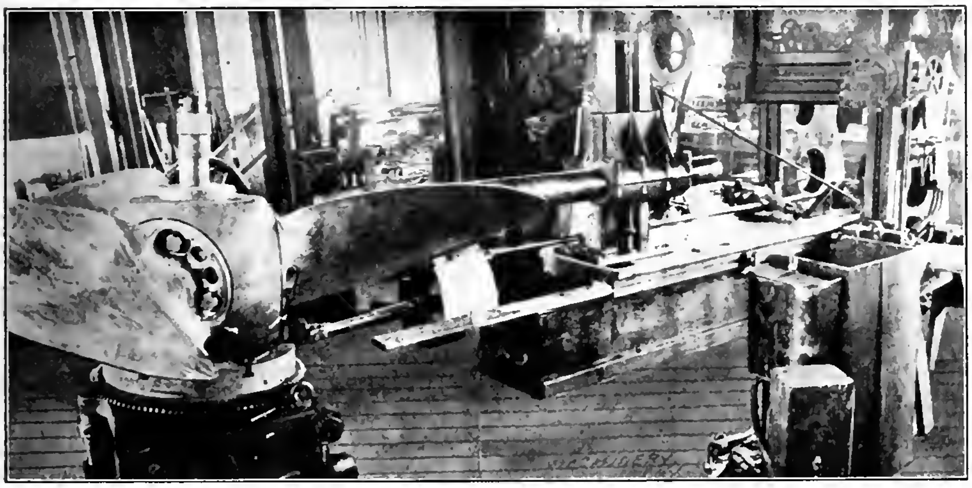


Fig. 2. Propeller Planing Machine in Operation.

The propellers are now cast, the hub bored, and, in the case of the one shown on the machine in Fig. 2, the blades are fitted to the body. The body in this case is finished on the boring mill with the exception of the screw holes, which are drilled and tapped in the radial drill. The blades are tested on the surface plate and the pitch line marked. The shanks are also laid off and prick punched around, after which they are centered in the horizontal boring mill and finished in the lathe.

The blades and body are assembled on the erecting floor and then placed in position on the planing machine. This machine, as shown in Fig. 1, consists of a regular planer on the platen of which is bolted an upright carrying a slide. The tool-carrying bar is fitted into this slide, the vertical movement of which is governed by the lead-screw shown. The slide is balanced by weights at the back of the upright, for the purpose of taking the strain from the screw. A motor driving the feed shaft is also bolted to the platen and used for quickly running the tool either way over the work. A ratchet and pawl arm carrying a roller is bolted onto one of the housings and this, in conjunction with the inclined plane block shown gives an automatic feed. Bevel gearing between the feed shaft and vertical slide screw gives the up and down movement of the tool, at the same time as the propeller is revolved by means of the worm and worm-wheel driven by gearing from the feed shaft. The revolving table is set upon an adjustable bed for the purpose of lining up the tool and its motion to the shape of the propeller and its angular deflection.

The propeller is firmly clamped to the table in such a position that the center of one blade is in line with the tool bar. A key locking the feed shaft to the slide screw is pulled out, and the tool is brought nearly to the surface of the blade. The locking key is then driven in, and the tool passed over the blade. The tool is tried in several positions by a small movement of the planer platen for each, and the adjustable bed inclined until the movement is about in line with the casting. The tool is then moved close to the propeller body and a slot planed around the hub for clearance for the tool, by passing the tool over the blade by the feed motion, the propeller meanwhile rotating; during this the platen remains stationary. When this slot has been cut to a sufficient depth—about $\frac{1}{8}$ inch to $\frac{1}{4}$ inch deep—the tool is raised to its highest point, ready for operation.

The platen movement is governed in the regular way by stops. It is set in motion, and the tool brought to its cut by the feed shaft motor. The inclined block is set in such a position that the roller will move one or two teeth on the ratchet as desired. All small adjustments are made with the hand-wheel shown on the tool head. Usually two cuts are necessary to finish a blade. The gearing is so arranged that the tool moves down a corresponding distance when the propeller blade rotates around its center. After finishing the first blade, the slide locking key is removed and

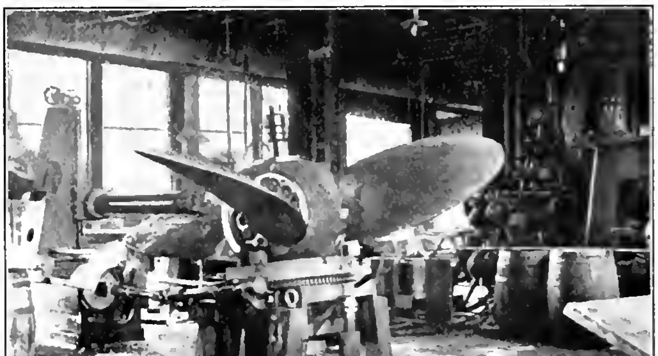


Fig. 3. Propeller Mounted on the Revolving Table.

the propeller revolved by motor into position, after which the operations previously described are carried out.

When finishing the blades, the propeller is carried to the erecting floor, where hand labor is employed to scrape and file-finish the surfaces. As the back is not planed, it takes some time to smooth it, but the face requires very little attention. Ordinary scrapers and bent files are used. Propellers made by this method have been tested and found far superior to those made by any other method known to the writer.

* * *

MACHINING FLY-WHEELS FOR GASOLINE ENGINES ON THE POND RIGID TURRET LATHE.

In the July, 1908, issue of MACHINERY we described and illustrated the operation of finishing automobile fly-wheels on a Libby turret lathe. In the present article a similar class of work is dealt with, the illustrations showing how fly-wheels for gasoline engines are finished all over on a Pond rigid turret lathe. Operations of this kind can be carried out easily on this machine also on account of its construction, which permits the carriage to be run under the chuck, so that wide facing tools may be bolted directly to the broad faces of the turret, thereby making a stiffer arrangement of tools than would otherwise be possible.

The work is finished in two cycles of operations, in the first of which the fly-wheel is turned complete on one side, the hole bored and reamed, and the outside circumference finished; in the second cycle the other side of the fly-wheel is completed. During the first operation, the work is held by the inside of the rim by means of a four-jaw chuck, using the hard jaws. The side of the rim, the tapering circumference of the recess, the web, and the hub are first rough-turned, using tools placed in the carriage tool-post.

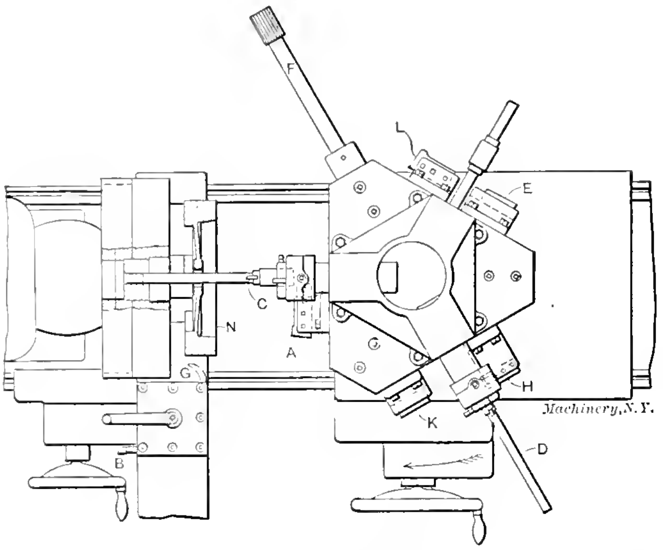


Fig. 1. First Cycle of Operations in Finishing Gasoline Engine Fly-wheels on a Pond Turret Lathe.

The hole is then rough-bored, using the bar *C*, supported in a bushing in the chuck, as shown in Fig. 1. The outside circumference of the wheel is rough-turned at the same time by a cutter, held in the extension turret tool-holder *T*, Fig. 3, and the taper fit on the inside of the fly-wheel is turned by means of cutter *A*, held in a facing head on the turret.

The outside diameter of the wheel is next finish-turned with a finish cutter *V* held in the same manner as the roughing tool for the same operation, in the extension turret tool-holder. At the same time the bore is finished, using a finish boring cutter in boring-bar *D*, supported in the bushing in the chuck in the same manner as the roughing bar *C*. The side of the rim and the hub of the wheel are also finished at this time by two facing cutters *H* and *K*, held in tool-holders on the face of the turret. When the finish cuts on the rim and hub are taken, the work is supported by a bushing on the boring-bar in the bore of the wheel, the boring cutter and facing tools being set in such relation to each other that the finishing boring of the hole is completed before the facing cuts are taken.

The web of the wheel is next finish-faced with the facing cutter held in the holder *E*, and the taper surface on the inside of the rim is finished by the tool *L* at the same time. While these last operations are performed, the work is supported by a bushing held on a supporting arbor, entering the bore of the wheel. In the next step, the bore is reamed, using a reamer held in a floating reamer-holder as shown at *F*. When the reaming operation is completed, a groove *N* is cut on the inside of the rim, using a tool *G* held in the carriage tool-post, as shown. The first cycle of operations on the fly-wheel is now completed.

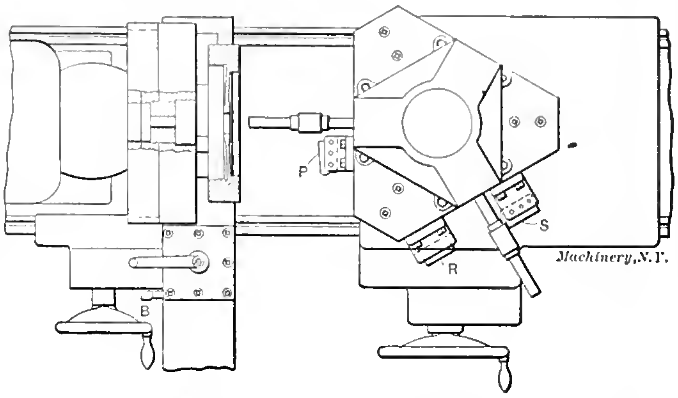


Fig. 2. Second Cycle of Operations.

The fly-wheel is then removed from the chuck, turned around, and held in soft jaws for the second cycle of operations, the jaws fitting the outside circumference of the wheel. The operations on this side are very similar to those performed on the other side, excepting that they are fewer, and therefore less complicated. In the first place, the side face and the inside of the rim, the web, and hub are rough-turned, using tools held in the carriage tool-post. In the next place, the inside of the rim and the web are finished, using the cutters held in the tool-holder *P*, Fig. 2, screwed to the face of the turret. The work is supported during this operation by a bushing held on a supporting arbor, having a pilot supported in a bushing in the chuck, the same as already referred to in the first cycle of operations. Finally the rim and hub are finished, the facing cutters held in the facing heads *R* and *S* being used, the work being supported as before.

The time required for performing these operations is about one hour. It should be noted that the design of the turret lathe permits several cuts to be taken on different parts of the work, simultaneously, thereby saving a great amount of time. While these operations are simple, they illustrate in a very practical manner the advanced labor-saving methods employed in automobile factories, and in other shops where large numbers of gasoline engines are built, and also how the cost reduction of machining the fly-wheels has been given special attention.

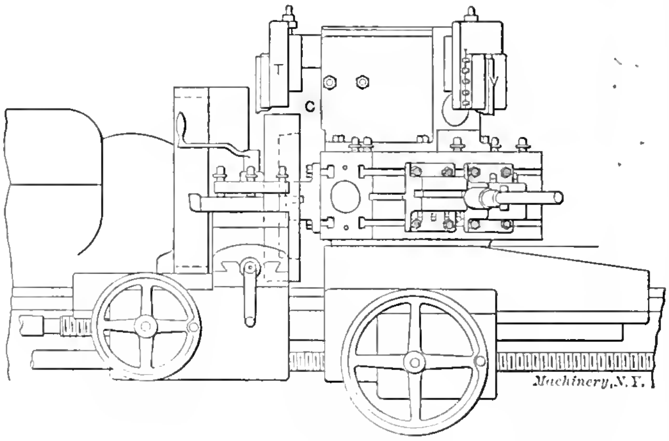


Fig. 3. Elevation of Turret and Tools for Finishing Fly-wheels, First Operation.

* * *

Use a keen knife to sharpen lead pencils. The tensile strength of the graphite core is very low, and a dull blade breaks it by pulling it in two, thus causing excessive waste of pencils.

SOME INTERESTING AUTOMATIC SCREW MACHINE WORK.

The automatic screw machine has, during the last few years, proved itself capable of performing a great many operations which but a short time ago were considered as properly belonging to the province of the engine lathe. This is true not only with regard to the size of the work operated upon, but also in regard to the number of operations, and the complication of the design of the piece of work to be machined.

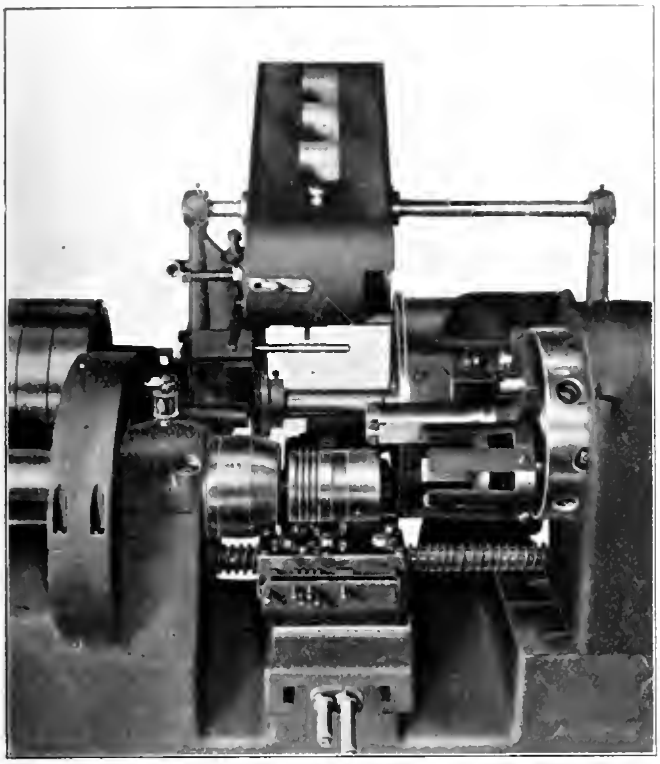


Fig. 1. Cleveland Automatic Screw Machine operating on Piston shown in Fig. 2.

In the present article some interesting work of this class performed on a Cleveland automatic screw machine, manufactured by the Cleveland Automatic Machine Co., Cleveland, O., is illustrated.

In Fig. 2 is shown a section and end view of a piston finished on a Cleveland 2-inch automatic machine in but a small fraction of the time which would be required to turn and bore the same piece by any other method. This piston is made from cast iron, and is finished on the various surfaces, as indicated by the finishing marks in the engraving, in eight minutes, after which, of course, it is ground on the outside. Two cuts are taken over the entire length of the piston, one for roughing and one for finishing. A forming tool on the front of the cross-slide faces the ends of the piston proper, and roughs out the grooves shown on the cylindrical surface. Then a forming tool on the rear of a cross-slide finishes the grooves in the ring; it has been found that one single roughing cut does not leave them quite smooth enough for the purpose for which they are intended.

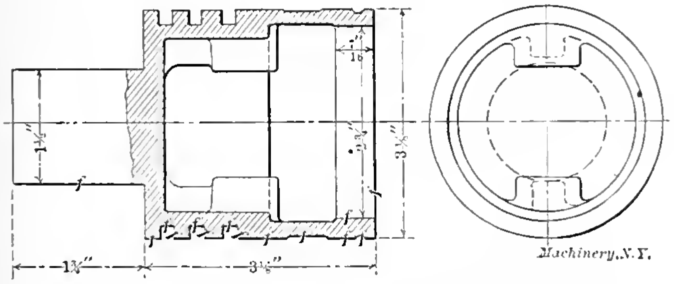


Fig. 2. Piston finished on a Cleveland 2-inch Automatic Screw Machine.

In Fig. 1 part of the machine on which these operations are performed, is shown, together with the tools employed, and with the work in place. It will be noticed that the machine is provided with a tilting magazine attachment, into which the rough castings are fed, and from which the machine receives the castings automatically as the work progresses. If the cast iron from which these pistons are made is not too hard, it has been found that it is not necessary to grind the tools employed any oftener than once every two days. It is of the greatest interest to note the extreme cheapness of cost of producing work in a machine of this kind. It is estimated that the operating expense for the machine is only one mill a minute, so that the piston shown being finished as it is in eight minutes, is produced at an actual labor cost of only 8 mills, or 0.8 cent. Of course, this means that the operator runs a considerable number of machines, which he can easily do, inasmuch as the machine, when properly set, requires very little attention.

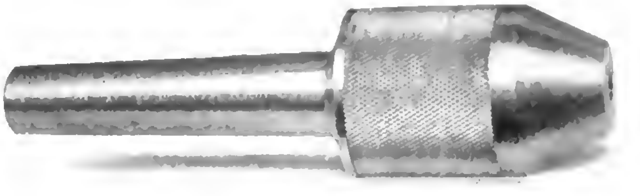


Fig. 3. Chuck shown in Detail in Fig 4, finished in 40 1-2 minutes

In Fig. 3 is shown another interesting article produced on a 4¼-inch Cleveland automatic screw machine, and which, as will be seen, is to be a drill chuck when completed. The parts of this drill chuck which are made in the screw machine, are shown in detail in Fig. 4. The work consists of four pieces: a shank or stem, a nut, a collar, and the chuck proper, all produced in the screw machine in 40½ minutes These pieces are all made from machine steel and are therefore finished all over. While this work was performed on a 4¼-inch machine, it would have been even better to employ a 3¼-inch screw machine, but in the present case the machine was to be employed for work of larger sizes as well, and therefore a large size machine was fitted up so as to be able to perform operations on smaller work also. It will be noted that the diameter of the stem is very small, considering the size of the machine, and it was required to arrange the machine so that it would give the correct speeds for small diameters as well as for large ones. Considering the time used in finishing the piston, as already stated, it will be seen that the actual labor cost is only 4 cents, and that if allowance is made for the time required for changing over from one class of work to another, after a number of pieces of one kind have been made, the total labor cost of the four parts would still be less than 5 cents.

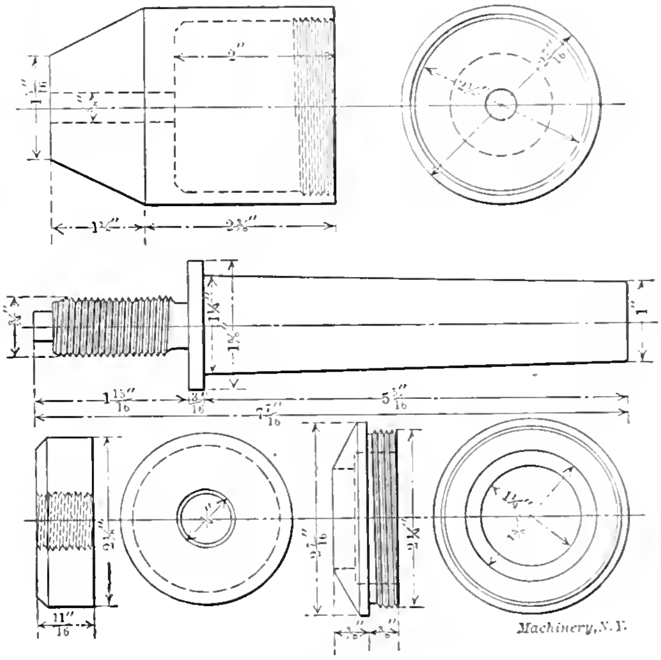


Fig. 4. Details of Chuck in Fig 3.

One of the most interesting operations in connection with the making of the chuck shown is the making of the stem. This, of course, must be made with the threaded end headed

out, and, [illegible] mean that it is not possible to produce the tapered part with tools placed in the turret. The taper end, therefore, is produced with a forming tool in the cross-slide, taking a cut the full length of the shank, which is over 5 inches, the steady-rest supporting with rollers the end of the bar on the part on which the thread is to be cut.

Fig. 5. Forming-tool Chips resulting from turning Shank of Chuck in Fig. 3.

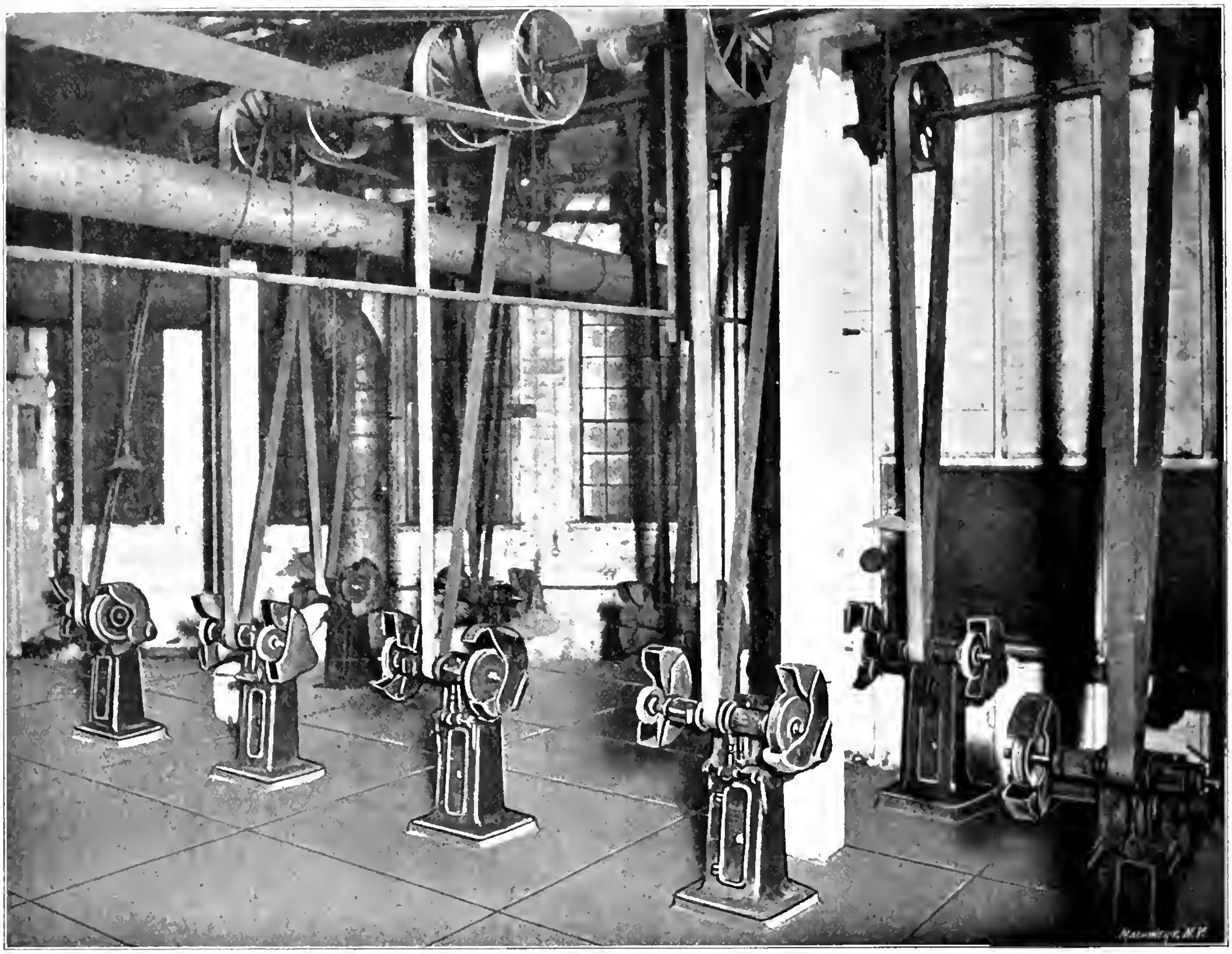
Chips have been removed from the tapered shank, the full width of the piece, and 20 inches long, without breaking. In Fig. 5 a photograph of one of these chips is shown. The possibility of obtaining such long chips, without breaking, indicates that in spite of the width of the forming tool, the cut is very steady, as otherwise the chips would break off as soon as they were removed from the piece.

The illustrations shown give a general idea of the possibilities of the large size automatic screw machine. It is interesting to speculate upon how long it would take even an expert mechanic to turn up the different pieces shown in Fig. 4 on an engine lathe, boring and threading them as indicated, and finishing them with the same accuracy that an automatic screw machine is capable of. When this time is compared with the time taken by the screw machine for performing the same operations, we have a good example of the labor-saving qualities embodied in modern automatic machine tools.

THE POLISHING ROOM OF THE FOX MACHINE CO.

The polishing room of the Fox Machine Co. is notable for its neatness and convenient arrangement. As may be seen in Fig. 1, this is quite largely due to the fact that the polishing stands are equipped with an exhaust system which is laid beneath the floor of the room, so that the ceiling and floor are not encumbered by unsightly pipes. It will be noticed, also, that there are no counter-shafts, the design of the machine used (see department of "New Machinery and Tools" for this month) permitting the spindles to be started and stopped without the use of clutches or tight and loose pulleys.

There are, in this room, ten double-end Fox polishing machines in position, with space for ten more. They are arranged in two rows of five each, all facing the same direction. The polishing department is a one-story building connected to the machine shop on one side and the rough store department on the other, so that the natural flow of the material to be treated passes through it. The plating department is also connected with it on one side. The building has windows on three sides and is also lighted by four large skylights directly over the machines, providing an abundance of light. The building has a cement floor in which the proper provisions have been made for installing additional machines as they are required.



The Polishing Room of the Fox Machine Co., which is equipped with an Exhaust System laid beneath the Floor.

As stated, the exhaust system is laid beneath the floor of the room. The dust is drawn into the column of the machine and thence into an opening in the cement floor, through ducts leading to the main header, indicated at the top of the diagram in Fig. 2. The ducts are made of galvanized steel and are entirely surrounded with concrete, so that even though the steel should rust out, the duct will still be complete. These run directly under each line of machines. The main header tapers from 18 inches in diameter at the end, to 30 inches diameter at the outlet. It is provided with a manhole at one

end, and at the other it leads into the upright exhaust pipe seen in the background of Fig. 1, connecting with a 40-inch exhaust fan.

The power for driving this lot of ten machines is taken from a 15 horse-power motor. The line of shafting runs over each row of machines and is belted direct to them without the use of counter-shafts. The amount of power consumed is small, especially when it is considered that most of these machines employ two men at a time. The use of roller bearings in the machines and in the line shafting will account largely for the small power consumption, which is sufficient for running all of the machines at their full capacity. This means not only a direct saving in the cost of the current, but also in the maintenance expense.

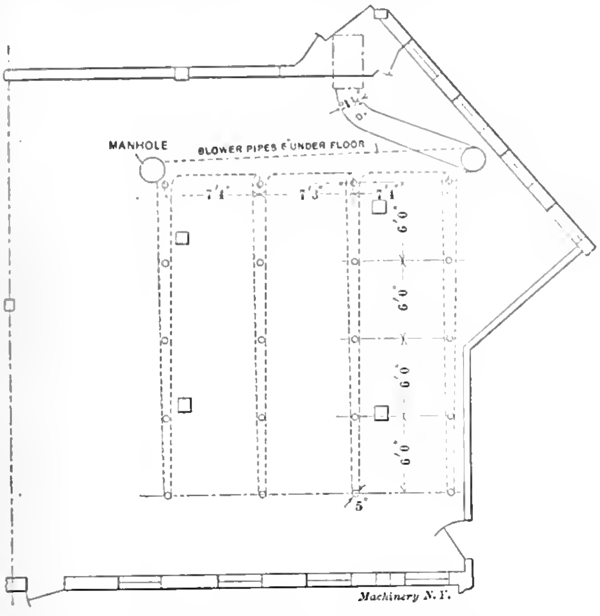


Fig. 2. Plan of the Fox Machine Co.'s Polishing Room.

Polishing rooms such as this present a marked and agreeable contrast with the unsightly and unhealthy conditions which existed almost universally in such work ten or fifteen years ago, and which have not by any means been yet entirely done away with.

* * *

An electric light plant in Rue Saint Roch, Paris, was built with its foundation and the facade of heavy masonry continuous with the walls of an adjacent house, the division walls being separate. The vibrations of the engines and dynamos so affected the adjacent property that the tenants were unable to sleep nights, and it became imperative to separate the foundation of the power plant from the tenement building so as to reduce the tremors. The company's engineer, Mr. Friese, conceived the idea of sawing the building foundations and facade apart. This was done with thin wire rope and wet sand. An elaborate frame-work was erected upon the sidewalk, having pulleys and counter-balancing weights and a traveling electric motor. A well was dug to receive the water and sand, and a horizontal hole was bored at the top of each pier of the foundation. A continuous steel rope was threaded through these holes and then carried back over the building to the motor and machinery on the sidewalk. The operation was successful, the foundation being cut at the rate of three or four inches per hour. After the cut had been carried clear down to the bottom, a second cut was made two inches from the first, thus leaving an isolated section which was easy to break down and clear away. A rope lasted about twenty hours. The facade was cut away in the same manner without interruption of the power plant or damage to the buildings.

* * *

Roller back rests are successfully used in turret lathe practice. They offer a minimum resistance to rotation of the work and polish it, giving the surface a smoothness and density not possible to secure with a cutting tool. These rollers have to be made very carefully, having to be hardened and accurately ground on the exterior and in the bore.

MACHINE SHOP PRACTICE.*

BORING AND PLANING CORLISS ENGINE CYLINDERS

M. B. STAUFFER†

The Corliss engine cylinder is a difficult piece to cast correctly, and have it free from defects in regard to soundness, etc., and the inexperienced man will often have difficulty in securing satisfactory results. The writer was connected with a firm which subjected all cylinders to a hydraulic test before any machine work was done on them. The cylinders were not made in this firm's foundry, and when the first ones were received from the independent foundry, they were machined in the usual manner, but on the testing block they showed leaks. The firm not being desirous of patching them and sending out defective castings, had to reject them. After this experience the hydraulic test was made. To close the cylinder for testing, strong wooden heads can be made to bolt or clamp over the openings, suitable packing being used on the joints to make them tight.

On the Shop Operation Sheet accompanying this issue, the method of boring a Corliss engine cylinder is given. The various steps in this operation are there described as applied to a regular Corliss engine cylinder boring machine, which is, of course, best adapted to the work. Such a machine, however, may not be available, and, therefore, it will not be out of order to give another method of doing this work.

If a vertical boring mill, having sufficient vertical tool travel, is at hand, the cylinder may be bored on this type of machine. The casting is set on the table of the mill and is trued by the periphery of the flanges on each end. The end resting on the table of the machine can be set by the concentric circles on the table. Both ends must run true, and the cylinder must be securely clamped, because the tools are to work at a considerable distance from the table, which gives a great leverage against the clamps. All the work that can be performed on this end of the cylinder may now be done, including the boring, counter-boring, and facing of the flange. The cylinder is then inverted, and it may be centered on the table with a special centering plate which fits into the finished counter-bore and which has a projection fitting into the hole in the spindle, which sets the plate concentric with the table. The counter-boring on the opposite end may now be done and the flange faced.

The port faces or seats for the bonnets may also be trued up on the mill, but if a double or four-head planer is available, it will be found more economical to plane these faces, and also the steam and exhaust flanges. In planing the port faces, the cylinder must be so set on the platen that its center will be level or parallel with it. If the casting is true to the pattern, it may rest on the rough port faces, though, of course, it will be necessary to test the other parts before it is machined, so as to make sure that there is sufficient stock to finish to all required dimensions. If the planer is provided with side heads, the flanges for the steam and exhaust pipes may be faced at the same time that the port faces are being planed.

The next operation to be performed is boring the valve ports. The finish lines for the holes may now be laid out with reference to the center line and crank end of the cylinder. In this case it will be necessary to lay out lines on each end of the ports. The holes which are to be drilled for the bonnets and the back caps should also be laid out. These holes should be drilled and tapped; then the ports are ready to be bored. A boring outfit which is commonly used, consists of a suitable bar for carrying and guiding the cutter; a lead-screw for feeding the bar, which extends to the end of the bar and usually has a star feed arrangement to actuate it; and two bonnets, with adjustable brass bushings, to act as bearings for the bar. These bonnets are fastened on the ends of the ports by studs inserted in the holes which were previously drilled and tapped. The stud holes in the bonnets are extra large to allow for the necessary adjustment. After the bar has been accurately centered with the lines previously laid out, the bonnets are securely fastened in place, and the

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* With Shop Operation Sheet Supplement.

† Address: Scottdale, Pa.

first cut started. The tool should have a square cutting face as the bar must necessarily be light and if the cutting edges of the tool are beveled to any appreciable extent, the bar will be deflected by the pressure of the cut. It is, however, essential that the corners of the cutting tool be slightly rounded, or they will soon be worn away. When the hole has been rough-bored, it should be carefully examined to see that the edges of the steam ports are perfectly sound and trued up properly. This can be done by having a light held at one end of the hole while inspecting the work from the opposite end. If the construction of the boring bar is such as to permit its removal without disturbing the setting, this should be done and the edges of the port slightly beveled with a file inserted in an extra long handle. This is desirable because it prevents the finishing cutters from coming in contact with any scale. The port may now be finish-bored, and if the bar is well constructed and the work carefully done the ports will not require subsequent fitting or scraping. After all the ports are finished, the cylinder may be drilled for the frame, head, and wrist plate stud if the cylinder is of the wrist-plate type. The drilling and tapping for the indicator pipes should also be done, after which the cylinder may be sent to the erecting floor for fitting and testing.

* * *

HOW A BIG BOILER STACK WAS ERECTED.

The improvements to the plant of the Crecker-Wheeler Company, of Ampere, New Jersey, manufacturers of electrical machinery, have reached the stage where work is being started on the new power house, which, when completed, will have a capacity of 4,800 boiler horse-power. This entire capacity will not be installed at once, and to furnish draft for the boilers temporarily, until the complete plant is installed, the company has just erected a steel stack, 72 inches in diameter and 105 feet high, having a total height of 125 feet when on the foundation.

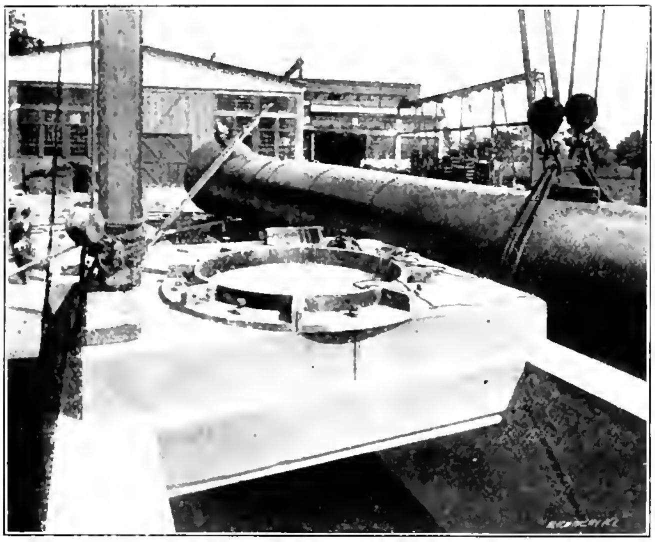


Fig. 1. Steel Stack 72 Inches in Diameter and 105 Feet Long, which was hoisted into Position in One Piece.

The engraving, Fig. 1, shows the stack lying alongside the concrete foundation; Fig. 2 illustrates the method of lifting, while Fig. 3 shows it in place. As will be seen, two large gin-poles were first erected, one on either side of the foundation, and supportd by steel stays leading from their tops to various anchorages. To the top of each pole powerful tackle was attached which was connected to a hoisting engine. The stack was first lifted in a horizontal position onto its foundation, after which the gin pole on the side of the foundation formerly occupied by the stack, was moved in as close as possible, so as to obtain a more nearly vertical pull on the poles. The tackle was then attached to the stack at a point slightly above the center of gravity and it was slowly lifted high enough to permit the bottom to clear the foundation. To facilitate the hoisting and at the same time prevent the bottom of the stack from being injured, it was supported upon a platform mounted on rollers as shown in Fig. 2.

This stack will supply natural draft to 800 H.P. water tube boilers (burning No. 2 buckwheat coal) with an ultimate capacity under artificial draft of 1,600 H.P. The boilers are of the modern high-pressure water tube type for generating steam at 200 pounds pressure. The furnaces of the boilers are each 9 feet 8 inches wide by 10 feet deep. The breeching connection between the stack and the boilers is 6 feet wide and increases in height as it reaches the stack to provide for future installation of boilers. The breeching is built of the arched top and bottom plate construction to make it self supporting. The weight of the stack and breeching is approximately 18 to 20 tons, and the stack was hoisted into position in one piece, which attests to the progress of engineering construction, as this would have been impossible a few years ago. The present stack is to be used temporarily until further development of the plant, at which time it is contemplated to erect permanent brick chimneys. For that reason it is located at present in position to provide for future development until the last boiler installation is made, and is erected on one of the future boiler setting foundations. The connection to the foundation is provided by means of a cast iron sectional annular ring which is bolted to the foundation and also to the stack. The stack was designed and erected by the engineering construction office of Mr. Walter Kidde, New York City, and was built by the Dover Boiler Works, Dover, N. J.

Fig. 2. View showing the Method of lifting the Stack.

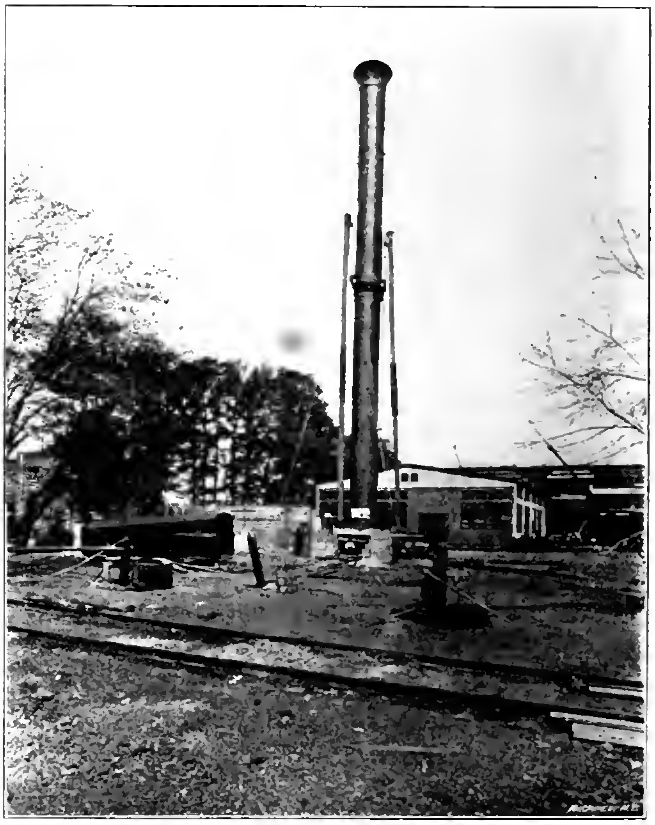


Fig. 3. The Stack after Erection.

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

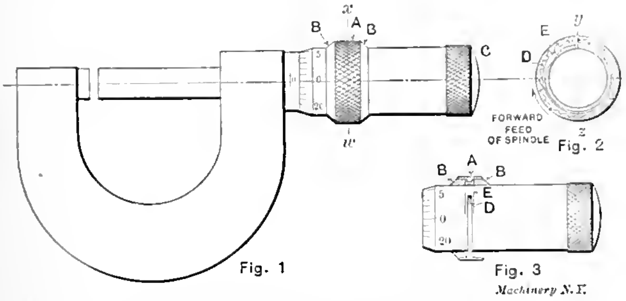
MICROMETER RATCHET STOP.

The accompanying illustration shows an improved form of ratchet stop or sensitive feed which I am using on my micrometer. It is more conveniently located than the ordinary form at the end of the spindle, so that it can be operated by the fingers of the hand that holds the micrometer, leaving the other free to hold the work being measured. This cannot be done with the ordinary stop, and, consequently, as careful inquiry has shown, a very small percentage of micrometer users ever make any use of this feature, an extremely desirable one, particularly in these days when the micrometer is no longer confined to the tool-maker, but is being introduced so largely into the machine shop and into the hands of less skilled workers. With many of these, unless the ratchet stop is used, the micrometer is very likely to be unduly strained, and the measurement taken will be incorrect; this will not occur with the form here shown, since as the micrometer is usually held in the right hand, the thumb and finger will naturally grasp the knurled operating ring *A*, Fig. 1.

Fig. 2 shows a section of the sleeve or thimble *C*, and ring *A*, on line *x-w*, with the spring or spring pawl *D* between them; and Fig. 3 is a section, on line *y-z*, of ring *A* and the retaining collars *B*, which latter are made a light force fit on the thimble. As will be seen in Fig. 2, one end of spring *D* is bent inward and held in a hole drilled in the thimble. The other end of the spring, which, as will be noted, nearly encircles the thimble, is bent outward and engages the teeth cut on the internal rib of operating ring *A*. In use, when the spindle is fed down on the work, continued turning of *A* causes the teeth to depress the free end of *D* into the recess *E* cut in the thimble, thus allowing the latter to remain stationary; reversal of the motion of *A* obviously causes positive engagement between ring and thimble, through spring pawl *D*, and consequent withdrawal of the spindle. An additional feature of value is that this form can be applied equally as well to the other forms of the micrometer, depth gages, etc., for which no ratchet stop has hitherto been available. Its satisfactory working in daily use for several years is sufficient proof that it is a good thing. I may add that the improvement is patented.

C. W. PITMAN.

Philadelphia, Pa.



Figs. 1, 2 and 3. Improved Form of Ratchet Stop which can be Operated by the Fingers of the Hand holding the Micrometer.

PROGRESSIVE PUNCH AND DIE.

In the engraving (Fig. 2) is shown a punch and die for making a complete piece such as shown unblanked at *A* in Fig. 1, at every stroke of the press. The strip is put into the die up to the first former, and at the first trip of the press two holes *B*, are pierced. These holes are then placed over the countersink punches *C* in the former and, at the second tripping of the press the plate is formed and the center hole pierced by punch *D*, and a second pair of holes pierced. The strip is again shifted, bringing the second pair of holes over the countersink punches and the formed part in the strip over the blanking die *E*. At the next stroke the formed part is blanked out, and at the same time a new part is formed and other holes pierced; this is continued until the strip is run through.

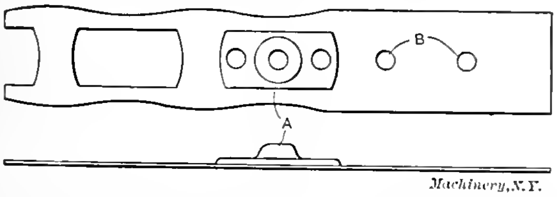


Fig. 1. Appearance of the Stock from which Plates A are Blanked

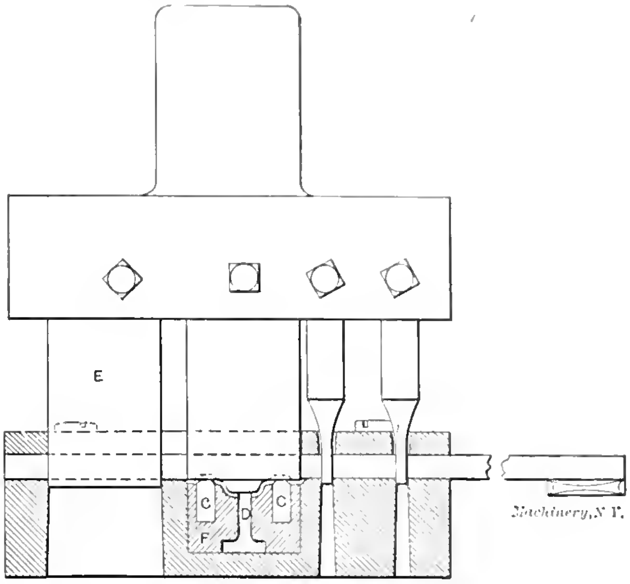


Fig. 2. Progressive Punch and Die for Forming Plates shown at A in Fig 1.

In laying out these dies, care must be taken to have the distances between the center lines to correspond, as otherwise the work will not come through the die perfect. There will also be the danger of breaking the countersinking forming punches, owing to the strain due to the irregularities in laying out. The die is so constructed that the former *F* can be removed when grinding. After the die is ground, the difference between its height and the original height is ground off the bottom of the former.

GEORGE CULLEY.

Springfield, O.

SIMPLE BUT EFFICIENT MILLING FIXTURE.

The accompanying illustrations show a piece of work, and the method employed for finishing the bosses on same by milling. In Fig. 1, which shows the work, the surfaces finished are indicated by the letter *f*. The fork end of the work is finished by the cutters *A*, *B*, and *C*, Fig. 2, while the other end is finished by the cutters *D*, *E*, *F*, and *A*, in the same figure. In Fig. 2 is also shown a plan view of the device which supports the work when being milled, Fig. 3 being a side view of the device. It will be seen that the fixture for holding the work is very simple, consisting simply of three V-block supports, one at *G* supporting the casting near the fork end, and two at *H* supporting the hub at the other end. There are two vertical standards *K* which are mortised for a key which clamps the work down on the V-blocks. The par-

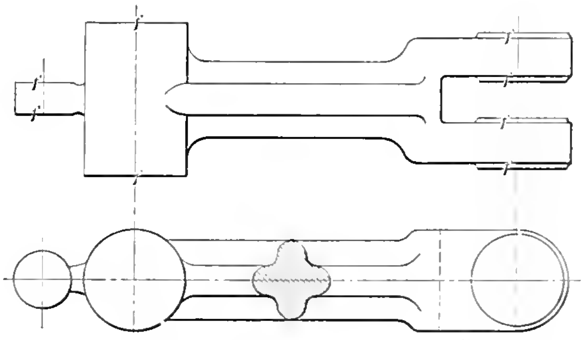
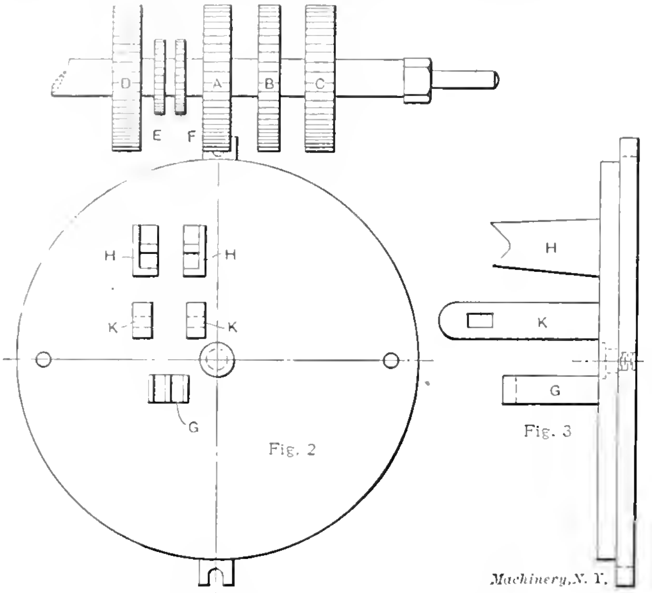


Fig. 1. The Work to be Milled.

ticular feature of this device is that the V-blocks are located at such a distance from the center that, when the hub is milled and finished, and the upper plate of the jig revolved one-half of a revolution, the center cutter *A*, which has been previously employed for finishing one side of the hub, will be in correct position to mill one side of the fork end, the spacing collars between the cutters, of course, being made to take care of the required distance. The stop pin is used for keeping the upper revolving plate in the correct position in regard to the lower bed-plate.

A milling fixture of this description can be used advantageously on a great number of pieces which are ordinarily jigged two or three times. One great advantage inherent in this class of fixture is that the work is finished at one setting, thus insuring that all the machined surfaces are in proper alignment. Another advantage is that the work is handled only once at the milling machine, while if milled in the usual way, the hub end would be milled with a straddle mill, and then the casting taken to the drill press, and after the drilling operation returned to the milling machine for finishing the fork end, the work being probably held on another milling jig, and located by a pin or stud through the hole in the hub. Y. ZIEGLER.



Figs. 2 and 3. Fixture for Milling Work shown in Fig. 1, at One Setting.

SELECTING A CYLINDER OIL.

In selecting an oil for cylinder lubrication, oil which is entirely free from any vegetable or animal fat should always be chosen; that is, only a pure mineral oil should be used for this purpose. Vegetable oils oxidize at comparatively low temperatures, becoming thick and gummy, and have no lubricating properties whatever. Animal oils also act in a similar manner when subjected to heat. Animal and vegetable oils are often mixed with mineral oil in order to form a cylinder oil having a high viscosity and fire test. Suspected compounds of this kind may be tested by adding a little soda ash or caustic soda, and shaking it up in a bottle. If it clouds up and looks soapy, it indicates the presence of animal oil. Such a compound should never be accepted at any price.

Paraffine is frequently added to cylinder oil, but this is also highly objectionable. Its presence may be detected by placing a bottle of the oil on ice for fifteen or twenty minutes. If it becomes cloudy, it shows the presence of paraffine, and should be discarded at once.

Engine oils having an opalescent green tinge when held up to the sunlight, instead of appearing clear red or yellow, contain either kerosene or some lighter hydro-carbon, which is not a lubricant, and which volatilizes as soon as it becomes heated. Oils showing this characteristic should be avoided. Ordinary lubricating oil for high-speed engines should have a viscosity ranging from 170 to 195 at an average temperature of 75 degrees. Its specific gravity should be between 29 and 31, and the flash test between 400 and 440 degrees.

When the steam pressure carried is less than 100 pounds per square inch, cylinder oil should have a fire test between 590 and 630 degrees. For pressures ranging from 100 to 200 pounds per square inch, the fire test may range from 600 to 660 degrees. The specific gravity of a cylinder oil having a fire test of 600 degrees should be from 26 to 27, and for 660 degrees, from 24 to 25. Sometimes when there is considerable moisture in the cylinders, it is desirable to use a small amount of animal oil in the lubricant. In this case refined and acidless tallow oil should always be used. Common lump tallow should never be employed for this purpose, as it contains an acid which corrodes the cylinder walls and also leaves charred particles in the steam. The amount of tallow oil to be mixed with mineral oil may be taken as follows: For steam pressures below 100 pounds per square inch, 8 to 10 per cent of tallow oil; and for pressures from 100 to 200 pounds, from 3 to 6 per cent. Cheap grades of cylinder oil are often adulterated with wool fat, which is used to cut the gummy ingredient and give the oil a good flow in a cold test. Wool fat causes the oil to separate and form a thick deposit at the bottom of the barrels. Oil containing this adulteration leaves charred particles in the steam the same as lump tallow. CHARLES L. HUBBARD.

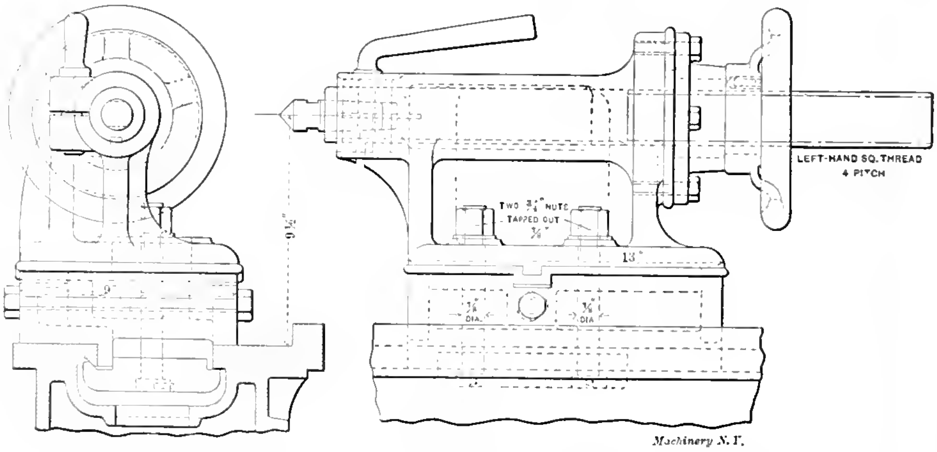
Auburndale, Mass.

A TAIL-STOCK DESIGN.

The engraving illustrates a new type (or rather an old type revived) of tail-stock, which has become popular in Europe, and in my opinion its superiority over the ordinary style is great enough to warrant its universal adoption. The bad feature of the ordinary tail-stock is that when the spindle is moved out, the bearing in the barrel becomes shorter, whereas to be right it should be longer.

This improved style, though it does not give more bearing the farther the spindle projects out, does the next best thing; it gives a uniform bearing whether the spindle projects more or less. The spindle is, of course, perfectly parallel, and is provided with either a square or Acme thread at the rear end. It will be seen that the screw (as a separate part) is dispensed with, and it isn't necessary to bore out the spindle to receive the screw, so that besides being more correct in principle, this design is cheaper to construct than the ordinary one.

Incidentally, the drawing shows one of the methods adopted in England, of always clamping the tail-stock in the same vertical plane. Of course, in America, with the inverted vee bed, this takes care of itself, but when a flat top bed is used, some means must be provided to ensure a proper location of the tail-center, otherwise taper work will result. I believe



Design of Tail-stock in which the Spindle Bearing is not affected by the Position of the Spindle.

that a method similar to this is used by William Sellers & Co. to overcome this difficulty.

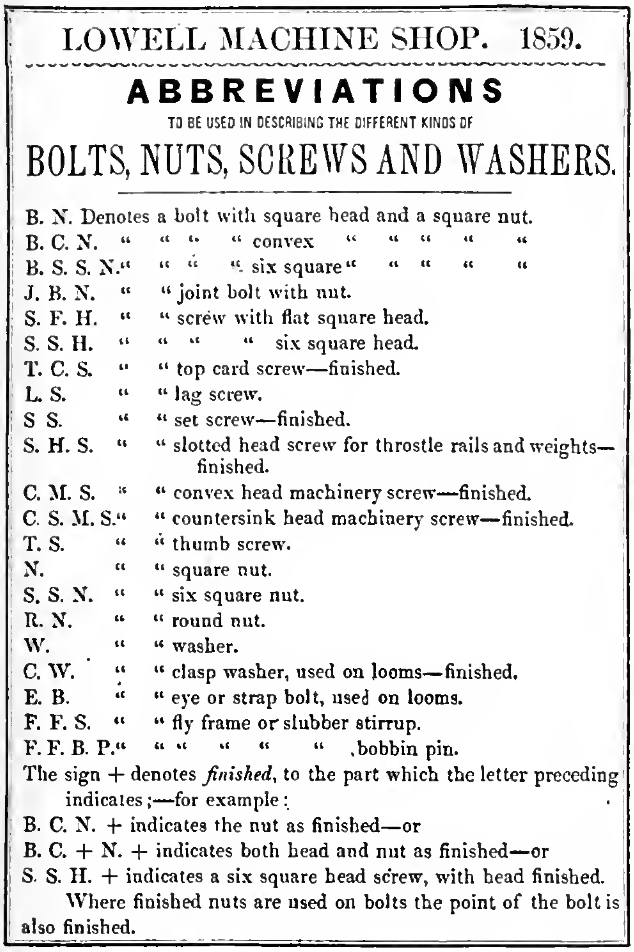
Another point, which, though insignificant in itself, is worth drawing attention to, is that the tail-stock clamping bolts are each ⅞ inch in diameter, with only ¾-inch nuts; this was done so that the wrench which tightens the tool strap bolts could also be used for the tail-stock bolts. As mentioned before, this is only a detail, but it is one that should receive more attention from machine tool designers, so that a machine will not have a set of wrenches which takes up as much room as itself. RACQUET.

[Our common form of engine lathe tail-stock is a good example of the sacrifice of utility in machine design to mere prettiness. The above design, which aside from minor details is essentially the same as that generally used by early lathe builders here and abroad, is much superior to the modern type, in rigidity and wearing qualities, no doubt. Its drawback is ugliness, and that seems to have been sufficient to discredit it in America notwithstanding its manifest superiority.—EDITOR.]

ABBREVIATIONS FOR BOLTS, NUTS, ETC.

The accompanying engraving shows an old list of abbreviations which is still used in ordering bolts from the bolt shop of the Lowell Machine Shop, builders of textile machinery. It is rather ancient history, but could hardly be improved on for brevity and clearness. Something of this sort is necessary on account of the large number of bolts used by the company, amounting to some 30,000 per week during the busy season of last year. PAUL W. ABBOTT.

Lowell, Mass.



LOWELL MACHINE SHOP. 1859.

ABBREVIATIONS

TO BE USED IN DESCRIBING THE DIFFERENT KINDS OF

BOLTS, NUTS, SCREWS AND WASHERS.

B. N.	Denotes a bolt with square head and a square nut.
B. C. N.	" " " convex " " " " "
B. S. S. N.	" " " six square " " " " "
J. B. N.	" " joint bolt with nut.
S. F. H.	" " screw with flat square head.
S. S. H.	" " " " six square head.
T. C. S.	" " top card screw—finished.
L. S.	" " lag screw.
S S.	" " set screw—finished.
S. H. S.	" " slotted head screw for throstle rails and weights—finished.
C. M. S.	" " convex head machinery screw—finished.
C. S. M. S.	" " countersink head machinery screw—finished.
T. S.	" " thumb screw.
N.	" " square nut.
S. S. N.	" " six square nut.
R. N.	" " round nut.
W.	" " washer.
C. W.	" " clasp washer, used on looms—finished.
E. B.	" " eye or strap bolt, used on looms.
F. F. S.	" " fly frame or slubber stirrup.
F. F. B. P.	" " " " " ,bobbin pin.

The sign + denotes *finished*, to the part which the letter preceding indicates;—for example:

B. C. N. + indicates the nut as finished—or

B. C. + N. + indicates both head and nut as finished—or

S. S. H. + indicates a six square head screw, with head finished.

Where finished nuts are used on bolts the point of the bolt is also finished.

List of Abbreviations for Different Kinds of Bolts, Nuts, Screws and Washers.

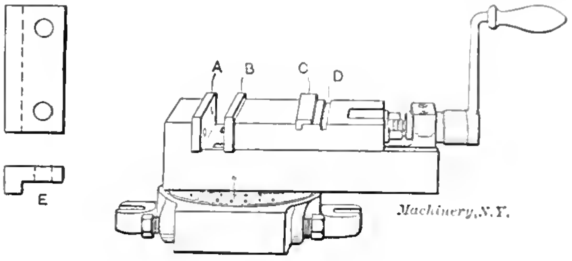
OBJECTION TO USING COPPER WIRE WHEN CASE-HARDENING.

Small soft steel or wrought iron parts should never be strung on a copper wire when case-hardening. The following incident will explain the reason why. A large number of small gears were to be case-hardened by the common process of enclosing them in an iron box filled with granulated bone, etc., and the person in charge thought it advisable to string the small gears on a wire, in order to prevent losing any of them. Not realizing that the fusing heat of copper is some 500 or more degrees less than that of steel, he picked up some copper wire and carefully strung all the small gears on this. The result was that when the box was put in the furnace, the copper wire melted and ran into the teeth and over the surface of the gears, so that it was necessary to put in two or three days of filing and scraping to remove the copper. Since the above incident happened, soft steel wire is always within handy distance of the hardening man when required for the purpose mentioned above. R. S. F.

AN ATTACHMENT FOR BROWN & SHARPE MILLING MACHINE VISES.

Referring to the illustration, *A* is the regular positive jaw of a milling machine vise, *B* the regular adjustable jaw, and *C* an attachment or false jaw to increase the capacity of the vise by using it instead of the jaw *B*, which is removed. In our shop we had occasion to hold work 3 inches wide, and the vise would only open 2¾ inches, so the above attachment, which we find very handy, was made, as it about doubles the capacity of the vise, especially on large flat work. An extra slot can be cut in the vise-back, as at *D*, and the false jaw can be used at either place. The jaw is shown in detail at *E*. It is held on by two filister head screws, and can be used on either the swivel vise, flanged vise, or on the tool-maker's universal vise. J. T. GEORGE.

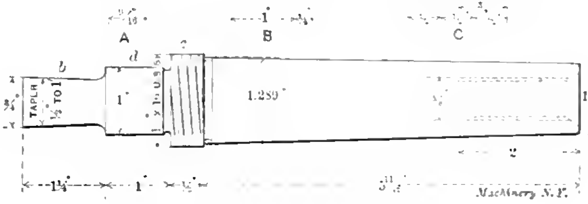
Attleboro, Mass.



Milling Machine Swivel Vise equipped with Attachment for Increasing its Capacity.

IMPROVED EXPANDING MILLING MACHINE ARBOR.

Having had considerable dove-tailing and end milling close to shoulders and walls of casting, and being caused much trouble with the old style split expanding arbors with the taper plugs and screws in the ends, I designed and made the arbor herewith illustrated. This arbor is made for a Cincinnati milling machine. The shank has a hole tapped in the end for drawing it into the milling machine spindle with a drawing-in rod. The threaded portion *c* is made to fit the hood or screw sleeve *C*. The straight cylindrical part *d* acts as a guide for *C*, and the tapered part *b* expands the



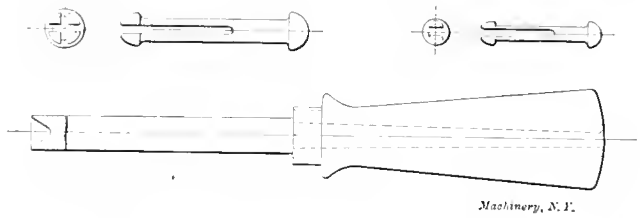
Details of the Expanding Arbor.

split sleeve *B*, which holds the milling cutter. This sleeve *B* is finished in one piece and a 1/16-inch radial slot is cut in from opposite sides to within about 1/16 inch of the bore. It is then hardened and ground all over on a tapered mandrel. The mandrel is then driven into the sleeve until it is parted, and the rough edges which are left are ground off on the side of the emery wheel. The taper of the split sleeve and the corresponding taper of the mandrel should be ground at one setting of the taper attachment, so they will coincide. The mandrel should be ground first, then sleeve *B*, until the large end of the tapered part *b* of the mandrel just enters the large part of the bore in the sleeve. It will be noticed that the hole in the collar or washer *A* is made a little larger in diameter than the part on the sleeve *B* over which it fits. This is done so that *A* will not interfere in the expanding of *B*. In assembling the arbor, the sleeve *C* is first screwed on, then the two halves of *B* are placed on the tapered part and the collar *A* passed over them to hold them in place. The diameter of the expanding sleeve *B* and the thickness of the collar or washer *A* should be made in proportion to the diameters of the holes and the thicknesses of the various cutters to be used. A spanner wrench is used on the sleeve *C* for drawing the arbor from the milling machine spindle and also for expanding *B* in the cutter to be used. It is evident that with this arbor a considerable pressure is obtained in the cutter, and a heavy cut can be taken. If the cutter slips, however, a slot may be cut across the end of the arbor, and a key long enough to project through the split bushing *B* and into a key-way in the cutter, inserted. This arbor has been in use for over a year on various jobs, such as dovetailing and general work, and it has paid for itself a number of times.

Lowell, Mass. FRANK G. STERLING.

SUBSTITUTE FOR COTTER PINS.

Referring to your article, "Substitute for Cotter Pins," published in the April issue, I beg to say that the pins there shown are not exactly like those which are used by Bofors-Gullspang Company, Sweden. These pins, which are shown in the illustration, are especially designed to connect certain parts in breech locks instead of using screws and nuts. They can easily be removed and there is one part instead of two or three as when a screw is used.



Substitute for the Ordinary Form of Cotter Pin, and Tool for Removing.

The smaller sizes can easily be removed with the fingers and also some of the larger ones. In order to more conveniently remove the larger pins, a special tool is made as shown in the engraving. JOHN INGBERG.

North Tarrytown, N. Y.

MAKING PISTON RINGS.

The making of piston rings is neither so small nor such an inexpensive item in the manufacture of gasoline engines, as it would seem to a casual observer. In the design of the ring itself, there are two main types: the concentric cast iron ring, and the eccentric cast iron ring. Of these two, the latter type is probably more used, at least by the more progressive gas engine builders. Again, in the splitting or cutting the ends of the rings there are two prevailing methods: one method being to cut the ends so that they are "jogged" like stair steps, the other being a plain diagonal cut. The last method is preferred by the majority of builders on account of the ease in making.

In the machining of the ring, before it reaches the splitting stage, we need but glance over the pages of almost any mechanical journal to find dozens of tools, jigs, and various contrivances for holding the casting, boring the inside, and turning the outside, to say nothing of the tools, single and in gangs, used to cut off the rings from the finished blank. In the boring tools, especially, has "genius" been busy trying to devise tools that will quickly and thoroughly remove the most valuable part of the ring. One firm that I know of, and I don't know how many more, bores out its rings and then peens the inside to make them stiff! Why so few firms have failed to notice and profit by the example of the largest gasoline engine factory in the United States, has long been a puzzle to me. This firm uses an eccentric ring and doesn't bore it out at all. In this way the ring is stiff just where it should be. The plain diagonal split is also used, it not only being the easiest to cut, but just as good as any other style. Why anyone should go on boring out rings when a moment's thought shows the advantages of not doing so, is beyond me. This way of making rings requires a little more care in the foundry, but this is nothing compared to the saving in the machine shop, not to mention the increased value of the ring itself. In making the castings, they are provided with the usual three lugs, and the inside is made the size that the rings would be bored to were they made that way. Extreme accuracy is not needed, for the piston grooves are always made deep enough to allow for slight variation.

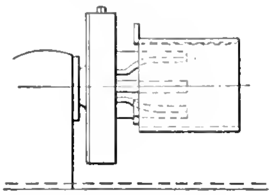


Fig 1. Long-jawed Universal Chuck used for Facing Ends of Ring Blank.

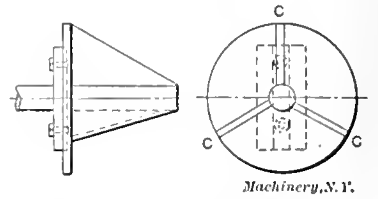


Fig. 2. Winged Center held in the Turret and used to set the Blank on the Face-plate.

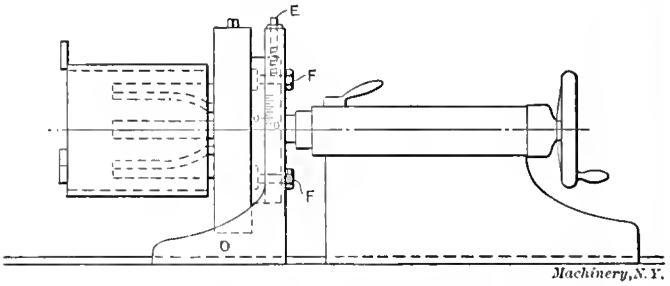


Fig. 3. Improved Device for Setting the Ring Blank.

In machining these rings, without boring, the first rig that I remember seeing was the one shown in Fig. 1. It was simply a three-jawed universal chuck, with extra long jaws fitted to it, as shown. The casting was placed on these, and the lugs faced off. The other end was slightly countersunk. This work being done, the casting was taken to a machine having a fixture in the turret such as shown in Fig. 2. This fixture was set the proper amount above the center to give the ring the required eccentricity. The casting was placed with the lugs toward the face-plate, and the turret, holding the fixture, run up so that the three rings came in contact with the slightly countersunk edge and held the casting against the face-plate. The turret was locked, and the lugs clamped to the face-plate. The turret was then run back, the casting turned and the rings cut off. This method, however, finally gave way to another, and the fixture shown in Fig. 3 was adopted. Less time was required, and all the work done on one machine. The body *D* of the fixture is of cast iron and is made to fit the ways of the lathe. A taper plug

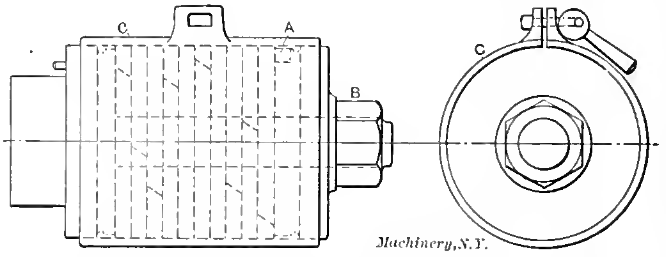


Fig 4. Fixture for Holding the Rings while finishing the Outside.

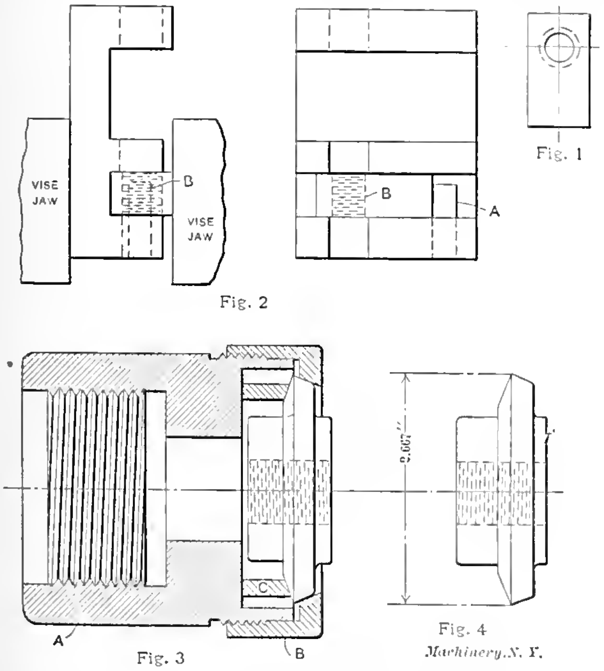
also connects it to the tail-stock spindle. The casting is held by a chuck similar to the one shown in Fig. 1. The amount of eccentricity given the rings is regulated by loosening the nuts *F* and turning the screw *E*, graduations which are provided, doing away with guess work. When the casting is placed on the jaws, as shown, the tail-stock and fixture is pushed forward until the lugs are a half inch or so from the face-plate. The tail-stock is then locked, and the fixture run up by using the hand-wheel. Paper is packed under the lugs where needed and they are strapped fast. The tail-stock and fixture is then run back out of the way, and the rings turned and cut off. After the rings have been ground on the sides and split in the milling machine, they are placed in the fixture shown in Fig. 4, and finished to the exact outside diameter. As will be readily seen, this fixture is of the ordinary type, the principal difference being the insertion of the hard steel block *A* used to set the tool to save calipering. After the nut *B* is tightened and the sleeve *C* removed, the point of the tool is run up against this block and the rings finished at one cut.

Another useless idea in connection with packing rings is that of putting a pin in the groove of the piston to keep the ring from turning. This is a relic of the old days, when cylinders had openings in them into which the ends of the rings were liable to spring and cause damage, and the pin was not originally intended to "stagger" the splits and thus prevent (?) the escape of gas, as many seem to think they were, or do.

Decatur, Ill. ETHAN VIALL.

DEVICES FOR HOLDING WORK WHILE TAPPING.

A simple and effective device for holding work while tapping often saves a great deal of time in the shop. In Fig. 1 is shown a piece of cold rolled steel ¼ x ⅜ inch, which is to be tapped as indicated. Fig. 2 shows the device which is used to act as a guide for the tap. The piece is inserted in the slot at *B*, and pressed up against the locating pin *A*, and then the piece with its guiding device is clamped between the jaws in a vise, as indicated to the left. This insures a straight tapped hole, and at the same time, if many pieces are to be made, the time saved is about fifty per cent. In Fig. 4 is shown a cast iron bevel gear which is to be faced and tapped as indicated. In Fig. 3 is shown the fixture used for holding this gear while facing and tapping. A holder *A* screws onto a spindle of a lathe, and the cap *B* holds the gear in position against the floating ring *C*. The cap locates the gear centrally and the floating ring takes the thrust and adjusts itself to the irregularities of the gear rim.



Devices for Holding Work while Tapping.

Alliance, O. E. D. GAGNIER.

NOVEL COMBINATION DIE.

In designing the combination die to produce the clip shown in Fig. 1, many things had to be taken into consideration. The clip had to be produced rapidly and cheaply, and therefore had to be done in a die that would produce a finished clip every stroke. The die had also to be arranged so that the brass strip could be fed in with the automatic feed. There were obviously two ways of feeding this clip: sideways, using 9/16-inch brass strip, and frontways, using 2 3/32-inch brass strip. The latter method was adopted because it would allow longer running of the press for each brass roll, as a 9/16-inch cross feed would only be required, against the 2 3/32-inch feed the other way; this method also made the die more compact, and brought the punches closer together. For cutting off, a shear punch was decided upon, thus totally avoiding any scrap except the four 3/32-inch punchings, which could not be avoided. As the stock was 22 B.W.G. it was not considered necessary to have a movable guide, but 5/16 inch was cut out at the side of the feed guide to allow the strip to bend down while the blank was sheared off. The shear *A* (Fig. 2) and the punches *B* were set at the same height so that punching and shearing would take place simultaneously. As the stroke of the press was not long enough to allow the forming punch *C* to push the clip right through the die, this punch was adjusted so as to force the clip in a forming slot 9/16 inch, which was enough to fold the sides up correctly. For stripping, a sliding, spring-return stripper *E* was used, which was forced downward by an adjustable set-screw *F*. The method of holding the punches, except the forming punch, is quite a departure from the usual method; they were simply made a slight taper, and fitted to the taper holes in the punch-holder block. Some might question the advisability of trusting to a taper to hold a punch during stripping, but in this case the resistance to stripping is comparatively slight and the punches are kept tight by the action of punching. To produce the catch *G* (Fig. 1) in the clip, the punch *H* was ground to the correct form, and a hole was cut clear through the die, thus allowing for grinding, and a small rubber actuated push-out was inserted which would lift the blank high enough to enable the catch, or step, to pass the edge of the die. This punch was made just long enough to cut the metal almost through, which gives a sharp, clear step as high as the metal is thick. At the bottom of the forming slot a rubber operated push-out was also placed. After the clip is formed, this works it upward about 1/16 inch, which is sufficient to loosen it owing to a slight taper in the forming slot. The clip holds to the forming punch and is drawn out and stripped. The most important practical points have now been described.

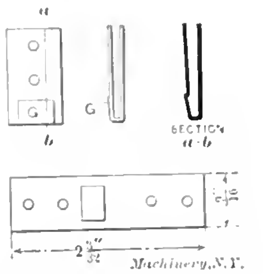


Fig 1. Clip formed by the Combination Die shown in Fig. 2.

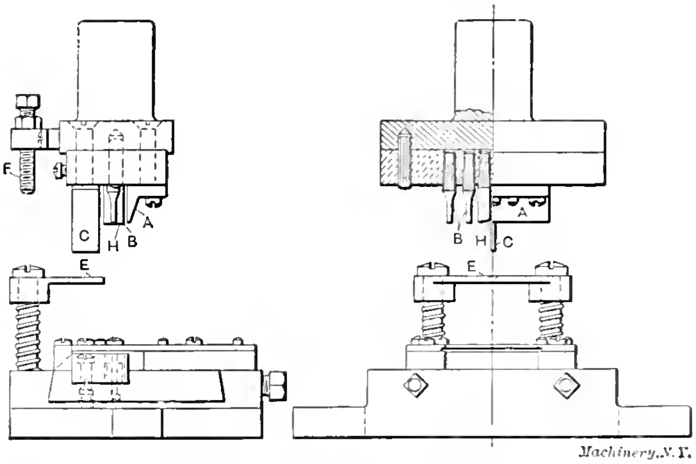


Fig. 2. Combination Die which produces a Clip such as is shown in Fig. 1, at each Stroke.

In operation, the brass strip is fed forward by the feed; then it is cut off by the shear *A*, and punched, simultaneously.

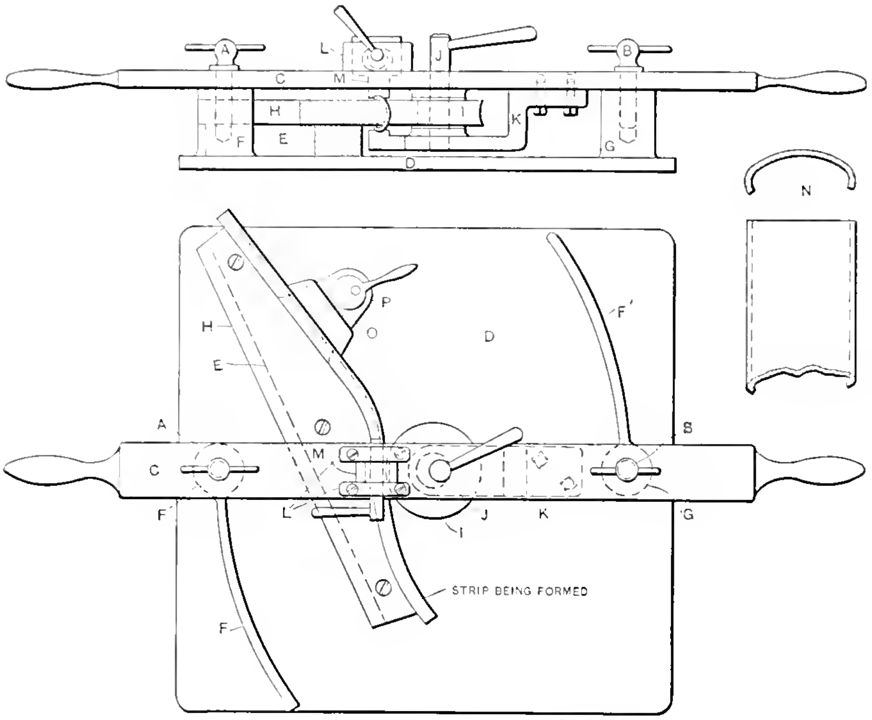
This loose piece is then pushed along over the forming slot, by the next feed of the brass strip, where it is folded by the forming punch C, after which it is withdrawn, stripped, and as the press is inclined, the clip falls clear of the die. The guides were made only slightly larger than the thickness of the brass strip thus avoiding any possibility of the pieces getting jammed, or riding.

GEO. P. PEARCE.

Exeter, N. H.

BENDING DEVICE.

The brass trimming used on an automobile dash is shown at N in the engraving. This strip is made of 18-gage brass, and is formed to the curve shown in the cross-section, under a punch press; it is then bent to conform to the curves on the dash. The strip shown in place in the bending device shows the shape of the bend. This is a difficult bending operation, as any change in the shape of the cross-section or marks or wrinkles of any kind will not pass inspection, so that the job requires more than the ordinary bar-and-roller former to turn the pieces out in large quantities and perfect.



Machinery,N.Y.

Device for Bending Brass Trimming similar to that illustrated at N.

Referring to the engraving, base plate *D*, bosses *F* and *G*, ribs *F'* and pad *E* are cast in one piece. A machine steel forming shoe *H* is fastened to the pad *E*. The clamping block *O* is mounted on the pad *E*, and is actuated by the eccentric clamping lever *P*. The cast iron bending lever *C* is drilled to receive the steel plugs *A* and *B*, these plugs acting as pivots about which the bending lever swings when forming the bend. An eccentric shaft is mounted in the pieces *L*, which gives a vertical movement to a pressure bar or foot *M*. A corresponding foot on the end of bracket *K* takes care of the bottom roll. A machine steel forming roller *I* revolves on an eccentric shaft *J*. By means of this eccentric shaft the pressure on the work can be regulated, and the roller can be backed away from the work when it is formed so that it can be removed. The thin ribs *F'* are machined on the top, and act as slides or rests for the bending lever *C*. The forming operation is done in the following manner: The first bend is made with plug *A* in place, plug *B* being removed. Bending bar *C* is moved to the starting position, pressure foot *M* is lifted and the forming roller *I* drawn back by means of the eccentric shaft. The strip is then inserted between the roller *I* and the forming shoe *H* and against a stop at the end. The stock is held in place by means of the clamping block *O*. The pressure foot *M* and forming wheel *I* are now brought against the stock and the first bend is made. The hole in the bar *C* now coincides with the one in the boss *G*, and the pin *B* is inserted and *A* withdrawn. Before starting the last half of the bending operation the forming wheel *I* is slightly released so as to relieve the sudden stretch in the metal, but during the bending the pressure is again applied. It will be seen that the stretching of the metal takes place on a line over the entire cross-section; however, owing to the temper of the brass a slight spring is bound to take place causing a difference in the pieces. After the bend is formed the foot *M* and the roll *I* are withdrawn by turning the eccentric shafts, and the strip is removed.

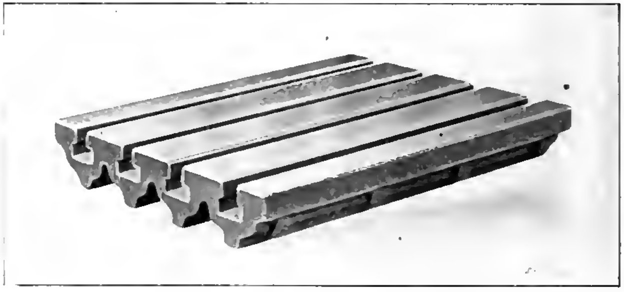
J. W. BROWN.

DRILLING PLATE, OR AUXILIARY DRILL PRESS PLATEN.

The accompanying illustration shows one of the handiest devices to be found in the machine shop, and one whose advantages are not appreciated to anything like the extent they should be. This device, which we call a "drilling plate," is a sort of supplementary table to use with the drill press. The upper face is provided with four T-slots to which the work is clamped by bolts and straps, or other convenient means. The bottom of the plate is formed by a planed ribbed surface, which rests on the regular table of the drill press. This ribbed base gives a much better bearing on the table than would be the case if the base had a full unbroken surface, as it permits the chips to be pushed to one side in the space between the ribs. The construction also makes a much lighter casting without sacrificing its rigidity.

The great advantage of this device is in connection with light work, in which two or more holes are to be drilled, reamed, faced or tapped, and which is of such shape as to require bolting down in order to keep it in proper position. Such work, if bolted on this plate, can be moved to bring it in correct alignment under the drill with the greatest ease, and in very much shorter time than is possible if the work is bolted to the drilling machine in the regular way. While the machine has all the adjustments required for centering the drill with the work, it is not always easy to make these adjustments; especially if the desired point comes near the center of the pivot of the table.

The device also permits the work to be shifted from one position to another with much greater exactness, thereby insuring more accurate drilling with less wear on the edges of the drill and the sides of the jig bushings. In such drilling as has been described, which easily comprises the majority of that found in the average shop, this plate will save from 15 to 50 per cent of the time consumed for the job, to say nothing of the saving on breakage and wear and tear of the drills and drill jigs. We have found that the workmen in our shop would do without any of the other conveniences of manipulation found in the modern drilling machine rather than forego the use of this device.



Auxiliary Drill Press Platen which Facilitates shifting Work in which several Holes are to be Drilled.

Notwithstanding its easy moving qualities, this plate has weight enough to prevent it from being whirled around, and also enough to keep the work from lifting and allowing the

drill to gouge in, with the attendant danger of breaking the tool. We make them in three sizes, 12 x 15, 14 x 18, and 16 x 20.

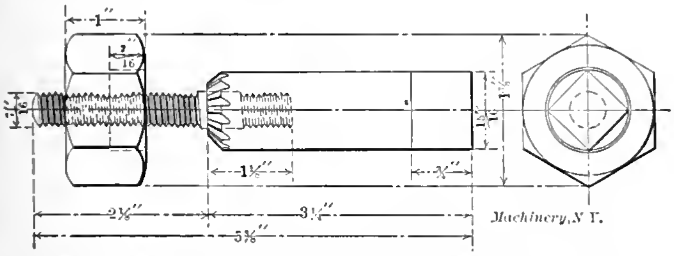
W. H. Shafer,

Cincinnati, Ohio. Supt. Cincinnati Machine Tool Co.

[Another use to which the supplementary drill press table may be put is that of increasing the product of a drilling department without increasing the number of machines. Two of these plates may be provided for each drill press, so that a workman may be setting up work on one plate, while the other is in position on the machine and the work is being operated on. A skillful man may be required for the setting up, as would be the case under any circumstances, while the actual using of the drill press may be entrusted to a workman of somewhat less ability, thus making a saving in wages as well as a saving in the capital invested in the machinery.—Editor.]

DEVICE FOR REAMING HOLES IN ECCENTRIC STRAPS.

In a great many railroad shops it is the practice, when resetting valves, to lengthen or shorten the blades of the eccentric by means of changing the holes in the straps. Under most locomotives there is very little room to work, and when it becomes necessary to change the holes in an eccentric strap arm a slight amount in order to lengthen or shorten the rod's position, the old way of chipping is often very tiresome, inaccurate, and the limited space between the eccentrics makes the whole work unsatisfactory. The little reamer shown in the engraving, was designed to be used in connection with this operation. After setting the valves and tightening the middle bolts, remove the others and put the reamer in place. Screw on the feed-nut and turn the reamer with a monkey-wrench. If the reamer feeds too fast, slack up on the feed-nut at the same time that the reamer is being turned. In this way the holes can be easily reamed.



Small Reamer which is handy for Reaming Holes in Eccentric Straps when setting Locomotive Valves.

Two Harbors, Minn. Austin G. Johnson.

CARELESS CIRCULAR DISTRIBUTION.

I have received circulars of woodworking machinery without any maker's name thereon. Probably the makers sent out a thousand or more in the same condition.

In this connection I would suggest that certain of the manufacturers revise their mailing lists. I get circulars sent to my 1894 Dresden address. Since then I have spent a year in Paris and six in Hanover. Robert Grimshaw.

Dresden, Germany.

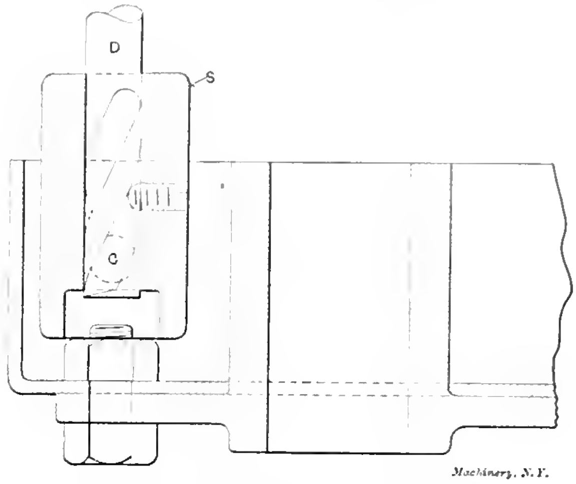
TOOLS WITH HIGH-SPEED STEEL CUTTING EDGES WELDED TO MACHINE STEEL SHANKS.

The welding of high-speed steel to tool shanks of cheaper steel has recently been spoken of as a novelty. That methods for accomplishing this are by no means new must be common knowledge to many practical men. At least one case may be mentioned dating as far back as 1904. The writer was being shown the locomotive works of Borsig at Tegel, near Berlin, and on questioning his guide as to the consumption of high-speed steel the latter replied: "A great deal, but comparatively little," and lifted the first planer tool in sight, saying, "We weld on that tip of high-speed steel; the weld, you observe, is quite invisible," and a rapid sketch in a note book showed the relative size of the welded tip. My informant added: "That is a trade secret. I am sorry I am not permitted to tell you more." From other remarks it appeared that the practice was very successful; but it does not seem probable that Borsig's was the only firm in the world welding high-speed steel tips to their tools in 1904, and it seems very unlikely that one would be justified in saying that, in the past, attempts to weld high-speed steel have been unsuccessful.

Staple Hill Park, Bristol, England. Charles R. King

CUTTING SCREW ENDS FLUSH WITH NUTS.

The accompanying engraving shows a section of a wheel hub and brake flange held together by eight ⅜-inch bolts, one of which is shown in the illustration. The location of the nuts is in the bottom of the recess formed between the brake band seat and the hub boss, and the end of each bolt stands out originally 3/16 inch outside of the nut. It was required that the bolt ends of these nuts be made flush with the nuts, and as there were a great many of these hubs made, the following process was employed in facing off the ends of the screws. Referring to the illustration, *D* is an ordinary twist drill, the cutting edges of which are ground at right angles to the center line of the body, regular clearance, of course, being given to the cutting edges. In drills of ½-inch diameter, or less, the thickness of the web at the bottom of the grooves is not sufficient to produce any appreciable difference in the pressure necessary for feeding the drills, but on larger drills it became necessary to make the web thinner by grinding the grooves deeper for a short distance back from the cutting edge. In fact, a great many tool-makers thin the web on twist drills regularly for ordinary drilling, because it lessens the pressure necessary to feed the drills into the work, and the drill is less liable to spring and drill a hole that is "out of true." In the illustration, *S* is a case-hardened steel sleeve which fits the body of the drill, and is held in place on it by a set-screw entering into the flute. The lower end of the sleeve is counterbored to a depth equal to the thickness of the nut, plus 1/16 inch, and with a diameter sufficient to permit it to pass over the corners of the nut. The cutting edges of the drill project into the counterbored space about 1/16 inch, leaving a distance equal to the thickness of the nut between the cutting edges of the drill and the lower end of the sleeve, which latter simply acts as a stop when facing off the ends of the screws. At *C* is shown a hole drilled through the sleeve to allow the chips to escape. By putting this simple tool into a drilling machine, the bolts are faced off flush with the nuts in a very short time. J. T. Grimshaw.



Method of Facing the Ends of Bolts with a Drill.

Detroit, Mich.

TAPER GIB DESIGN IN "JIGS AND FIXTURES."

In the August issue of Machinery in the fifth installment of "Jigs and Fixtures," by Mr. Einar Morin, two taper wedges or gibs are shown in Figs. 54 and 55. As shown in the illustrations, the wedge cannot be adjusted because it will bind, the screw being inaccurately shown. The usual and correct way of making a taper gib adjustment is to drill and tap for the screw at the same angle as the wedge, that is, parallel to the movement of the wedge. A makeshift method is to drill as shown in the sketch, and to enlarge the hole in the ear of the wedge so that side movement is provided for. Elmer G. Eberhardt,

Newark, N. J. Newark Gear Cutting Machine Co.

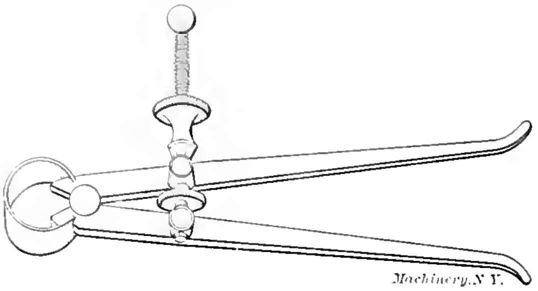
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

LOCK-NUT FOR CALIPERS.

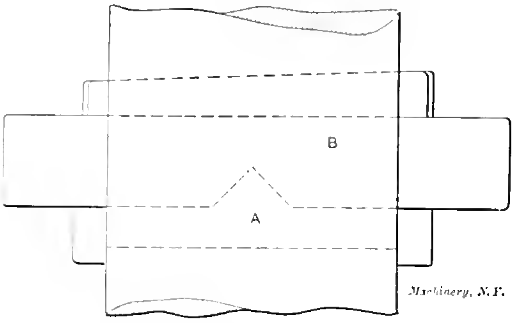
A simple and secure method of converting spring calipers into transfer calipers is shown in the illustration. An extra nut is placed between the caliper legs thus affording means of locking them. This nut can be taken from another pair having the same size fulcrum stud, but a special thin one permits the use of the calipers for smaller sizes. The two nuts can be locked and the calipers kept to the same diameter for any length of time, even though carried in the pocket or grip—something very desirable when fitting parts for a job that is far from the shop. Donald A. Hampson.



Middletown, N. Y.

CENTERING SELF-HARDENING CUTTERS.

Self-hardening cutters were to be used in the boring-bar of a large boring mill, and as I am foreman of the tool-room it was "up to me" to devise some way of getting the cutters central in the bar, as there was no way to machine them. This was accomplished as shown in the engraving. The bar was milled flat on each side of the slot, and the centering piece *A* carefully fitted to it. The V-shaped tongue on the centering piece, and the corresponding V-slot in the cutter *B* causes the cutter to be set central when it is keyed in place. This job is very satisfactory and preferable to annealing the self-hardening cutters as they are not as durable after having been annealed and hardened again. J. R. Weaver.



Plainfield, N. J.

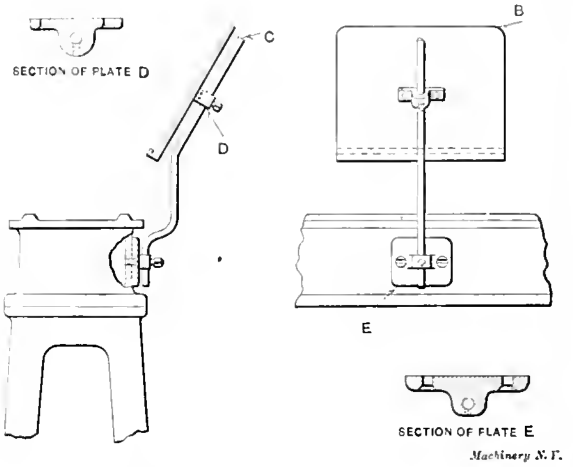
HANDY CENTER INDICATING TOOL.

A center indicating tool for locating the prick-punched centers of work true with the machine spindle on a boring mill or a milling machine, may be made as shown in the accompanying line engraving. The shank of the tool may be tapered or straight to be held in a chuck. The ball shown at the front end of the hole in the shank is ¾ inch in diameter, is hardened, and has a hole drilled through the center in which the pointer is inserted. When using the tool, the shank is inserted in the spindle of the machine, and the end of the pointer is placed in the center hole of the work to be centered. After having been thus located, the pointer is moved back out of the prick-punch hole in the work and the machine started up. If the end of the pointer wiggles or moves about in a circle, it indicates that the center of the work is not in line with the axis of the spindle. The cap *A* in the front of the hole is driven into the hole in the shank, and holds the ball in place. On the other side a bushing *B* is pressed up against the ball by the spring *D*, so that whenever the pointer is set out of line with the spindle, it will be held in this position by the friction between the bushing, ball and cap, caused by the pressure of the spring. There is a small hole through the entire shank to permit the pointer to be driven out of the ball, if required, for repointing.

Poughkeepsie, N. Y. W. W. Cowles.

LATHE BRACKET FOR BLUE-PRINTS.

The bracket shown in the illustration is very simple and will keep blue-prints or working drawings constantly before the mechanic. It is made of two cast iron plates *D* and *E*, rod-arm *C*, bent at any desired angle, and sheet iron holder *B*. The size of screws should be determined by the size of bracket made. As the reader will notice, there are no breakable parts, and very few loose ones. I would suggest that the surface on the arm *C*, which comes in contact with the set-screws, be filed or milled flat; this will keep the bracket from turning. By using a bracket of this description, the percentage of mistakes made will be greatly reduced and more accurate work done. L. H. Georger.



Buffalo, N. Y.

A BLUE-PRINTING KINK.

In the winter months it is hard to judge the time required to make sunlight blue-prints, and so I hit upon the idea of making a scale of colors with which to compare a test piece of paper. Take a piece of blue-print paper four inches wide and ten inches long. Cover all but one inch with a heavy piece of paper. Expose this one inch for say one minute in a mild light, then move the cover so as to expose one inch more for one minute, which exposes the first inch two minutes, and so on, inch by inch, until all ten inches have been exposed, and the first division has been exposed ten minutes. I used a light that I had previously found would print just right in a ten-minute exposure. Any other time interval could be used. Now wash the paper thoroughly, and when dry you have a scale with which to compare other prints. Figure out the relative times that would have been required to bring each color to a perfect blue-print, by dividing the whole time by the time exposed, and mark this number on the color, this number to be used as a multiplying factor. Now, in order to get a perfect print, put the tracing you wish to copy out with a small piece of blue-print paper, and leave it, say two minutes, until it would be printed some, but not enough. Then wash dry with blotters and compare with the scale sheet. Say it was like the fourth color from the bottom. The factor would be 2½. Multiplying this by the two minutes equals five minutes, the time required to make a perfect print in that light. I am pleased with the uniform results obtained. Austin G. Johnson.

Two Harbors, Minn.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

FLATHER 30-INCH VERTICAL TURRET MACHINE.

The E. J. Flather Mfg. Co., Nashua, N. H., has recently completed and placed on the market the vertical turret machine shown herewith. As may be seen, it is of simple and attractive design, embodying a number of new features. One of the most noticeable of these features is the use of a cross-rail adjustable for height. In most machines of this size (30-inch swing) the cross-rail is solid with or bolted to the column, at a height that will clear the highest work on which it is expected to use a tool. Under these circumstances, for work close to the face of the chuck, the turret slide has to be extended to nearly the full limit of its travel, making it very difficult to take cuts up to the full capacity of the machine. Other special features of this mill that might be mentioned are a new design of work spindle and bearing, a quick-change gear feed mechanism, the making of the base and column in one casting, the provision for an unusually long cross-slide movement, and the use of a thread and nut feed for the turret slide in place of the usual rack and pinion movement.

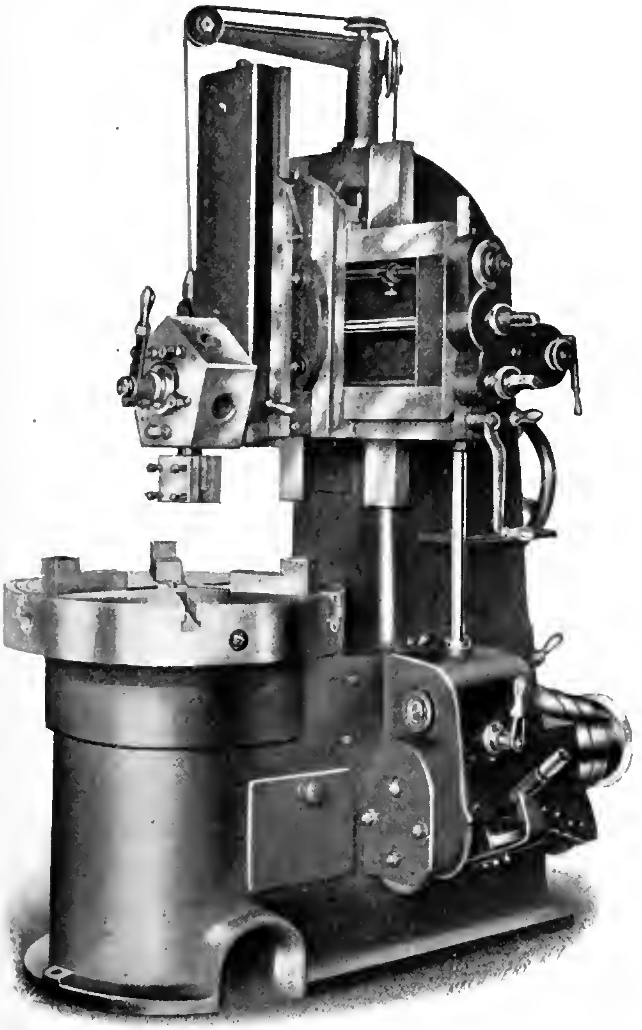


Fig. 1. The Flather 30-inch Vertical Turret Machine.

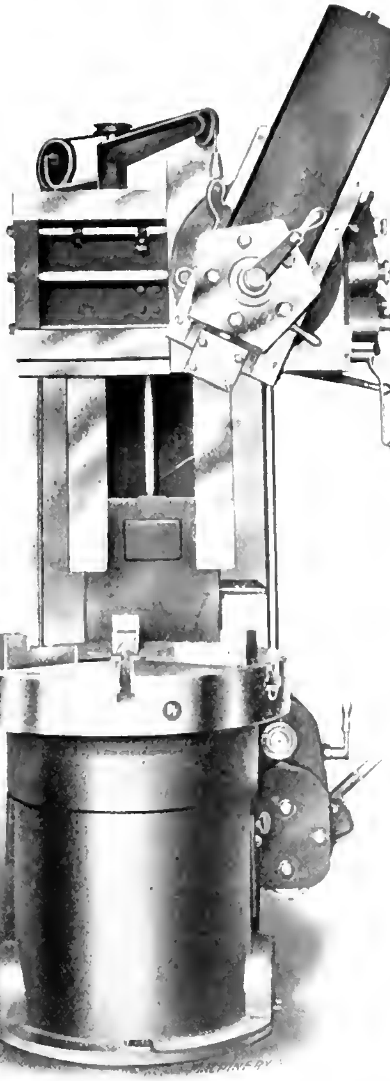


Fig. 2. Front View of Turret Machine.

The Table, the Spindle and the Drive.

In Fig. 3 at *A* is shown the cast iron spindle of the machine, made with thick walls and ribbed in its large diameter so as to be very stiff and strong. The journal for this spindle is formed in two parts. The thrust is taken on the upper beveled face of sleeve *B*, which is screwed and doweled to a machined seat in the solid base of the machine. This thrust bearing, it will be seen, is of large area, and is provided with ample means for lubrication. The side strain is taken by the long bearings of the shank of the spindle in bushing *C*, which fits closely into sleeve *B* on its outside diameter, and is provided with a taper internal bearing scraped to fit the taper journal of the spindle. To the lower end of bushing *C* is threaded the nut *D*, which is split and provided with a clamp screw, as indicated by the dotted lines. To the lower end of spindle *A* are threaded the lock nuts *E E*, which adjust washer *F* against the lower end of *C*. It will be seen that provision is thus made for taking up both the wear of the thrust and the side wear on the journal. By loosening *D*, nuts *E* may be screwed up to give the required tightness of fit for the journal, and then *D* may be screwed up to give the required amount of play for axial motion. The table is 30 inches in diameter, and has 16 changes of spindle speed, obtained by a combination of four-step cone, back gears, and two-speed countershaft. The table is driven by spur gear teeth cut in the periphery of the extended diameter of the spindle, where it is bolted to the table. These mesh with pinion *H* on a vertical shaft, connected by bevel gears *J* and *K* with the driving shaft.

Feed Mechanism and Automatic Stop.

Twelve changes of feed are provided by a quick-change gear device, shown at the base of the machine on the operator's side. The six changes obtained in this mechanism are doubled by a positive clutch, giving the following feeds in revolutions per inch: 7, 8, 9, 10, 11½, 12, 21, 24, 27, 30, 34½, and 36. It should be noted that provision is made for cutting threads of unusual pitches other than those given, by using other gears in place of those provided in the gear casing at the front of the feed box in Fig. 1. The feeds are reversible, and each

rate is the same for either the vertical movement of the turret slide or the horizontal movement of the saddle on the cross-rail.

Worm gearing has been entirely avoided in the feed mechanism. To make this possible in the case of the turret slide, the usual rack and pinion has been replaced with a screw *L* and nut *M*, as shown in Fig. 5. The connection with the splined shaft *O* in the cross-rail is made by bevel gears through short shaft *N*; the screw is stationary while the nut revolves, as shown. Both cross and vertical movements are provided with an automatic trip, controlled, in the case of the cross movement, by dogs adjustable lengthwise on a stop rod, which is seen above the splined feed rod in the cross rail in Fig. 1. This rod is also provided with fixed stops at the limits of its motion, making it impossible to over-run the saddle on the cross-slide and damage the feeding mechanism. The feed stop operates on the feed clutch at the rear of the cross-rail, as shown in Fig. 3, dropping it out of engagement when the stop strikes the dog. The movement of the turret slide is controlled by a stop acting on the same stop rod, through the medium of a train of gearing and the index dial, shown at the right end of the cross-rail above the splined feed rod shaft in Fig. 1. The vertical movement of the turret slide may be adjusted to stop after any desired amount of movement, by setting the adjustable dial to read for the desired amount. This mechanism acts on the stop rod to throw out the clutch in the same way as for the horizontal movement.

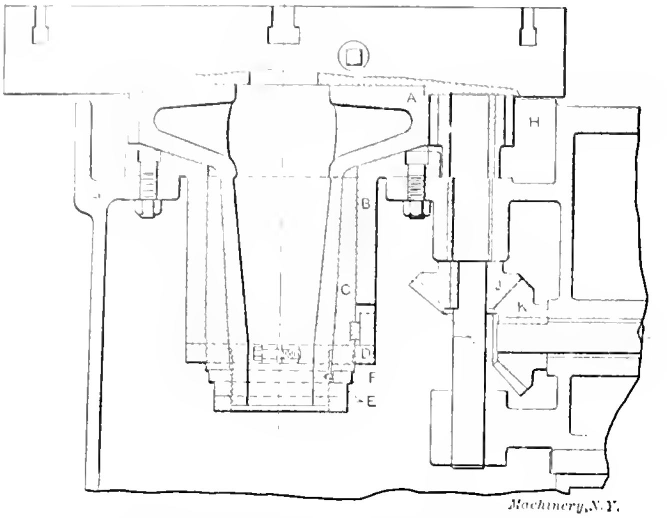


Fig. 3. Vertical Section of Spindle and Table Drive.

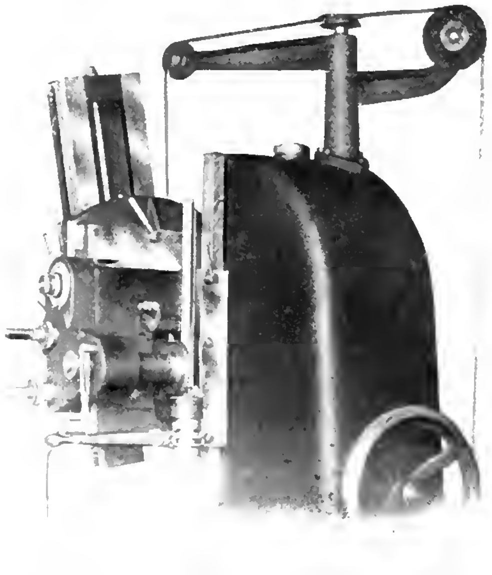


Fig 4. Arrangement of Cross-rail, Feed Mechanism, etc.

The Turret and Turret Slide.

The turret slide is, of course, set on a swivel saddle so that the movement may take place at any desired angle. The automatic stop operates at any angular setting of the saddle. The slide is counter-balanced by an arrangement which, it will be seen, is very simple as compared with that provided in many designs of this apparatus. It consists simply of a swinging crane arm carrying idler pulleys so located as to follow the movement of the slide freely. The turret is five-sided, and is 10 inches in diameter. The tools are clamped in place by hardened steel set-screws *P*, seated in bushed nuts *Q*. The lock bolt, of hardened steel, works in a hardened steel index ring.

Dimensions.

The principal dimensions of the machine are as follows: The extreme diameter of swing is 32 inches. The cross-rail may be adjusted by the hand wheel shown at the rear of the column in Fig. 4, to give from 8½ inches to 26 inches of height over the face of the chuck. The maximum distance under the turret head is 28½ inches, giving a total adjustment for the cross-rail of 17½ inches. The turret slide has a vertical feed of 17 inches, and is mounted on a cross-slide which has a travel of 23 inches, thus making it possible to turn reverse bevels on work of unusually large diameter. The machine stands 88 inches high, and occupies a floor space of about 68 x 47 inches. The approximate weight is 5,300 pounds.

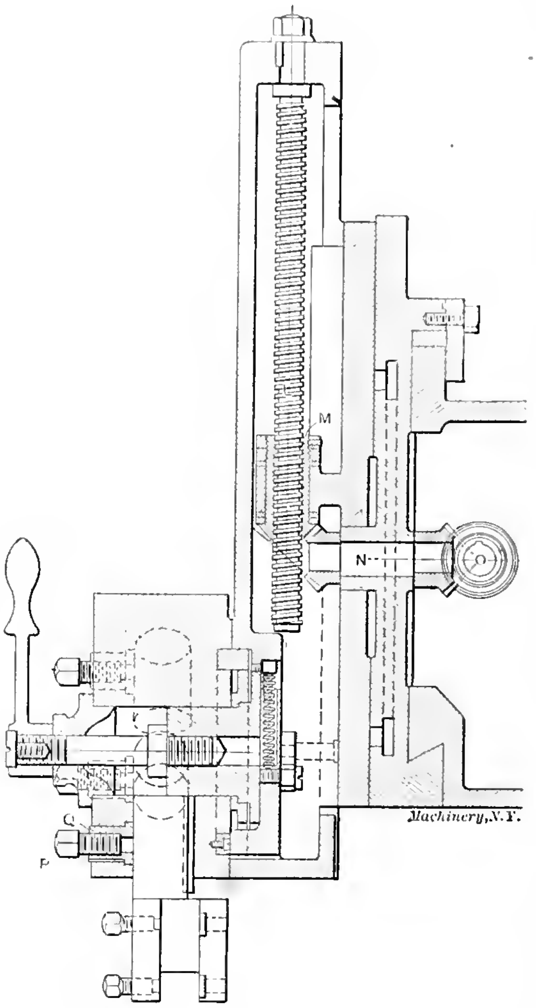


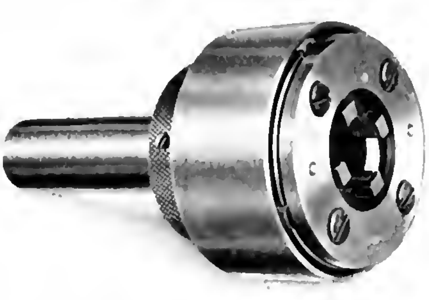
Fig. 5. Section through Turret Slide, showing Screw Feed.

This machine is intended for the regular routine work of the boring mill, and for that reason it has not been encumbered with special features. It may be built at a cost that is reasonable in view of the cutting power and rigidity which the builders have aimed to obtain. The lines of the machine, as may be seen from the engravings, are simple but pleasing.

SOLID ADJUSTABLE THREADING DIE FOR USE ON TURRET LATHES, ETC.

The die-head shown herewith is designed to use a die formed of separate chasers and to so hold them as to give them an adjustment through a wide range of diameters. It is intended for use in machine operations where solid dies or adjustable round dies would otherwise be used.

The adjustment is made very easily, by loosening the front clamping plate and turning the outer hardened hood to the right or left as required, keeping the dies pressed against the inner bearing meanwhile. The seating of the outer edges of the dies against the tapered inner surface of the shell adjusts them simultaneously to a varying diameter as the hardened hood is turned. The chasers are tightened in place by locking the hood with a set-screw, and clamping the front plate up against them. The chasers (which are made of high grade tool steel or high speed steel, as required) are carefully tempered, and have a much longer life than one-piece threading dies, since they can be easily and quickly removed from the head and sharpened on an emery wheel or grindstone. They have a slight clearance in the threads which permits them to act freely with no drag. In addition to the advantages of a long life and the solid holding of the chasers, the feature of adjustability is very important, it being possible to use the same set of chasers for a wide range of diameters.



Die made by Adjustable Collet Co.

The heads are made of any suitable length to accommodate long threaded work. They may also be furnished with plain chasers and used as adjustable hollow mills. The material and workmanship of the tool is stated by the manufacturer, the Adjustable Collet Co., Cleveland, O., to be of exceedingly high grade, making the device an accurate and durable one.

FOX POLISHING MACHINE.

The accompanying illustrations show a polishing machine built by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich. This machine is of interest in itself, and makes possible, as well, a great improvement in the arrangement and general conditions of the polishing room beyond what is commonly met with in work of this kind. The machine is mounted on a substantial base, to the top of which is mounted a yoke which carries the arbor. This is best seen in Fig. 2. The lever shown at the front of the machine is attached to a shaft carrying an eccentric by which this yoke is raised or lowered. The lowering of the yoke and the contained arbor brings the pulley into contact with the belt, and starts the machine. To stop the machine, the lever is thrown back; this raises the pulley away from the belt, and brings the band brake, shown at the right of the pulley in Fig. 1, into operation, instantly stopping the spindle. The connecting-rod from the eccentric to the yoke is adjustable in length so that the belt may be brought down to exactly the right tension when the lever is thrown in, thus avoiding the necessity for treatment with resin or special preparations. The spindle or arbor is mounted in Hyatt roller bearings. The fit is a close one, but leaves enough freedom so that the spindle may be spun between the end of the thumb and finger. The use of these bearings in this machine has been very successful, and has led the builders to adopt them for their entire plant. In spindles running as fast as those used for polishing, a small amount of friction means a considerable amount of power, so that the matter of getting good bearings is an important one. The rollers and casings of the bearings are ground for high speeds, and are thoroughly protected against dust and grit.

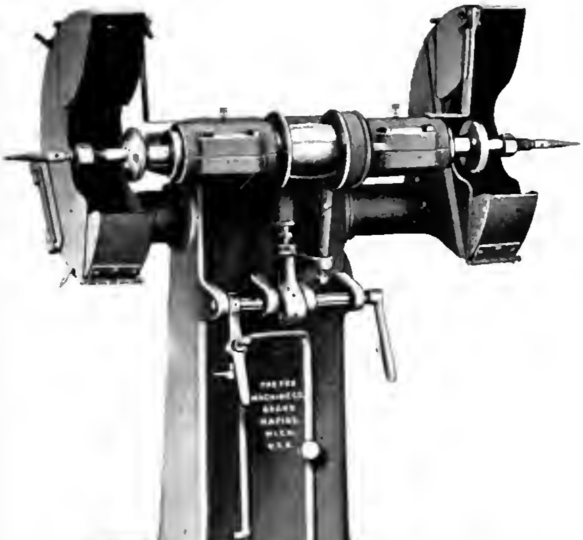


Fig. 1. Fox Polishing Machine with Exhaust into Base.

Each machine is provided with a pair of substantial steel dust hoods, attached to flanged brackets which are bolted to the column of the machine. The dust is exhausted from these hoods through brackets down into the column. From here it may be either led away through exhaust ducts in the floor, or through an opening at the rear of the base. The hoods are hinged so as to open up to permit the removal and insertion of polishing wheels.

Fig. 2. Side View of Base, showing Belt Tightener and Brake.

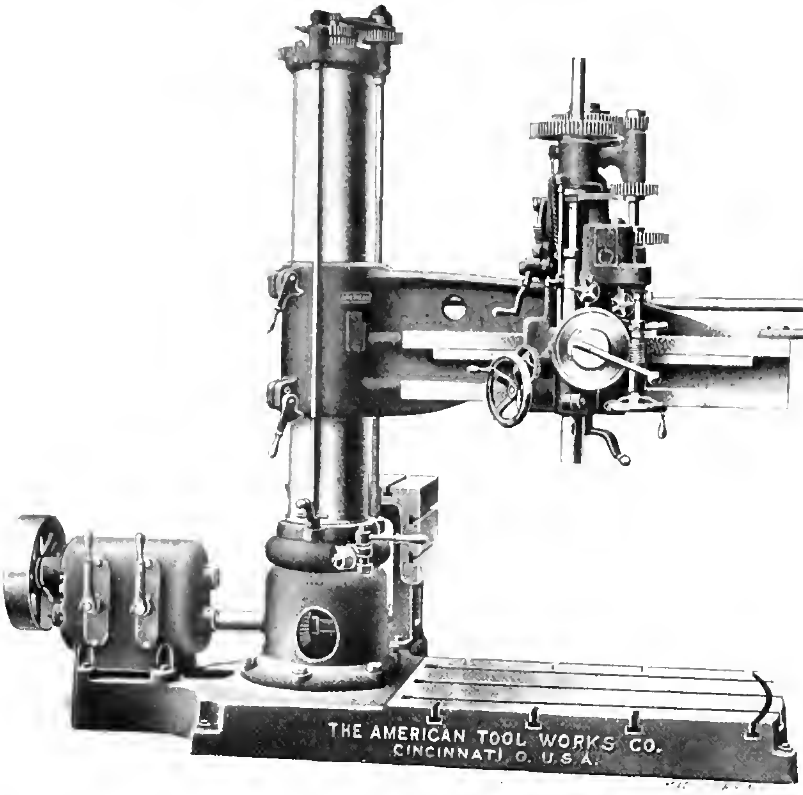
In designing the machine, it was the object of the manufacturers to produce a tool which would stand continuous service without requiring repairs. Really remarkable results have been obtained on this score. Ten machines of this type have been in constant use in the shops of the builders for about four years, most of them with two operators to a machine. It is stated that in that time the cost of repairs has not exceeded 25 cents; there has not been a single hot bearing, nor has one of the bearings ever been adjusted.

AMERICAN TOOL WORKS CO. HIGH-SPEED RADIAL DRILL.

The accompanying illustration shows one of a new line of radial drills designed and built by the American Tool Works Co., 300-350 Culvert St., Cincinnati, O., in order to take advantage of recent developments in high-speed drills, especially those of modified flat drill form like the "Celfor," "Norka," and other types which we have described from time to time. These drills have been developed until, with proper machinery for driving them, they will pierce a hole practically as quickly as it can be punched, in the case of work where punching is practicable. The radial drill has been steadily growing in favor for general work, owing to the convenience of its operation, and the facilities it offers for presenting to the tool, work of all shapes and sizes. The drive of the machine, however, has of necessity to be so long and complicated that in previous designs it has been impossible to bring from the driving pulley to the point of the tool, sufficient power to use these new high-speed drills to their full capacity. By strengthening the machine generally, improving the feed, and providing triple back gearing at the spindle head, the makers of this machine believe that they have provided a radial drill which obviates the defects of previous designs.

General Design.

The general design follows that of the 2-foot radial drill built by the same firm (see "New Machinery and Tools" in the July, 1908, issue of MACHINERY), and so will be only briefly described. The column is of the double tubular type with the outer sleeve revolving on conical roller bearings, hardened and ground. The inner member extends to the full height of the column, and has bearings at both top and bottom. This gives the equivalent of a double column and makes a very rigid support. The base is very heavy and is strongly ribbed, especially at the point of support. An extension of the base at the back is drilled to receive a plain box or a universal table, as ordered. The arm is of combined parabolic beam and tubular section, giving great resistance to bending and torsional strains. Its design leaves its lower edge parallel with the base, permitting work to be operated on in close proximity with the column without requiring the spindle to be unduly extended.



A Radial Drill, Especially Designed for using the New Forms of High-speed Tools.

The Drive.

The machine illustrated has a speed box drive, though it will be furnished with a cone pulley instead, if desired by the purchaser. This speed box, by the operation of the two levers shown, provides four speed changes, all controlled by friction clutches, which permit a change of speed without stopping the machine. From the speed box, power is transmitted in the usual way to the splined driving shaft shown extending along the back of the arm. The connection between this splined shaft and the driving shaft of the head is effected through a reversing mechanism operated by friction clutches, and controlled by the lever seen projecting forward toward the operator's position from beneath the cross-rail. The locating of the reversing arrangement here between the speed box and the triple back gears gives the clutches the advantage of a high speed even on slow, heavy work, thus providing them with ample power for the most severe conditions the machine will be called on to meet. This arrangement also facilitates the use of the reversing lever in combination with the back gear lever for tapping, giving a slow forward movement and a quick reverse. The triple back gears (a construction which, so far as our memory serves us for the moment, is a novelty in radial drill construction) are located in the head close to the spindle. The use of triple gears and the placing of them in this position is a prime factor in the matter of bringing a sufficient amount of power to the point of the drill, as it makes this possible without requiring transmission shafts of unwieldy size, and the transmission of high torque through sliding keys.

The drive just described provides for twelve changes of speed, the four in the speed box being tripled by the triple gears. This number is doubled by the use of a two-speed counter-shaft, giving 24 changes, which range in geometrical progression from 18 to 346 revolutions per minute, all immediately available without stopping the machine. This wide range of speeds, in conjunction with the high driving power, makes the machine as useful for the lighter work as for the heavy service for which it has been particularly designed. Particular attention should be called to the fact that the changes can be made without stopping the machine. The counter-shaft and speed box changes are effected by friction clutches which, of course, can be operated without shock at any practicable speed. The triple back gears are provided with a special feature which in combination with the rounding of the edges of the teeth of the gears, permits throwing them in at high speed with practically no shock to the parts. These arrangements make possible very rapid manipulation of the machine without any danger of breakage.

The Feeding Mechanism.

This machine is provided with eight rates of feed, covering a range in geometrical progression from 0.0066 inch to 0.0633 inch. These feeds are all obtained by the shifting of the knobs shown below the feed box. The dials with which these are provided indicate the rates of feed directly, making unnecessary any reference to index plates before making the change. These feeds are geared and positive, thus insuring a maximum productive capacity. The friction connec-

EXAMPLES OF TESTS MADE ON AMERICAN HIGH-SPEED RADIAL DRILL.

DRILLING TEST IN CAST IRON TWO INCHES THICK.

Size Drill.	Speeds.		Feeds.		Back Gears.		Actual H.P.
	Revolutions.	Cutting Speed.	Per Rev.	Inches per min.	Ratio.	Position.	
$\frac{1}{2}$" C.	356	46.6'	.046	16.3	1.48	Top	5.75
1" C.	216	56.6'	.046	9.9	1.48	Top	5.45
$1\frac{1}{32}$" H.S.	313	84.5'	.046	14.4	1.48	Top	13.2
$1\frac{7}{32}$" H.S.	313	99.8'	.046	14.4	1.48	Top	15.3
$1\frac{15}{32}$" H.S.	216	83.1'	.033	7.1	1.48	Top	12.6
$1\frac{23}{32}$" H.S.	216	97.0'	.033	7.1	1.48	Top	16.8
$1\frac{31}{32}$" H.S.	128	66.0'	.033	4.22	4.22	Middle	15.6
$3\frac{1}{2}$" H.S.	60	55.0'	.024	1.44	4.22	Middle	10.2

DRILLING TEST IN STEEL ONE INCH THICK.

Size Drill.	Speeds.		Feeds.		Back Gears.		Actual H.P.
	Revolutions.	Cutting Speed.	Per Rev.	Inches per min.	Ratio.	Position.	
$\frac{9}{16}$" H.S.	356	52.3'	.012	4.27	1.48	Top	4.2
$\frac{3}{4}$" H.S.	313	61.5'	.012	3.75	1.48	Top	10.8
$1\frac{1}{32}$" H.S.	188	50.9'	.024	4.51	1.48	Top	9.0
$1\frac{5}{32}$" H.S.	188	56.9'	.024	4.51	1.48	Top	9.3
$1\frac{23}{32}$" H.S.	128	57.6'	.024	3.07	4.22	Middle	8.4
$1\frac{31}{32}$" H.S.	167	86.2'	.012	2.00	1.48	Top	7.8

TAPPING TEST WITH PIPE TAPS IN CAST IRON TWO INCHES THICK.

Diameter Tap.	Speeds.		Feeds.		Back Gears.		Actual H.P.
	Revolutions.	Cutting Speed.	Per Rev.	Inches per min.	Ratio.	Position.	
4"	18	21.2	$\frac{1}{8}$"	$2\frac{1}{4}$	12.02	Bottom	6.6
5"	18	26.2'	$\frac{1}{8}$"	$2\frac{1}{4}$	12.02	Bottom	7.7
6"	18	30.8'	$\frac{1}{8}$"	$2\frac{1}{4}$	12.02	Bottom	9.0

Note: C = carbon steel, H.S. = high-speed steel.

tion is provided, however, between the feed work and the feed pinion shaft. While this is strong enough to carry, without slipping, the heaviest feed the tools are capable of standing, it will serve as a safety device to prevent any damage to the feed mechanism. The spindle sleeve is provided with a depth gage and automatic trip acting on the worm clutch. The graduations being on the sleeve, the reading of depths is very simple; all depths can be read from zero. Two or more tripping dogs can be supplied, making it possible to counterbore a number of holes without reversing. The trip acts automatically at the extreme of the feed, preventing possible damage to the feed mechanism. The spindle is easily handled, being counter-balanced and provided with a quick advance and return lever, as well as with a fine hand adjustment, which may be used as well for hand feeding.

In the tables are given some examples of tests which indicate the power consumed under various severe conditions of service and illustrate as well, the capacity of the machine for transmitting this power. The driving of a 6-inch tap is an interesting illustration of the possibilities of the machine.

Unless otherwise specified, this radial drill is furnished with plain box table, counter-shaft and cone pulley drive. At extra expense it will be provided with the speed box as described, a universal table, and an electric motor drive. It is particularly adapted to the use of the latter, as it is only necessary to mount the motor on an extension of the base opposite the speed box, to which it is connected by chain or gearing.

STOCKBRIDGE GEAR-DRIVEN SHAPER.

The Stockbridge Machine Co., of Worcester, Mass., has recently designed a shaper with a drive in which all the changes of speed are effected by changes of gearing, thus adapting it either to be used as a constant speed pulley machine, or to be driven by a constant speed motor. The machine is designed new throughout, instead of following the plan sometimes adopted of taking a standard form of shaper and adding a gear box to it. Fig. 1 shows this machine as designed.

The Speed Change Gearing.

The construction of the gear box, which is, of course, the vital feature of the new design, is indicated in the vertical section in Fig. 2, which shows the pulley-driven arrangement. Power is received at pulley A, which is fastened to the driving shaft B. To the latter are keyed a series of five gears, C_1, C_2, etc. These engage corresponding gears D_1, D_2, etc., mounted on a stepped steel sleeve E, which is journaled in ring oiling bearings at F and F in the casing. In the bored interior of sleeve G (to which pinion D_1 is keyed) and on the interior periphery of each of the gears D_2, D_3, D_4 and D_5 is a series of cast iron expansion rings H_1, etc. These are expanded by the wedge-shaped plungers J_1, etc., whose lower ends are raised by suitable cam surfaces in rod K. The speed changes are "selective"– that is to say, any one of the changes can be obtained without going through the intermediate steps between it and the last previous change. In making a change knob L is rotated, revolving K to bring the proper cam surface into agreement with the proper plunger to operate the clutch desired, giving the speed indicated by a dial surrounding knob L on the hub of hand-wheel M. The plunger thus brought into alignment with the cam on K is then raised and the clutch tightened, by shifting K end-wise. This is done by a clutch fork operated by the horizontal handle shown above the hand-wheel in Fig. 1, engaging sliding collar N shown in Fig. 2. This shifting of K thus binds any desired one of gears D with sleeve E, which is thus driven at a corresponding speed from shaft B. On E are keyed pinions O and P, meshing with gears Q and R respectively, which run loosely on the crank-gear pinion shaft S. A clutch T operated by a lever at the rear of the change speed box engages either Q or R with S, this in effect being a back gear change. It will be seen that ten rates of speed are thus obtained.

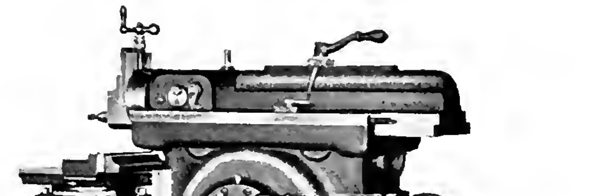


Fig. 1. Stockbridge Shaper, arranged for Motor Drive.

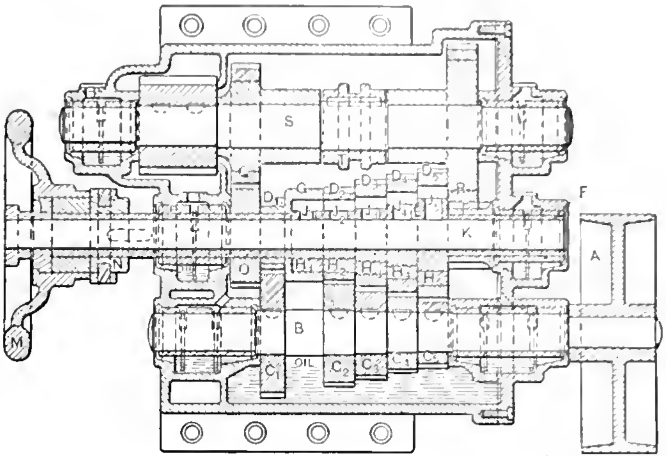


Fig. 2. Gear Box with Constant Speed Pulley Drive.

The details of this gear box have been carefully worked out. The gear teeth are all cut in steel, excepting in the case of the driving pinion of the crank gear. The friction rings H may be adjusted for wear by means of screws reached through a hand-hole at the back of the gear box. The gears run in oil and the boxes are all bronze bushed and provided with ring oiling facilities. The handwheel M will be found useful in moving the ram by hand for fine settings. The dial which shows to what position knob L has been turned, is marked with numbers giving strokes of ram per minute for each of the five gears D. Locating this gear box at the back of the shaper and bolting it direct to the column makes a stiffer, as well as a more compact construction than the more common one in which it is built out from the side of the shaper.

General Features of Design.

As was stated, the machine has been newly designed for this new gear drive to give it the necessary stiffness to make all the increased power of which it is capable, useful at the point of the cutting tool. A number of new features of the design may be mentioned. One of them is the construction of the rocker arm, of which a cross section is shown in Fig. 3. As may be seen it is provided with a cored U-shape rib on either side, giving as rigid a construction as could well be made for this part. The slot is of unusual depth and width, giving ample bearing surface for the crank-pin block. The rocker arm is held between two boxes at the bottom and is tied to the ram at the top, preventing the possibility of any tendency to come out of alignment.

The ram itself has been strengthened and stiffened over previous designs. On the working side the gib is solid with the column. On the other side it is made complete in one piece and bolted solidly to the column. Taper packing is provided for taking up wear and the whole construction adds considerable to the stiffness of the shaper.

The method followed of attaching the saddle to its slide on the face of the column is new in shaper construction, though it is exactly identical with that which has been followed for

a long time in the similar bearing on the column-and-knee type of milling machines. It is believed by the builders to give a much superior construction to that ordinarily followed for shapers as it gives one bearing surface cast solid with the saddle or cross-rail, and this, in combination with the method of tightening provided, prevents all possibility of the cross-rail's tilting away from the column when the gib on the opposite side is loosened. The adjusting gib is on the working side of the machine and is locked by the tightening of two binder screws, which serve to make the cross-rail practically a part of the column. This arrangement also makes it unnecessary for the operator to go around to the further side of the column to tighten the binder bolts, as is necessary when two loose gibs are used.

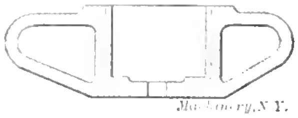

Machinery,N.Y.

Fig. 3. Cross-section of Crank.

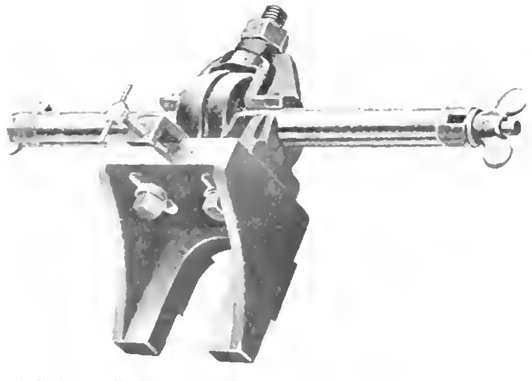
The regular distinctive features of the Stockbridge shaper are continued in this machine. Among them is the automatic down feed which was illustrated in the department of "New Machinery and Tools" in the November, 1907, issue of MACHINERY. The crank motion provided on this machine is well known. It gives a very even cutting speed for the entire length of the cut and a quick return of between three and four to one. This is obtained without jar to the machine, as the high speed is gradually brought to zero at either end, reversing the stroke easily and smoothly.

For the pulley drive machine, the construction shown in Fig. 1 is modified by using a regular base instead of the extension base there shown for supporting the motor. The driving shaft then has mounted on it a single diameter pulley, as shown in Fig. 2 instead of the geared connection for the motor used in Fig. 1.

KRIEGER BORING TOOL AND HOLDER.

The boring tool shown herewith is built by the Krieger Tool & Mfg. Co., 83 to 91 West Randolph St., Chicago. Its particular advantages are the firmness and convenience with which the boring tool may be held and adjusted, and the simplicity of its attachment to the lathe.

The bracket on which the tool is held may be slipped over the tool-post, and clamped by a square block passing through the tool-post slot and tightened down by the regular screw. The boring-bar holder proper is attached to the face of the bracket by bolts passing through the slots shown. This may be raised or lowered to bring the tool to the proper height, by means of the screw shown, which provides for very fine adjustment in a vertical direction. The holder is in the form of a V-block having a V-clamp supported by it, which is clamped down on the tool by the stud and nut shown. This is adapted for a wide range of boring-bars (from ¼ up to 1¼ inch) which it will hold so firmly as to prevent any possibility of turning.



A Universally-adjustable Boring Tool Holder used in the Regular Tool-post.

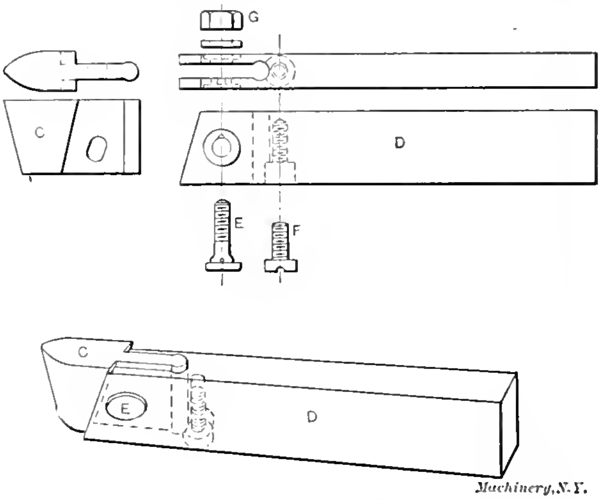
These boring-bars have been previously described (see "New Machinery and Tools") in the April, 1908, issue of MACHINERY. The blades, formed of simple pieces of square stock, may be set in either of two positions; they may be inclined, as would be necessary to recess the bottom of a blind hole, for instance, or set straight, as would be done in machining a cored hole large enough to admit the boring-bar. The blade is clamped in place by the thumb screw at the back end of the bar, there being no headless set-screw or other delicate contrivance of that kind at the business end of the tool.

With this holder the bar can, of course, be accurately lined with the center of the spindle, and extended to a distance just sufficient to reach the bottom of the hole which is being bored, thus giving the maximum degree of rigidity to the tool support.

TOOL-HOLDER FOR HIGH-SPEED STEEL.

The cutting tool shown in the accompanying engraving is the invention of Mr. F. E. Bocorselski, the superintendent of the Baush Machine Tool Co., of Springfield, Mass., who manufactures the device. It is made in two styles, of which the first, shown in Fig. 1, is adapted for more severe service. In each case the holder *D* is made of 20-point carbon steel, case-hardened, and the blade is drop forged from high-speed cutting steel. This makes a durable and effective tool.

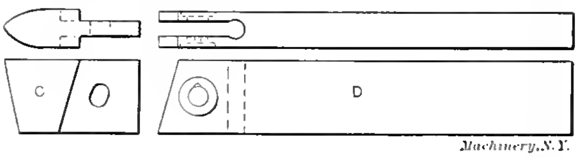
In the style shown in elevation and perspective, in Fig. 1, the drop forged blade *C* is provided with a tenon, as shown, entering a corresponding mortise in the holder *D*. The front end of the latter is cut off at an angle, as shown, and the tenon of the blade is beveled to fit this angle; the rear end of this tenon is provided with a bead fitting a hole drilled through the shank into which the slot is cut. The blade may thus be set into its seat from the top and tapped into place, when it will fit firmly on all its bearing surfaces in the shank. To hold it in position sideways bolt *E* is used, which clamps the thin sides of the holder firmly against the shank of the blade. One advantage of this construction is the large bearing area and intimate contact between the blade and the holder, which permit the rapid conduction of the heat. The two parts, it will be noticed, are of the same height and section, so that the full cross-section of the holder is available for this purpose. An ejector screw *F* is used for removing the blade for grinding or changing cutting edges. This, it will be seen, may be screwed up against the under side of the tenon of the blade, ejecting it from its wedge seat in the holder after bolt *E* has been removed. This screw may also be used to give a more firm support to the blade by screwing it up against the blade after clamping it in place.



Machinery,N.Y.

Fig. 1. Details of Tool-holder.

The other form of tool-holder, Fig. 2, is without the ejector screw and the bead on the tenon of the blade, the bolt and the bearing of the taper seat of the blade against the end of the holder being relied on to hold it in place. This



Machinery,N.Y.

Fig. 2. A Holder of Simpler Construction.

holder, which is doubtless intended for lighter service, is identical in other respects with that in Fig. 1. The blades, drop forged from high-speed steel, are made of various other forms, as well as in the shape shown in the engraving, for turning cast iron, thus fitting them for the full range of lathe work.

FERRACUTE DRAWING PRESS FOR METAL CASKETS.

The Ferracute Machine Co., of Bridgeton, N. J., has recently completed the remarkable double-action drawing press shown herewith. It was built for the Montross Metal Casket Co., of Philadelphia, and, as may be surmised from the firm name of the purchaser, is intended for blanking and forming the cover and body of seamless metal caskets. Examples of its work are shown on the floor around the base of the machine. The machine is, of course, as useful for producing similar work in other and less lugubrious lines, such as bath tubs, horse troughs, automobile bodies and miscellaneous large drawn work in steel or copper. The machine is interesting because of its large size (it weighs nearly 100 tons and is capable of exerting a pressure of 1,000 tons) and for the mechanical features of its construction as well.

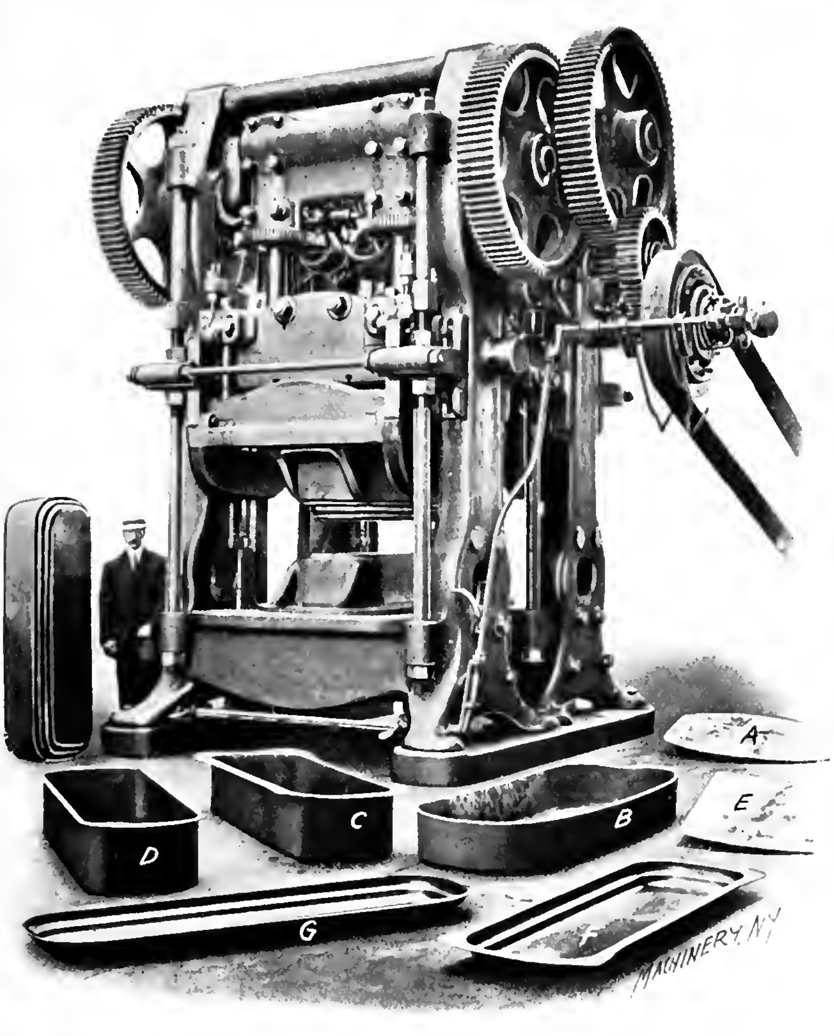


Fig. 1. A Press for Drawn Work of the Largest Size; Built up from Two Presses on the Same Base.

This press is virtually formed of two separate presses, mounted on an iron base. The frame is thus composed of four heavy cast iron columns, each of which is reinforced by two 4¾-inch steel rods, which add materially to the tensile strength of the columns. Besides being united at the base by the bed, these columns are connected at the top by stays, and by the necessary mechanical connections for the mechanism. The construction allows vertical pressure to be communicated to the table ram at four points, there being two crank-shafts, with double pitman rods for each. The adjusting gears of the four pitmans are connected by gearing, so that one hand-wheel moves them all; the adjustment is exceedingly delicate, as one turn of the hand-wheel gives only 0.001 inch of movement. A small electric motor, which may be seen in the interior of the machine between the two outer pitmans, is connected with this adjusting mechanism to enable adjustment to be made rapidly when the ram is to be raised or lowered any considerable amount.

The double-action mechanism is unusual and interesting. The outer slide or blank holder is hung from the inner ram by four heavy studs. It descends with the ram for about half of its stroke, when it is arrested by meeting the lower die and the work. At this point the continued descending of the inner die operates a toggle mechanism, forcing adjustable wedges in on top of the blank holder, transferring the pressure directly to the frame of the machine, this pressure not being borne by the main shaft as in ordinary cam presses. The four toggle levers which operate this wedge mechanism are connected with adjustable tie-rods by which the holding down pressure may be varied to suit the conditions of the work. This arrangement has been used by the builders for some time on smaller presses, but has never before been applied to large drawing presses. One advantage of the construction is that in this machine the whole outer ram or blank holder may be quickly removed by unscrewing the nuts from the top of the studs, allowing the outer ram to drop down through from the inner ram. By removing it in this way the machine may be made into a single-action press in which the full power of the ram is available. It is then especially adapted for working cutting dies, owing to the long and accurately adjustable gibbed slide bearings with which the machine is provided. This transformation of a double-action press into one of the single-action type is believed by the builders to be a new feature.

The machine is triple geared, with all the gearing cut from the solid. The five large gears are each 5 feet in diameter and 10 inches face. The ratio of the gearing is 200 to 1. The friction clutch used is of modern design, especially adapted for high speed and heavy service.

As stated, the weight of the press is nearly 100 tons, and it is capable of exercising a pressure of 1,000 tons. The stroke of the inner punch or ram is 28 inches. The outer ram may have, if desired, as much as 24 inches of movement, but with the presses adjusted as shown in the illustration, its stroke of 14 inches is capable of producing a shell of very nearly that depth. The crank-shafts are each 10 inches in diameter, forged from high carbon steel. The pinions are of phosphor bronze. An adjustable positive knock-out attachment is used in connec-

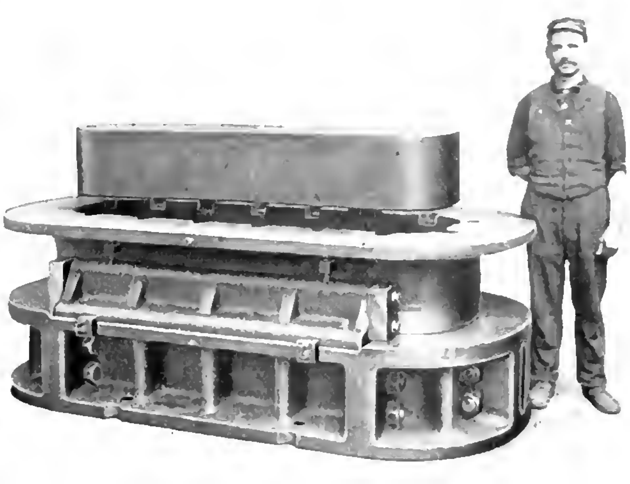


Fig. 2. One of the Drawing Dies used in the Press shown in Fig. 1

tion with the dies, two of the rods which connect the knockout with the ram are shown in the engraving.

The work shown about the base of the machine is 6 feet long, 20 inches wide, and 12 inches deep for the body of the casket, while the lid is 4 inches deep, giving a total height of 16 inches for the completed article. The parts are arranged in the order of the operations. At *A* is the blank for the body of the casket. This is first rough drawn, as shown at *B*, to a depth of 9½ inches. It is then, at *C*, redrawn to a full depth of 12 inches. The edges are next trimmed, and at *D* the edge is shown formed. The operations on the lid are similar; except that but one drawing operation is necessary, the blank being shown at *E*, the drawn shape at *F*, and a completed cover with trimmed and formed edge at *G*.

One of the drawing dies (that for the last drawing operation) is shown in Fig. 2. It is, of course, of large size, but it has been reduced to minimum dimensions by careful designing. The lower die is shown on the floor with the blank holder resting on it. The upper die, or punch, is shown suspended above that.

WALKER NO. 2½ SURFACE GRINDER.

In the "New Machinery and Tools" department of the February, 1908, issue of MACHINERY we illustrated and described the No. 3 surface grinder built by the Walker Grinder Co. of Worcester, Mass. This machine is now available in a smaller size, the No. 2½ shown herewith. This, besides being of smaller dimensions, incorporates a number of improvements as well, particularly in the feed mechanism.

The main features of this grinder are the same as in the original machine. The work table slides on ways directly on the bed of the casting, while the cross movement is effected by moving the wheel column in or out. The guiding surface of the wheel column is extended, by means of projecting horns, on ways which pass through openings in the rear of the base so that the wheel is supported practically under the working point at even the outermost extreme of adjustment. The table has an automatic reciprocating movement, controlled by the dogs shown which can be adjusted to any desired position in the slot on the front of the table. The cross feed is arranged to feed automatically in either direction at the will of the operator, at each end of the stroke, and is provided with a safety device which prevents the possibility of forcing this automatic movement beyond the limits of the cross travel.

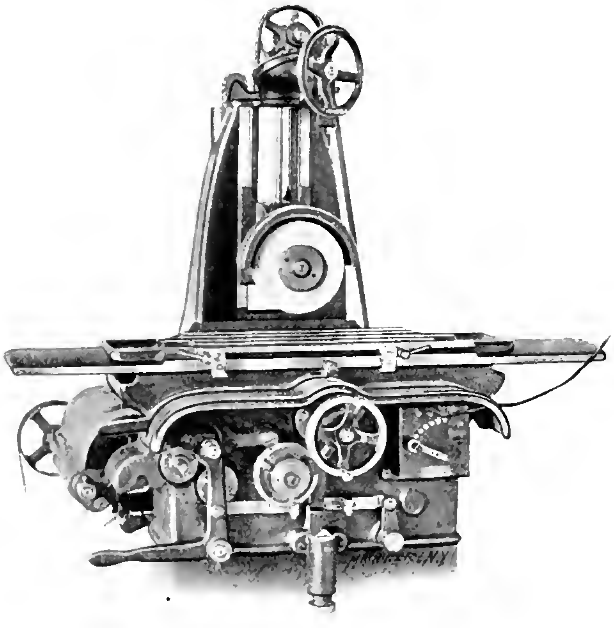


Fig. 1. Walker Surface Grinder with Friction Feed.

The improvement in the automatic cross feed consists in operating it from a friction device, similar to that provided for planers, instead of having it operated by the reversing lever for the table motion as in the previous construction. This gives a more strongly driven feed, and relieves the dogs of all work except that of shifting the positive clutch which controls the table feed.

The friction disk for operating the cross-feed is mounted below and just to the left of the cross-feed hand-wheel in Fig. 1. This disk plays between stops, which may be adjusted to any suitable position about the circumference of the carrier in which they are mounted, to give the desired amount of feed at each end of the stroke. The reversing plate, which is thus given a definitely limited movement at the end of the stroke, has pivoted to it a plunger having rack teeth cut in it, meshing with a pinion mounted loosely on the cross-feed screw. This plunger is confined in a holder which is also loosely pivoted about the same axis. The point of attachment to the cross-feed plate is such that it may be given a movement each side of the dead center, thus giving an out and in movement to the plunger at each end of the stroke. This out and in movement is transmitted to the pinion, which in turn carries an arm with a reversible pawl engaging a ratchet wheel on the cross-feed screw. By reversing this pawl, the direction of the feed is regulated.

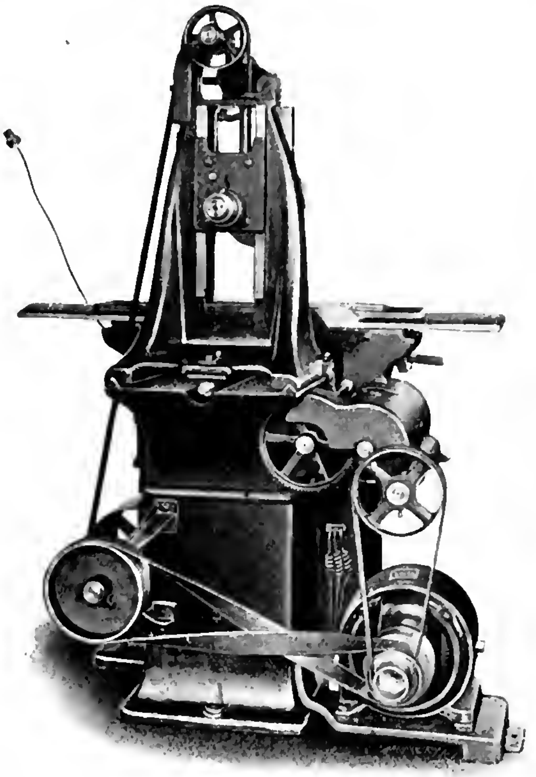


Fig. 2. Rear View of Grinder showing Wheel and Feed Driving Connections.

The machine we show is motor driven. The motor is mounted on a special base connected with the base of the machine, and fastened to the floor at its outer extremity. By this means, although one end of the motor base rests on the floor, the whole arrangement is still a self-contained unit. It will be noted that the motor is placed on the clean side of the grinder, the direction of rotation of the wheel throwing the dust and emery toward the opposite end. The motor shown is of the direct current type, but an alternating current motor will be furnished if desired. The starting box is in a convenient location at the right-hand side at the front of the machine, as shown in Fig. 1.

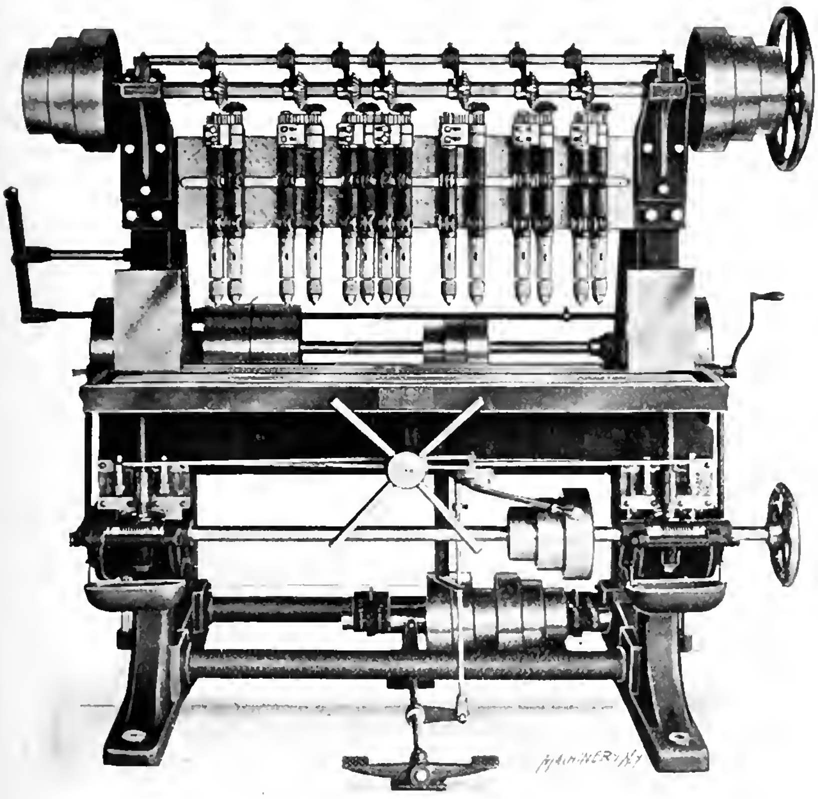
As may be seen in Fig. 2, the outer end of the armature shaft is provided with a three-step cone. Two of these steps are of considerable width for driving the emery wheel drum. The two speeds thus provided, allow for speeding up the spindle as the wheel wears to smaller diameter. The third step of the cone pulley on the armature shaft is connected with the table feed driving mechanism. A feed movement of somewhat different construction from the belt-driven type shown in our previous issue, is used with this motor-driven machine. No bevel gears are used in reversing by this movement. The shaft on which the feed driving pulley is mounted carries two pinions, one of which meshes directly with a mating gear on the reversing shaft, while the other one is connected with

a similar gear through an intermediate idler, the location of which may be understood by looking at the feed box at the left of Fig. 1. The clutch for connecting these two gears alternately with the reversing shaft on which they are loosely mounted, is of the positive instead of the friction type, as in the older design. The automatic movement in this new machine has also been improved, being so constructed that the workman can reverse the cross-feed and set the automatic stop for the return stroke without waiting for the stop to be released from the previous movement.

The machine as shown is arranged for dry grinding, but provision has been made in its design, and in the water guards and other attachments which will be furnished, to use water if desired by the purchaser. This machine will grind a length of 20 inches, a width of 8 inches, and a height of 10 inches with a full-sized wheel. The same motor arrangement shown can be applied to No. 3 machine, if desired.

IMPROVED SPINDLE ARRANGEMENT FOR ANDREW MULTIPLE DRILLING MACHINE.

We have described in this department in previous issues of MACHINERY (February, 1906, November, 1907, and April, 1908) various designs of the multiple drill built by M. L. Andrew & Co. of Cincinnati, Ohio. These drilling machines follow the general design shown in the engraving. The frame of the machine consists of two side housings connected by suitable distance pieces and a cross rail at the top, on the latter of which the spindle heads are adjustable. The work table is supported on a screw at each end for feeding the work up to the drills. These feed screws are operated simultaneously by worm gearing, which keeps the table always horizontal, at right angles to the axis of the drill spindle. The feed screws act on double split nuts, which are simultaneously closed or opened by a single lever, thus furnishing means for throwing the power feed in or out of action. A pilot wheel is provided for raising and lowering the table by hand. Three rates of feed are furnished, and three spindle speeds. The uses of the machine are obvious, it being possible to drill a number of holes at one setting, spaced through a great variety of layouts.



Andrew Drilling Machine with Double Spindle Drive allowing Close Spacing.

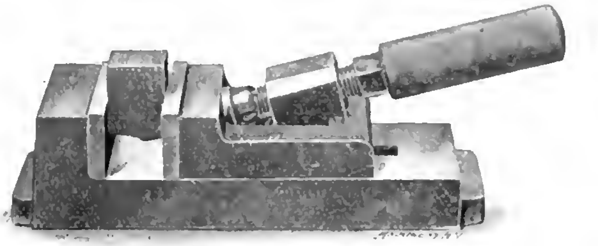
The improvement illustrated in the machine herewith shown relates to a provision for decreasing the minimum distance between two adjacent spindles. In the older design, this was limited by the driving mechanism, which consists, as may be seen, of a horizontal shaft at the top of the machine connected by bevel gears with the various spindles. These bevel gears have to be large enough to drive drills up to 1/2 inch in diameter, and they consequently limit the closeness with which any two adjacent heads can be spaced. The improvement consists, as shown, of driving two heads from one set of bevel gearing, by connecting the two heads with an idler gear, mounted with a swivel adjustment on the driving spindle, to correctly mesh with a spur gear on the driven spindle of the pair. As these driving spur gears take no room sidewise outside of their diameter, the spacing of the spindles is limited only by the requirements of the spindles and the heads. This improvement, in connection with the bracket arrangement for the side adjustment of the spindles for staggered holes (described in the February, 1906, issue) materially increases the range of usefulness of this machine.

ARMSTRONG QUICK-ACTION DRILL VISE.

The illustration shows a drill vise made by Armstrong Bros. Tool Co., 113 N. Francisco Avenue, Chicago, Ill. The special feature of this vise is the provision for rapidly sliding the jaws in or out to suit the work, without the necessity for using the slow screw movement for this purpose. When the jaw has been adjusted to position it may be tightened by turning the knurl handled screw shown. The vise is, of course, useful as well for many operations in the shaper or milling machine and it is provided with projecting lugs for strapping it to the table of the machine.

The movable jaw is held in alignment by a hinged clamp which fits a slot machined in it, and extends down through a similar central slot in the base. Through the upper member of this hinged clamp is threaded the tightening screw, with its knurled handle. The inner end of this tightening screw carries a ball jointed abutment (such as used for the heads of jack screws) which bears against an inclined surface on the rear of the jaw. When the screw is loose and the rear end of the handle is raised, the jaw and its contained clamp is free to slide to any desired position. The pressing down of the handle, by means of an eccentric surface formed by the upper part of the clamp, binds the latter firmly in position on the base. The turning of the screw against the jaw and the consequent tightening of the work in place, tends still further to throw the handle down and to bind the clamp still more firmly in place. It will be noticed that the screw points downward. This has the effect of pressing the sliding jaw downward and against the work instead of lifting it as is the case with vise jaws of the ordinary construction, operated by a screw in the base. By this means the work is held true and solid with one turn of the handle.

The sides of this vise are ground parallel and at right angles with the bottom so that work can be drilled from three different sides. The jaws are made of tool steel. The device is made in three sizes. No. 1 has a jaw 2 inches wide, 15/16 deep and opens 1 3/4 inch. The corresponding figures for the No. 2 vise are 2 3/4, 1 3/16, and 2 1/2 inches re-



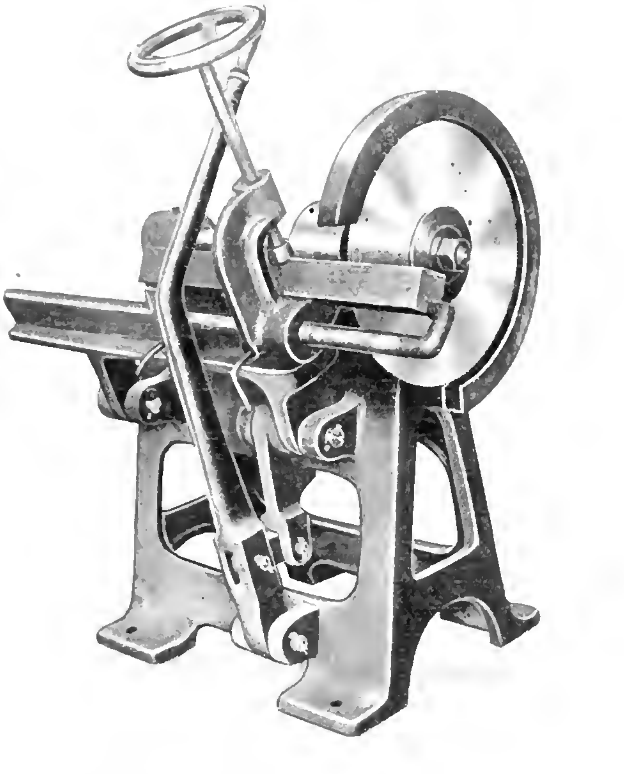
A Drill Vise that can be Rapidly Adjusted.

spectively, and for the No. 3 vise $3\frac{1}{2}$, $1\frac{7}{16}$ and 3 inches respectively. These vises weigh $4\frac{1}{4}$, $8\frac{1}{2}$ and 16 pounds respectively.

THE BILLINGS & SPENCER HOT SAW.

The cold saw shown herewith has been designed by the Billings & Spencer Co. of Hartford, Conn., and is especially adapted for the work of the drop forging plant. Used as a hot saw, it is employed for the rapid cutting off of bar stock and trimming the ends of such forgings as crank-shafts, spindles, axles, etc. While designed primarily for use as a hot saw, it is capable of cutting cold steck as well, in the smaller sizes.

The carriage is swung toward the saw about a pivot, by a compound lever movement, actuated by the long hand-lever shown. This gives a rapid-acting feed, and at the same time a very powerful one. The carriage is provided with a hand-wheel for clamping the work, and an adjustable stop for setting the work to length. The saw used is 20 inches in diameter and $\frac{1}{8}$ inch thick, and should run at 2,500 revolutions per minute. It is driven by a 4-inch belt. The capacity of the machine for hot sawing of steel of all kinds, is for work up to 3 inches in diameter. Cold iron or soft steel up to $1\frac{1}{2}$ inch in diameter can be handled.



Hot Saw Especially Adapted to the Requirements of Drop Forging Work.

LANG'S HEEL BLOCKS AND STUDS FOR SETTING UP AND HOLDING LARGE WORK.

In the September, 1905, issne of MACHINERY was pnblished an article entitled "Importance of Good Clamping Facilities in Machining Large Work," in which was described the surprising saving of time effected on such work in the shops of the Bullock Electric Mfg. Co. of Cincinnati, Ohio, by the use of special appliances for clamping on planers, boring mills, etc., and on the flcor plate for use with portable tools. One of these appliances was a form of T-bolt head made by the G. R. Lang Co. and used with plain studs threaded at each end. These were supplied for each machine, in a box, together with a variety of clamps; this provided from 1 to 2 dozen T-heads and 3 to 12 dozen studs, ranging from 3 to 36 inches in length, supplied with suitable nuts and washers. The use of these obviated a tremendous amount of lost time in the hunting up of suitable clamping arrangements. In addition, each machine was provided with turn-buckles having forked stub ends, to be used as drivers and braces, and with cast iron heel blocks also made in step form, so as to be adjustable for height. This latter appliance is now manufactured as a regular stock product by the G. R. Lang Co., of Meadville, Pa.

This device is shown in Fig. 1. As may be seen, the form of the blocks explains their use. They are made in two sizes, 4 and 6 inches high respectively, and can be stacked up to extend to any height from 1 inch to 3 feet if necessary. These steps are obtained in increments. The fractions of an inch can be taken care of by using small pieces of flat iron and washers between the steps and the ends of the clamp. These blocks are cast from accurately machined metal patterns which produce good flat surfaces, and thus give a solid bearing snpport to the clamp. In addition to their other conveniences, they have that of stability. It is not always possible to leave work from Saturday night to Monday morning without it becoming loosened, especially if wood blocking is used.

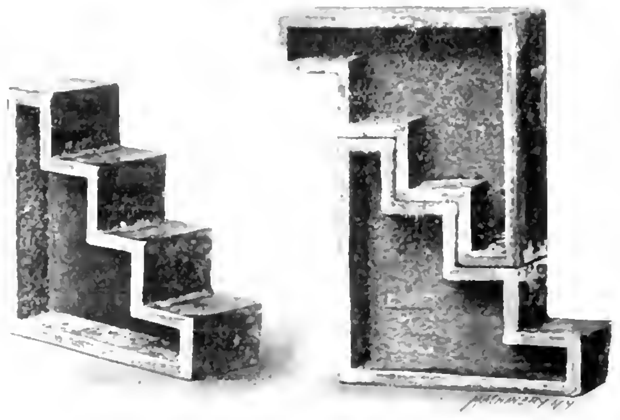


Fig. 1. Adjustable Cast Iron Stepped Blocking.

In Fig. 2 is shown a modification of the bolt head mentioned in the former article. These heads are made of a good qnality of steel, and are carefully machined to fit the slots they are to be used in. They are especially adapted to places where the maker's T-bolt heads would interfere with the work—in such cases, for instance, as bolting chuck jaws to a boring mill table, and other similar short work. They may also be used on old machines where T-slots have been badly broken out by the use of poorly fitting bolts, and where a good machine fit is required to hold. Standard sizes are kept in stock, but special sizes will be furnished when the dimensions of the T-slots they are to fit are given by the customer. The use of the studs with these, in place of the ordinary T-bolts, gives the same advantages as with the builder's previous form of bolt head. It is not only cheaper to fit the machine with these than with forged bolts, but it costs less to keep them in shape. The stnds are made of steel and hardened, and will greatly ontwear the ordinary bolt, which wears out on the upper threads and becomes useless for the greater part of its length. The square head shown in Fig. 2 is not tapped entirely through. It is thus possible to make them into permanent bolts by simply screwing studs down tightly into them, where they will stay until removed with a wrench.

Fig. 2. Machined Steel Tee-head.

CINCINNATI TWO-SPEED PLANER DRIVE.

What seems to be the limit of simplicity in the construction and operation of a two-speed planer drive, has been designed by the Cincinnati Planer Co. of Cincinnati, Ohio. This arrangement is shown applied to a standard planer in Fig. 1. The only change in the construction of the machine is the addition of a second tight pulley on the driving shaft, and a provision for a second speed in the counter-shaft, as shown in Fig. 2. This gives two forward speeds with constant reverse at high speed, without manipulation of the counter-

shaft belt shifters, the only change being the shifting of a plug in one of the belt forks in the reversing.

Fig. 2 shows the arrangement of the pulleys on the counter-shaft and on the driving shaft of the machine. With the exception of loose pulleys *A* and *B*, the arrangement of this counter-shaft is unchanged. The regular driving pulley *C* has a speed, as will be noticed, of 400 revolutions per minute, for a cutting speed of 50 feet per minute. This pulley is keyed to the shaft and drives the usual forward driving pulley *D* and the reversing pulley *E*, the latter of which, it will be noticed, has a heavy balance rim. On the driving shaft of the machine the forward belt is shifted from loose pulley *F* to pulley *G* for the cutting stroke, being returned to *F* for the reverse, which is effected by shifting the backing belt from loose pulley *H* to driving pulley *G*. This is, of course, the usual arrangement. In addition to the belt from the main line to the loose pulley *K* on the counter-shaft, there is a second one running at half the speed which drives loose pulley *B* on its left-hand side, at 200 revolutions per minute. By a change in the reversing mechanism of the planer, the forward motion belt instead of playing between *G* and *F* and being driven by a pulley *D*, may be shifted to play between tight pulley *J* and loose pulley *F*, and be driven at a reduced speed by pulley *B*, giving a forward cutting speed of 25 feet per minute.

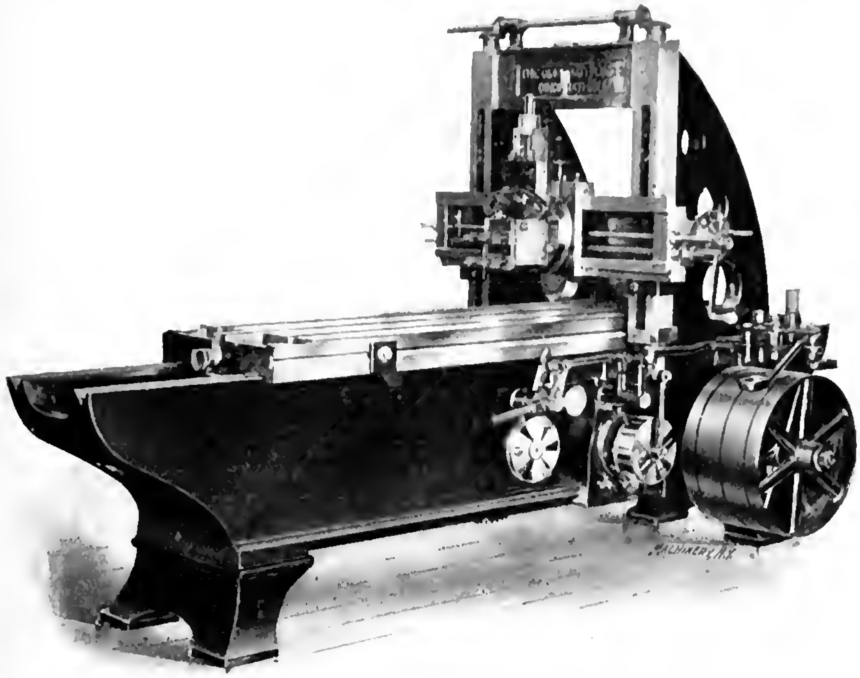
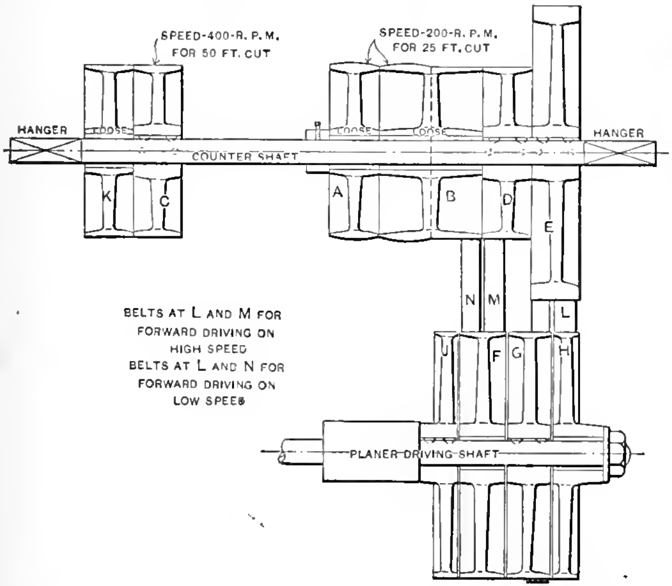


Fig. 1. Cincinnati Planer with Modified Belt-shifting and Driving Pulley Arrangement for Two-speed Drive.

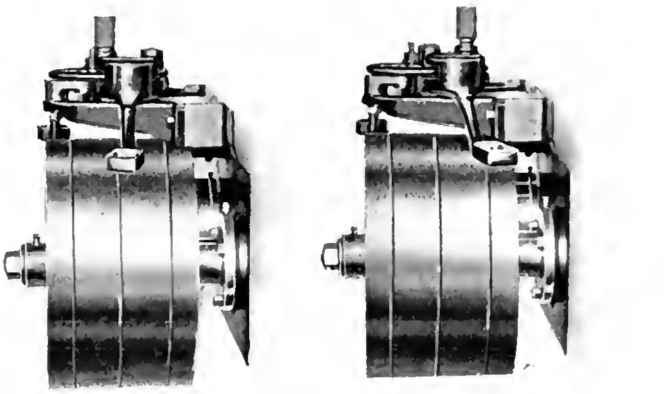


Machinery,N.Y.

Fig. 2. Arrangement of Pulleys on Counter-shaft and Driving Shaft.

This change in the position and direction of shifting of the forward cutting belt, is effected by changing the connection between the reversing cam and the forward belt shifter. Figs. 3 and 4 show the two positions of this apparatus. In Fig. 3 the knurl handled plug shown, passes down through its seat in the belt lever into the slot in the reversing cam, which thus actuates the belts in the usual way. By shifting this plug to the position shown in Fig. 4, on the opposite side of the fulcrum of the shifting lever, the direction of movement of the shifting is reversed, and the position of the belt is changed so that it operates on pulley *B* in Fig. 2 instead of on pulley *D*, giving the reduced cutting speeds.

Only one belt shifter is required for the counter-shaft, as this provides for simultaneously shifting the belt onto and from loose pulleys *A* and *K*, so that no more movements are required for the counter-shaft operation than with the usual simple arrangement. It will be noticed that the loose, slow-cutting pulley *B* revolves on the shaft only the difference in speed of the two drivers *B* and *C*, so that the service is not severe. The loose pulleys on the counter-shaft are arranged with special bronze bushings which allow room for a large reservoir of oil in the center. Slots on opposite sides lead from this central reservoir to the shaft and are so disposed as to cover practically the entire bearing surface. These slots are filled with felt which gradually draws the oil by capillary attraction to the journal. These pulleys, arranged in this way, need oiling only two or three times a year.



Figs. 3 and 4. Position of the Driving Belt Shifter Plug for Fast and Slow Drive.

The machine to which this drive is shown attached in Fig. 1, is one of the builder's regular 24 x 24-inch planers. It will be seen that very little change has been made in its design, the alterations being confined to the reversing mechanism, and the addition of an extra driving pulley.

PEERLESS HIGH-SPEED REAMERS.

The Cleveland Twist Drill Co., Cleveland, Ohio, is making a new form of reamer with high-speed steel cutting edges and carbon steel bodies and shanks, united into a solid, inseparable unit. The high-speed blades only are hardened, so that while the tools have all the hardness and cutting qualities of solid high-speed tools, they are at the same time less brittle than reamers made entirely of carbon steel. This special construction allows these tools to be marketed at a price very much below that of ordinary high-speed reamers. The process of fitting the high-speed steel blades into and solidly joining them to soft steel bodies, is done by a process termed "brazo-hardening," which has been developed and patented by the builders.

These tools are made in a number of styles, of which three are shown in the accompanying engravings. Fig. 1 shows a solid reamer of the kind largely used in screw machine work. The inserted high-speed blades are plainly seen in the engraving. Fig. 2 is a tapered shank expansion chucking reamer, in which the variation of size is obtained by screwing in or out a taper plug seated in a taper hole in the end of the reamer. The end of the reamer is split to allow the blades to spread or contract as the plug is screwed out and in. Shell reamers also are made on this expansion plan, as shown in Fig. 3, though in this case the threaded and tapered member which spreads the split ends of the reamer, is a bushing instead of a plug. This bushing is turned for adjustment by means of a keyed plug inserted in it, with a head flatted for a wrench. The advantage of the expansion reamer of this form is that it may be kept up to size at the point where it is most subject to wear. Besides this, the amount of longitudinal clearance is varied according to the material to be cut, so that jamming in the hole is prevented. This results from the fact that it is necessary to expand a reamer more to get a given size in soft metals than in hard metals, and this greater expansion gives the greater longitudinal clearance required. Owing to the process of using a soft body, and a hard cutting edge, the Peerless expansion reamers will stand much more expansion than the carbon steel reamers of similar design, and the builders state that they are the only expansion reamers which have as many cutting edges as the corresponding size of the solid type. Their price is about the same as that of the ordinary solid high-speed reamer.

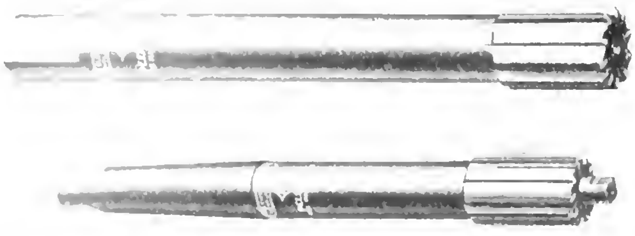


Fig. 1. Solid Roughing Reamer with Brazed Blades of High-speed Steel.
Fig. 2. Expansible Reamer with Blades similar to Fig. 1.

Fig. 3. Expansion Shell Reamer with Brazed-in Blades of High-speed Steel.

COMBINATION REVOLVING OIL-STONE AND GRINDER FOR GENERAL EDGE TOOL SHARPENING.

We have described in previous issues of MACHINERY (see New Machinery and Tools for June, 1907, and April, 1908) two forms of the edge tool sharpening machine built by Mummert, Wolf & Dixon Co., Hanover, Pa., in which the sharpening is done by a revolving oil-stone wheel in place of an emery wheel or grindstone. It is stated that tools may be ground in this way with the same effectiveness as by hand on the oil-stone, but in a great deal shorter time. The latest development in this idea is shown in the accompanying engraving, which represents a machine made by the same builders, and provided with all the various wheels necessary for keeping wood-working and patternshop tools up to a high degree of efficiency.

As may be seen, two wheel spindles are provided, of which the upper one, running at a high-speed, is provided with an ordinary emery wheel, a leather stropping wheel, and an emery cone. The lower one carries two oil-stones, one of fine grain and the other of coarser texture. The machine is driven from the upper high-speed spindle by a 2-inch belt on the 3-inch diameter driving pulley shown. This spindle is connected to enclosed spur and spiral gearing which reduces the speed of the grinding shaft (which should be about 1,800 revolutions per minute) down to 260 revolutions per minute for the oil-stones' spindle. These stones run in a dished tray, which is provided for catching the kerosene oil with which they are supplied. After the stones have once been filled with this oil, but a small amount is required daily to keep them in condition. The oil is provided by the closed oil pot shown above the cone wheel, mounted on hinges so that it may be moved out of the way when working on the upper spindle. The use of kerosene keeps the wheels clean and sharp, and prevents glazing. The wheels readily absorb the oil, and when not running appear to be dry. As soon as they are rotated at the proper speed, the oil is brought to the surface by centrifugal force. The adhesion of the oil to the stone prevents it from falling off, though oil guards are provided to keep it from flying in the case there is any loose oil in the pan below the wheel.

The outfit of wheels provided, as mentioned, covers practically the full range of tools used in the wood-working shop or pattern-shop. The grinding cone is useful for sharpening pattern-maker's gouges having inside bevels. It is conveniently placed where it can be used without interference between the tools and the oil-stones. The leather wheel, which is mounted on the large diameter of the cone, is for stropping the tools after grinding. The edge of the leather on one side of the wheel projects outward, making it possible to strop inside bevels. The periphery of the wheel is used for flat tools such as chisels, plane bits, etc. The regular grinding wheel at the back of the spindle may be conveniently used with a narrow wheel 8 or 10 inches in diameter for gumming saws, grinding molding bits, etc.

A New Design of the Mummert, Wolf & Dixon Oil-stone Tool Sharpener.

Two grades of oil-stones are provided, as described, one of comparatively coarse grain for rapidly bringing the grinding edge into shape, while the other has a very fine grain and puts on a keen, smooth edge. If the workman desires he may make use of the tool holding attachment shown, for grinding plane bits, chisels and other tools having straight edges. It may be swung up into position and set for any desired angle

of cutting edge. The blade is clamped in the holder and shifted back and forth across the face of the wheel. When not in use, it is left hanging downward where it is out of the way of the operator.

The machine is shown arranged for counter-shaft drive. The counter-shaft may be placed either on the ceiling or beneath the floor, the position of the pulley making this possible. For motor drive a different form of pedestal is provided, to which the motor is attached. This is belted direct to the pulley on the upper arbor, making a very compact arrangement.

LINDHOLM ROTARY CENTER TEST INDICATOR.

The centering of prick-punch marks, jig buttons and similar reference points in fine machining, tool-making, etc., has always been a painstaking and time consuming operation. When doing this work on the face-plate of a lathe, the operation is much simpler as it is possible to apply a test indicator to the prick-punch mark or button, and center the work easily and quickly. So far as we know, the notion of making a test indicator which would do this when the work is stationary and the spindle revolves, has not occurred to anyone before the invention of the device we show herewith. If it has occurred, the arrangement has at least never been put on the market.

Fig. 1. The Lindholm Rotary Center Test Indicator.

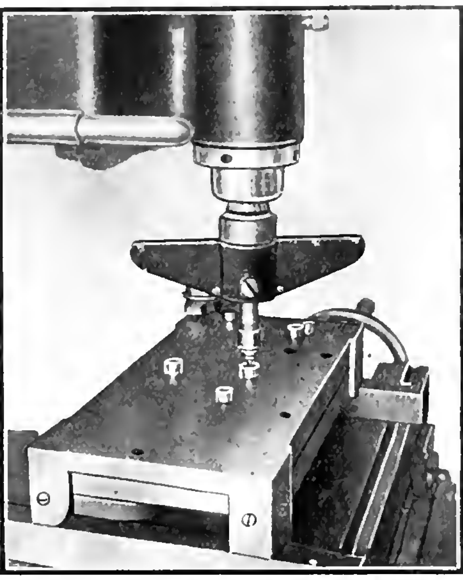


Fig. 2. Indicating the Concentricity of a Jig Button with the Spindle.

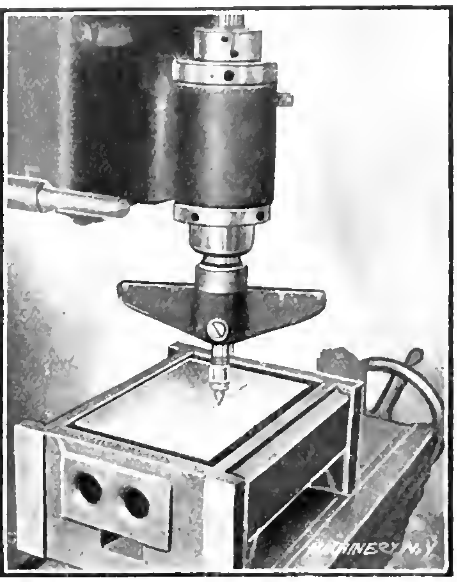


Fig. 3 Centering a Prick Punch Mark with the Spindle.

Description of the Instrument.

The indicator for this purpose here described, is made by Lindholm & Dennis, New Haven, Conn. Fig. 1 shows an exterior view of the device, while the construction is more plainly seen in the line drawing, Fig. 4. The instrument is mounted on a shank *B*, of any suitable form to be held in the spindle of the milling machine, drill press, or other machine in which the work is to be done. This has firmly screwed to it a body or frame *A*, which carries the indicating point and the multiplying mechanism. The indicating point *E* is mounted on a stem *C*, which is supported in turn in a ball joint formed in the body *A* by its spherical end, and the spherical seats in the two set screws shown. When the work is set so that the point of *E* enters the prick-punch mark or the center hole of the jig button and is pressed lightly in place by the spring supporting it, the revolving of the machine spindle in which the instrument is set, causes the stem *C* to "wobble" with reference to the body of the instrument if the axis of rotation of the spindle is not in alignment with the reference point in the work. If it is in line with the axis of rotation, the stem runs as true with the instrument as if it were solid with the body *A*. The "wobble" which takes place if the work is not lined up with the spindle, is transmitted through arm *J* (which is fast to stem *C*) through levers *K* and *L*, to the fine wire attached to the long end of the latter. This wire passes through a hole in the shank of stem *C*, where it is attached to the end of a stirrup *G*. This stirrup passes through slots in the sides of the stem, and engages thimble *D* sliding on the outside surface of *C* where it moves up and down under the influence of the stem itself, as the spindle is revolved, this movement being multiplied by the levers just described. Spring *H* keeps the stirrup and thimble normally at their lowest position, and furnishes the resistance against which the movement of the stem is transmitted through the lever mechanism.

The movement of the thimble on the shank is read by a series of graduations in the periphery of the latter. These graduations, which are 1/32 inch apart, represent thousandths of an inch of eccentricity. Of course, the advantage of having the indicating done by this thimble instead of by a pointer moving over a dial, is that the readings can be taken while the instrument is rotating. This would not be the case with a dial, as the workman would have to take readings in different positions of the spindle, stopping the latter and following it around to the indicating point for each reading. As will be shown later, it is very important that readings be taken while the spindle is revolving.

While the uses of this instrument would seem so obvious as to need scarcely any description, a number of interesting results have been observed in practical use. The device was invented a number of years ago, and has been used in at least two large establishments where the finest kind of tool-making is done, and the makers state that in these plants it has revolutionized methods in jig making, and has proved to be a great time saver and cost reducer in the tool-making department.

Uses in Tool-making and other Fine Machine Work.

In tool-making it is well known that the greater part of the time on a job is consumed in getting ready and setting up; this is noticeable, for instance, in setting a jig or fixture on a face-plate or lathe, by indicating a prick-punch mark or button centrally with the spindle. It is not necessary to explain the maneuvers gone through in strapping and clamping the work properly, balancing the face-plate, and then knocking the work back and forth to get the button or prick-punch mark central. The time required for all this on fine work runs up into the hours on even simple fixtures. The use of master plate or micrometer methods does not effect a saving of time when used in connection with the lathe, as the same preliminaries must be gone through. In handling work of such dimensions and shapes that it would be impractical to use the lathe, the milling machine is used, but this does not reduce the time expended, no matter what the method used. Accuracy is difficult, also, when using the method of locating the points by the graduations on screws, or by trying to split thousandths of an inch in vernier readings. To overcome this uncertainty, obtain accurate results,

and reduce the time employed to the minimum, this rotary indicator was designed.

The instrument is inserted in the spindle of the machine used, the pointer of the indicator is placed in the prick-punch mark or button on the work, and the exact location of the center of the button or prick-punch mark with reference to the axis of rotation of the spindle is seen at once on starting the machine. Adjusting the work so that it becomes central requires but a fraction of a minute. Releasing the indicator and inserting the boring tool requires but a short time more, and the machining operation is at once commenced.

It has been found by the use of this instrument that the same speed should be used when indicating the work as is employed when boring the hole, thereby insuring the same conditions of the machine in relation to the work when boring as when indicating. An instrument was tried on a vertical milling machine to determine the accuracy of the spindle and the table in relation to each other when the machine had been running for a certain length of time in one case, and when allowed to stand for an hour in the second case. After the machine had been running for some time it was stopped and a jig with a button placed on the table and the pointer of the indicator placed in the button, which was then indicated centrally with the spindle. The machine was next stopped for an hour, the indicator remaining in place in the button. The machine again being started, the spindle was shown to be out of center with the work by 0.0005 inch. Allowing the machine to run brought the spindle back to its former position. The time required for this was about ten minutes. This experiment was tried a number of times, and proved that the condition of the spindle in relation to the work should be taken into consideration when doing accurate work. [This was doubtless due in part to temperature changes, but perhaps more to the distribution of the oil over the surface of the journal, which is different in running conditions than when the spindle is standing still.—EDITOR.]

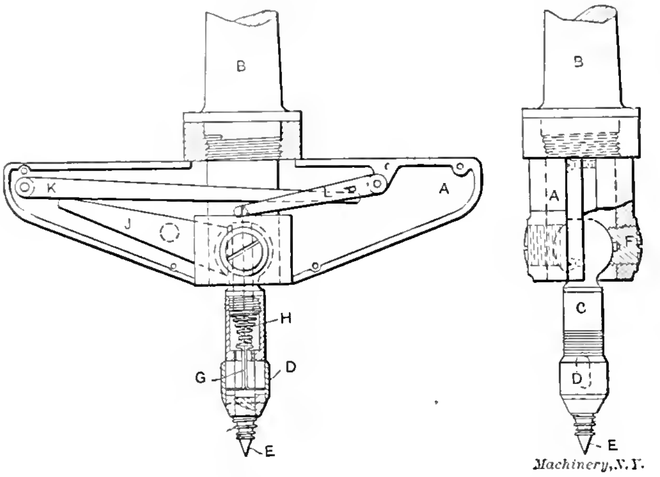


Fig. 4. Details of the Construction of the Instrument.

Another experiment was tried to determine what effect a light blow would have on the table. A lead hammer was used, striking very light blows. This was found to alter the setting from 0.0025 to 0.0005 inch, showing that a slight jar would have a tendency to change conditions. All clamps and stops were securely fastened during this test.

In Fig. 2 is shown a jig with the buttons in place, located on the table of the milling machine. The point of the rotary indicator is placed in the button and the machine started. The indicator revolves with the spindle, and the thimble moves up and down showing just how much the button is out of center with the spindle. The table is then adjusted until the thimble is at a stand-still. The time required need not be more than 20 seconds. The instrument is removed and a boring tool inserted, the same speed being used as when indicating. In Fig. 3 the same vertical milling machine is shown, but instead of using a button, a small prick-punch mark has been made at the intersection of two lines, and the point is placed directly in this. The time required to indicate is about the same as for the button, and the accuracy of the operation depends entirely on the question of the accuracy of the tool-maker in placing the prick-punch mark. The indicator will locate the latter exactly in line with the spindle. Fig. 5 shows the rotary indicator in place in the horizontal milling machine. Here the instrument revolves about the horizontal axis and the thimble oscillates to and fro.

The device can, of course, be used on other tools—on the drill press, for instance, with the indicator in the spindle and the pointer in a prick-punch mark. In this case the work is done under somewhat the same difficulties as in the lathe—that is, a hammer or mallet must be used to bring the work central. The indicator can be used in the lathe tail-stock as well as in the spindle. It will be noted that any form of shank convenient can be used for this instrument. Figs. 2, 3, and 5 show a straight shank screwed into the body of the instrument, which is held by a collet in the spindle of the machine; Figs. 1 and 4 show a taper shank.

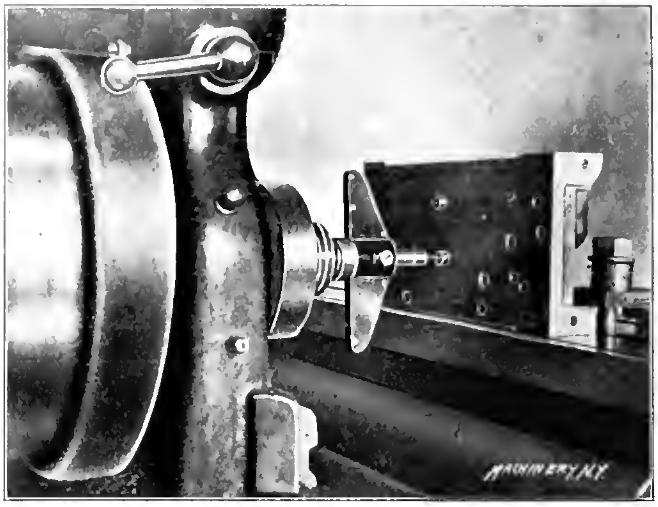


Fig. 5. Use of the Indicator in the Horizontal Milling Machine.

HIGH-FRAME WHITNEY POLISHING JACK.

In the department of "New Machinery and Tools" of the March, 1907, issue of MACHINERY, was illustrated the Whitney polishing jack, built by the New Britain Machine Co., of New Britain, Conn. The essential feature of this jack was that it was designed to be belted from below, the belt passing through the frame and through the floor, to the line shafting on the ceiling of the floor below. No counter-shaft was required, the machine being arranged for starting and stopping by raising and lowering the spindle, and thus tightening or releasing the belt. This arrangement makes a machine which may be handled by even female help with ease and safety. So far as the operation of the machine is concerned, there is also a great advantage in belting downward, as the pressure is taken against a solid bearing instead of upward against a box cap. This gives a steady running spindle.

Fig. 1. Whitney High-frame Polishing Jack, made by New Britain Machine Co.

The new Whitney "high" polishing jack shown herewith, may be used with the operator standing, or seated on a high stool. The starting and stopping of the spindle is done by means of the toggle lever shown at the front; raising it lowers the hinged plate on which the spindle boxes are mounted, and thus loosens the belt, at the same time bringing the pulley down against a brake block and stopping it at once. This

relaxes the belt as well, greatly lengthening its life. By the use of this brake, a heavy emery wheel 14 inches in diameter by 2 inches wide can be stopped from full speed in three seconds. The pressing down of the lever raises the arbor again and tightens the belt into working tension. The lever and the attached link passes by the dead center enough to lock it in position. There is no possibility (as there is with a shifter) of having the belt run off and of being obliged to start slowly on this account. There is, in fact, very little to accelerate on this machine, so that the starting is done in a very short space of time. An ordinary leather-covered wooden polishing wheel, of course, requires less time. Where frequent changes of wheels are to be made, as is quite necessary in the general run of polishing work, this question of quick stopping is an important one.

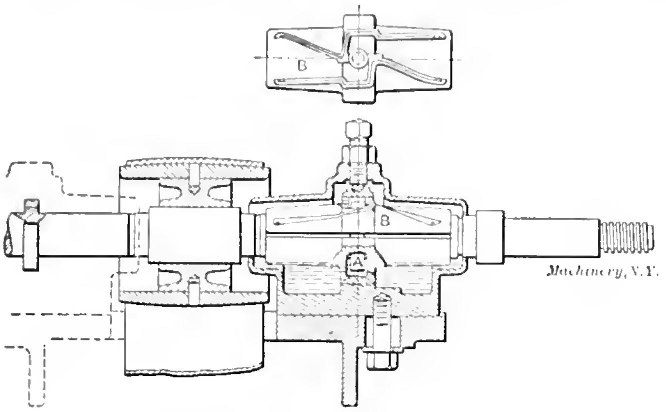


Fig. 2. Design of Spindle and Bearings.

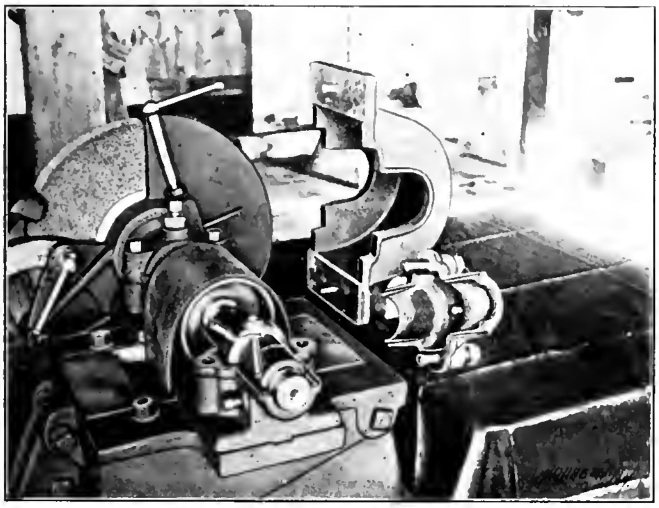


Fig. 3. Belt-cover, Bearing Cap, and Upper Half of Box removed.

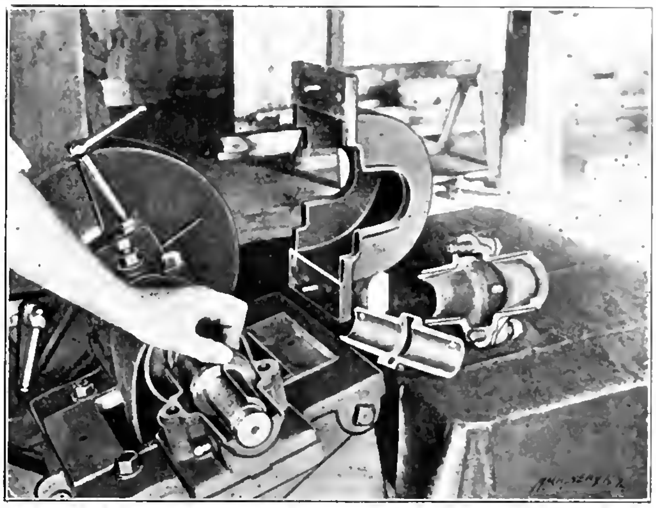


Fig. 4. Removing the Lower Half of Box.

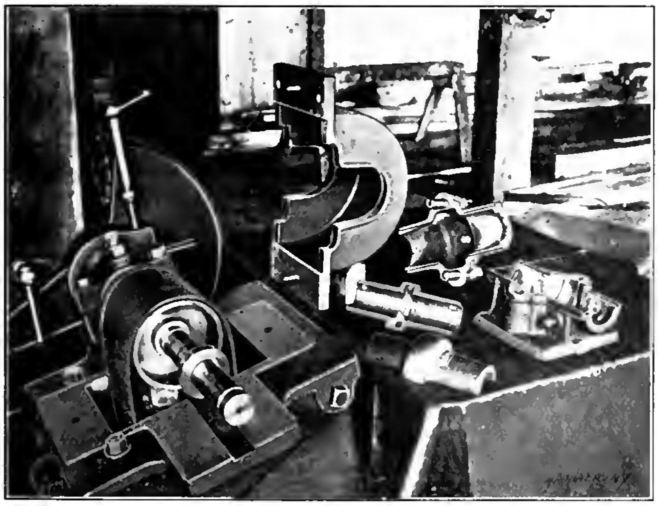


Fig. 5. Removing the Outer Bearing.

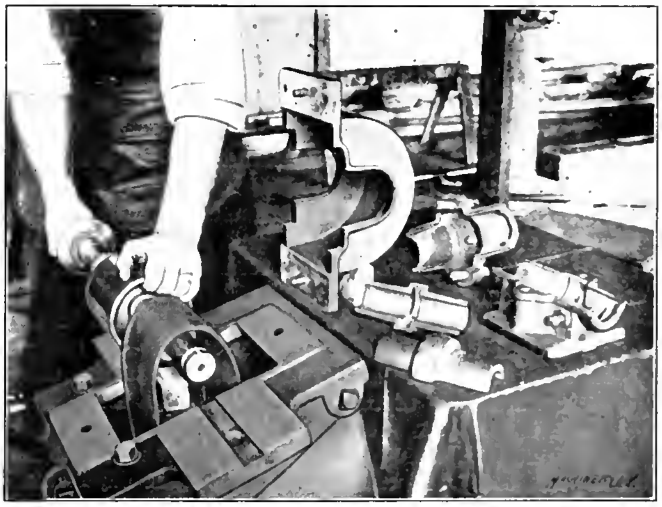


Fig 6. Removing the Spindle.

The line drawing, Fig. 2, and the views in Figs. 3 to 6, which show the dismantling of the head, illustrate the oiling arrangements. The bearings are made in halves, as shown, with a central recess in which is confined a collar A solid with the shaft. These collars take up the end thrust. They run in a reservoir of oil which is conveyed to the top of the upper box *B*, where it escapes through the horizontal openings at one side or the other, depending on which side of the shoulder is receiving the thrust. From whichever side of the collar the oil is delivered it is led by ducts, as shown, to oil holes at each end of the bearing. By cutting open the casing of the bearing, it has been found that the oil ways and oil holes are entirely full immediately on the starting of the spindle, and the flow continues without intermission as long as the spindle runs. No more than the proper amount of oil can be gotten into the reservoir, as the self-sealing oil covers are situated at the proper height to receive and hold a definite amount. The end thrust collars being located inside the box, have their oil throwing tendency thus put to good instead of evil uses. The spindle may be run in either direction, the only change necessary being to turn the tops of the boxes around so that the arrows cast thereon will point in the direction of the desired rotation. The shafts are ground and the boxes are made of gray iron. This, with the copious lubrication provided, gives a glazed bearing of a kind that is very durable. The bearing, as may be seen plainly in Fig. 2, is self-aligning, and accommodates itself to any possible spring or vibration at the high speeds prevalent in polishing practice.

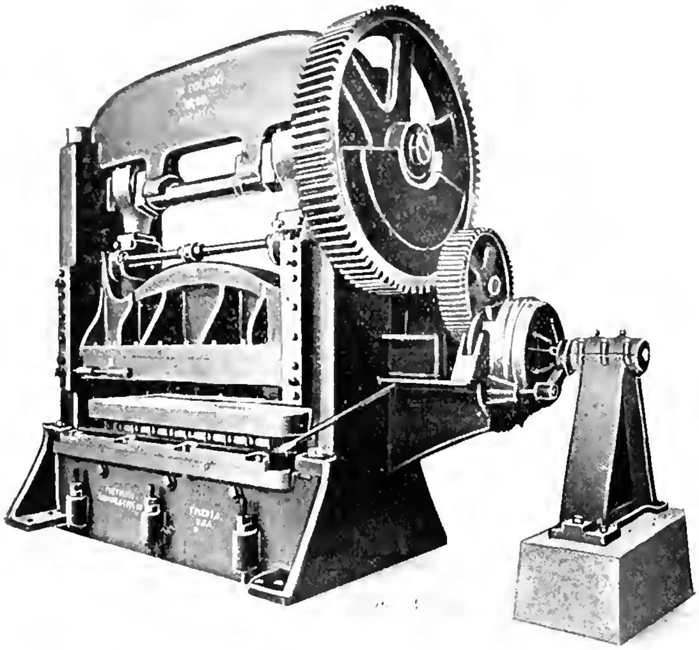
Figs. 3 to 6, which show the successive operations in dismantling the head, give a good idea of its construction. The removal of two bolts in the cap, as shown in Fig. 3, permits the latter to be removed and allows the upper half of the box to be picked off from the shaft. The lower half of the box may be tipped around and pulled out from the under side, as shown in Fig. 4. The bearing pedestal may now be slid out endwise on one side (see Fig. 5), and the whole spindle, bearing box, and wheel frame removed from the other

side. All this is done as may be seen in Fig. 6, without removing the belt, which is then enough slackened to permit relacing.

It might be mentioned in connection with this design of frame that the insurance requirements are fully met, as in the case of fire there is nothing to burn and there is really no communication between the floors through the belt holes, as the joint between the base and the floor prevents the water from passing downward, or fire from working upward. It is not necessary to have the line shaft on the floor below, as a low platform may be built to contain it and the form of hanger used that allows the driving pulley to revolve partly in the frame of the machine. This will call for but little rise above the general floor level.

TOLEDO HEAVY SINGLE-ACTION DRAWING PRESS.

The press shown herewith, built by the Toledo Machine and Tool Co., Toledo, O., is designed for very heavy drawing, on work of comparatively shallow form, having been originally designed for making seamless casket covers. It is applicable, of course, to any work of a similar nature. The operation consists in first placing a plain flat piece in position on the dies. The press is started by the friction clutch shown, and the descending of the ram, at a single stroke, clamps the work and draws it to the desired form. The resulting blanks are practically free from wrinkles and buckles.


Single-action Press for Large, Heavy, Shallow Drawing.

The pressure ring shown in the illustration rests on studs or pins around the exterior of the lower die. On this ring the flat sheet is placed. As the ram comes down and strikes the work laid on top of the pressure ring, the latter is carried down against the pressure of the studs or pins, which are supported by a heavy spring arrangement in the interior of the press bed. The tension on this ring is adjustable by means of six studs mounted on the outside of the base, three of which show in the illustration. These serve to adjust the spring pressure from the outside, it being thus unnecessary for the operator to get down under the press bed. A special foundation has to be provided for the machine, so constructed as to provide a pit under the press for the attachments, and for that portion of the bed which projects below the floor line.

Two men only are required to operate the machine—one operator and a helper. It is stated that the placing of the work in the press, the forming of the shape, and the removal of the finished work can be completed in ten seconds. A desirable feature of this die is the fact that it is made adjustable for a number of lengths of covers or tops, without removing either the upper or lower members from the machine. This is particularly advantageous on work of this kind, owing to the enormous size and weight of the parts.

The complete weight of the press is about 85,000 pounds. It takes in 102 inches between uprights and has a table 52 inches wide from front to back. The stroke is 12 inches. With stroke and adjustment up, the distance from the bed to the bottom of the slide is 27 inches.

NORTHERN TYPE "S" VARIABLE SPEED MOTOR.

The direct driving of machine tools by electric motors has developed in the past few years to such an extent as to result in a radical development in motor design, to meet the requirements of this work. Prominent among these requirements is that of variable speed, which is advisable to avoid complicated mechanical construction, and which is also used in connection with the mechanical changes for giving finer gradations of speed. There are well-known difficulties met in connection with the attempt to build a variable speed motor, even with the design in which the variation is obtained by inserting resistance in a shunt field circuit. The chief difficulty is the sparking met with at the extremes of the speed changes, particularly at the highest speed, when the field has been weakened. This sparking is due to the distortion of the magnetic field by the armature reaction, which increases the voltage between the adjacent bars of the commutator as they pass under the brush. The particular point of improvement in this new type "S" motor is the construction of the magnet core, which greatly reduces this distortion of the field, permitting a wide variation without any trouble at the commutator.

Fig. 1 shows the motor as a whole, while Fig. 2 shows the peculiar construction of the field. Each pole, it will be seen, is made in two parts with an air gap between. The whole field itself is built up of punchings of the shape shown. When the field is weakened and the effect of the armature reaction is therefore at its greatest, there is very little shifting of the field, owing to the reluctance of the air gap between the two sides of the pole pieces, which effectually prevents one stream of magnetic force lines from passing over into the path of the other. The lines thus travel nearly straight to the pole faces, at an even density, where the small inwardly projecting tips permit them to expand and distribute themselves fully over the entire air gap. The magnetic circuit from pole to pole is shown in Fig. 2. It should be particularly noticed that while the pole pieces are in halves, the magnetic circuit in each quarter is complete, without joints, as each one includes in itself a north and south pole.

This arrangement of the magnetic circuit lends itself readily to effective and simple mechanical construction, as it is possible to construct the entire magnetic circuit of the motor from soft sheet steel stampings. This increases the magnetic efficiency, as all joints are eliminated, and the possibilities of blow-holes and other defects are avoided. For this reason, therefore, less section is required, with a consequent reduction in weight, while the material used is of the kind

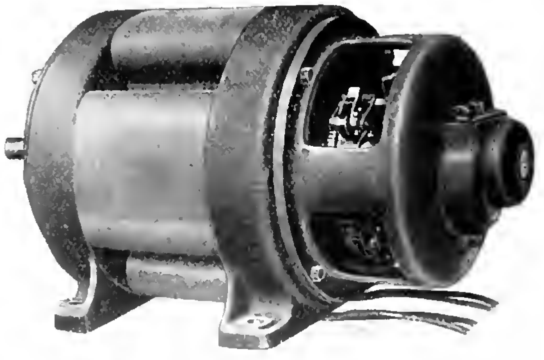


Fig. 1. New Variable Speed Motor made by Northern Electrical Mfg. Co.

best adapted to respond quickly to changes in full strength, owing to its low hysteresis. The laminated construction also prevents any eddy currents from being set up in the pole faces. All of these points are especially desirable in a motor for use in variable speed work. The construction, in addition, lends itself readily to special ratings, as the length of the machine can be so increased as to span the gap in ratings between successive frames, as it is simply necessary to stack up the proper width of armature and field punchings to give a motor of the size required. Before being finally secured together, the whole mass is placed under hydraulic pressure and compressed, where it is held rigid while the retaining rivets are set. The end flanges are machined and tapped for the bearing frames.

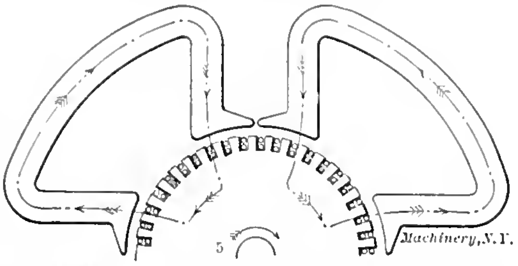


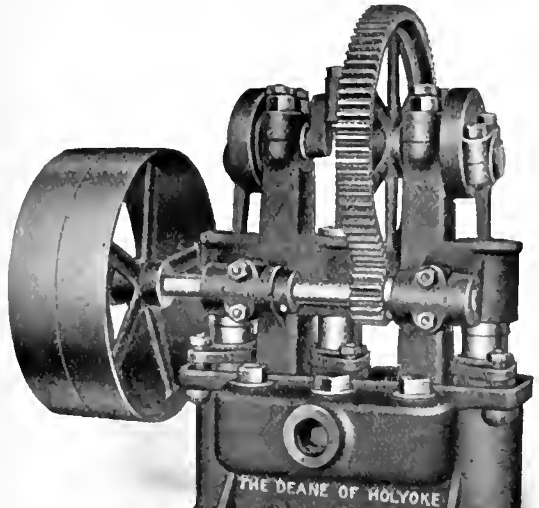
Fig. 2. Diagram showing Split Field Magnet Core which prevents Field Distortion.

The armature is of the characteristic type made by this firm. It is wound with machine formed coils and has a commutator of hard drawn copper bars. A box type brush holder is used, with easy means of adjusting the tension on the brush and for removing it for inspection. The bearings are of the self-aligning type. The motor will be furnished in the enclosed form when desired. It is especially efficient under these conditions, as the laminated construction reduces the eddy-current heating to a minimum, and the nature and extent of the exposed surface are such as to greatly assist in the dissipation of the heat generated by the internal resistance.

These motors are built by the Northern Electrical Mfg. Co., Madison, Wis. They are made in sizes up to 50 horse-power, under constant speed, with a wide range of adjustable speed ratings up to 6 to 1 in regular designs, and with even larger ratios under special conditions.

DEANE TRIPLEX POWER PUMP.

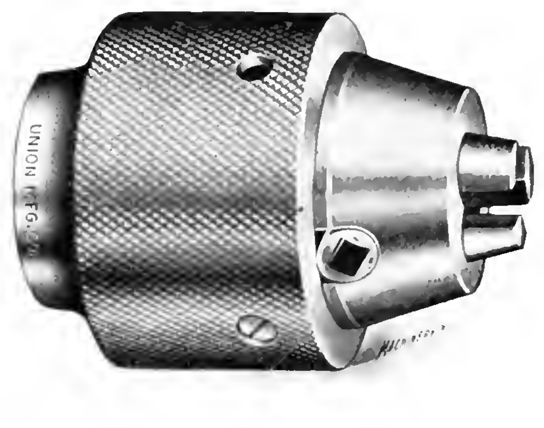
The accompanying illustration shows a power triplex pump put on the market by the Deane Steam Pump Co., of Holyoke, Mass. Special pains have been taken in the design of this machine to make it simple, compact and rigid, and particularly to make it entirely accessible for inspection and adjustment in all its parts. The crank and pinion shaft bearings and the connecting-rod bearings are adjustable for wear. The crank-shaft and connecting-rods are drop forged. The stuffing boxes, which are unusually deep, are of the stud gland type. The design of the frame is such as to afford an unusual amount of room for repacking the plungers, which, it will be seen, is done from the outside. Each valve is separately accessible through a quickly-removed hand-hole cover. The valves are of rubber or bronze, depending on the service for which the pump is required. A drip flange is carried all around the pump at the top of the water cylinders to catch leakage from the plungers, and any oil which may run down over the frames from the working parts. The machine is supplied regularly with tight and loose pulleys, as shown, but may be fitted with double gearing and a special base for direct connection to a motor, at a slight additional cost.



Deane Triplex Power Pump.

UNION GEARED DRILL CHUCK.

The accompanying engraving shows a geared drill chuck which has just been placed on the market by the Union Manufacturing Co. of New Britain, Conn. It is called the "Union geared drill chuck." In its general construction it is the same as the "Czar drill chuck," made by the same builders for many years. The parts are of steel, and the standard of workmanship followed in the old chuck is carried out in this new one. The improvement in construction is the provision of a pinion meshing with a circular rack for rotating the knurled sleeve with a key, instead of by grasping it by hand, as was necessary in the former construction. This has the well-known advantages of tighter gripping possibilities, and of making it unnecessary to hold the spindle with one hand while the tightening is done with the other. The particular construction followed in incorporating this improvement gives a pinion enclosed within the body of the chuck, which the builders believe is superior to the construction in which the gearing is outside, or in which the pinion is part of the wrench, as it insures perfect alignment of the pinion with the rack, and also avoids unnecessary wear of those parts.



Geared Drill Chuck with Enclosed Pinion.

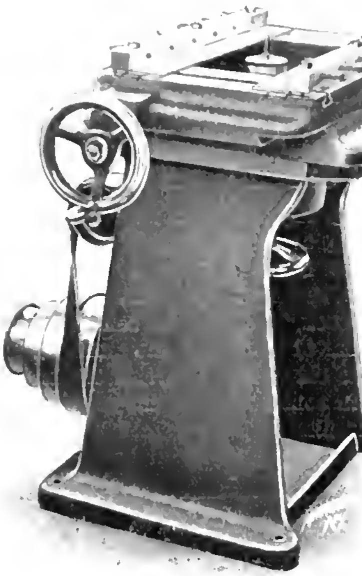
BILLINGS & SPENCER MILLING MACHINE FOR DIE CUTTING.

The Billings & Spencer Co. of Hartford, Conn., is building the specialized form of milling machine shown herewith for making trimming and punching dies. It was developed originally for the making of these dies, in the shops of the builders, especially for drop forging work, but it is, of course, as useful for making the trimming and punching dies used in sheet metal work.

The salient feature of the machine is the inverted spindle, in combination with a work table provided with screw and hand-wheel movement in two directions. With this construction, by using a mill tapered to give the amount of draft desired for the die, the latter may be clamped in the chuck jaws shown on the table, and be worked out to fit the outlines scribed upon it, in such a way that the operator can follow the action of the cutter along the line with nothing to interfere with his vision. This is more convenient for this particular work than the ordinary vertical spindle milling machine, in which the cutting through has to be done blindly with the design on the lower side of the work, or has to be

done by the expedient of employing a mill having a reverse taper—that is, a larger diameter at the end than at the shank. Even when using such a mill, however, the cutter spindle obstructs the vision of the operator more or less.

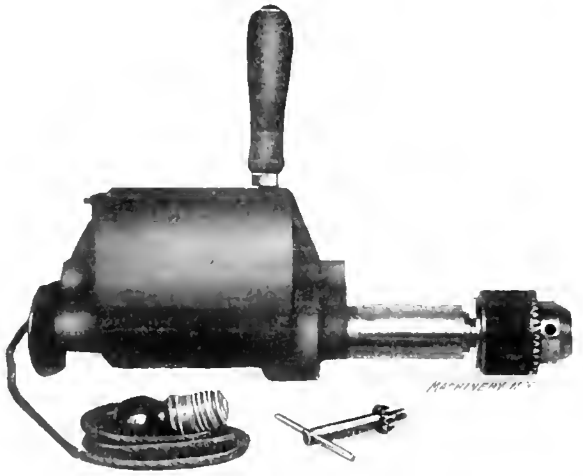
With this machine, the operator stands at the front, where he can control the movement of the work by the two cross-slide hand wheels, one on his right and the other on his left. The inverted spindle holding the cutter is placed in the opening of the heavy universal carriage. The construction of the spindle is such as to hold the cutter very rigidly, at the same time allowing it to be easily removed or replaced by the operation of the hand-wheel located at the base of the spindle, and partially seen in the engraving. In removing the cutter, the turning of the hand-wheel releases it and at the same time forces the collet outward, acting as a positive ejector. The spindle is provided with an efficient oiling system, insuring perfect lubrication to all the bearings. Four collets (⅜, ½, ⅝, and ¾ inch diameter) are furnished with the machine.



An Inverted Milling Machine for Die Work.

WILLEY PORTABLE ELECTRIC BREAST DRILL.

The drill shown herewith is made by the Willey Machine Co. of Jeffersonville, Ind. The main feature of the design is the simplicity of its construction; this is a matter which has to be carefully considered in making a machine which will be durable under the rough usage to which tools of this kind are often subjected in service. But two gears are used, both cut from solid bar steel. The drill spindle has two long bearings, with removable bushings of high grade phosphor bronze, in place of the single short bearing often met with in drills of this type. Owing to the low speed of the motor, the wear on the commutator, bushings, gears and bearings is comparatively slight. By simply removing two nuts the entire machine can be taken apart by any ordinary mechanic for inspection of the enclosed mechanism, no electrical knowledge being necessary. All these points tend toward increasing the durability of the tool, and facilitate inspection and maintenance.



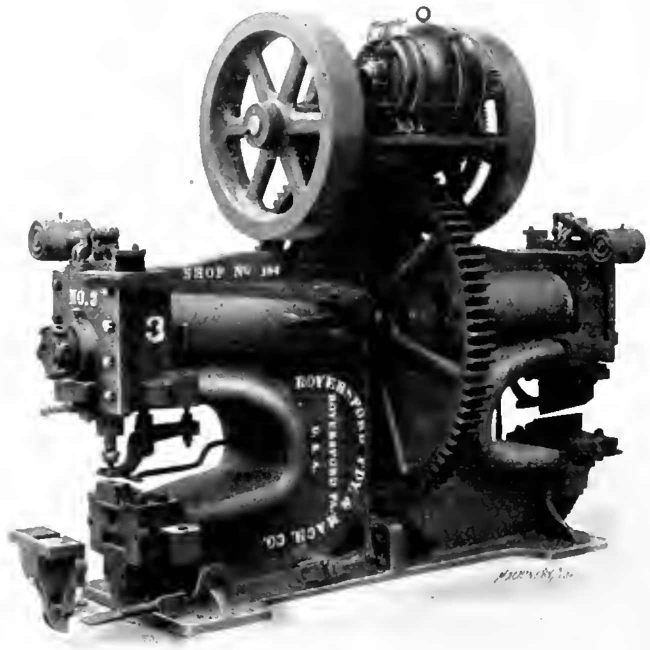
An Electrical Breast Drill of Simple Design.

All the electrical connections are attached to the main casing of the machine, and are not disturbed when it is taken apart for any purpose. A snap switch is located on the side of the frame, convenient for starting and stopping the drill. Special attention has been given to ventilation, insuring cool running and high efficiency of the motor. A system of air ducts has been provided in the armature for this purpose similar to those found in larger electrical apparatus.

The tool is made in four sizes, having a maximum capacity of ¼, ⅜, ½, and ¾ inch respectively in steel, the largest of these having two speeds. The motors are wound for either direct or alternating current and for any voltage up to 250. The side handle shown can be quickly attached or removed as required by the work in hand.

ROYERSFORD COMBINED PUNCHING AND SHEARING MACHINE.

Royersford Foundry and Machine Co., Royersford, Pa., has recently gone into a heavier line of punching and shearing machines than it has built for some years past. Having found a constant call for heavier work, the builders have designed the No. 3 punch and shear shown herewith, which is made with either 26- or 32-inch throats on both sides, with the added provision of a 4-inch extension on the punch side, which gives a depth of 30 or 36 inches at this point.



Combined Punch and Shear for General Work.

These machines are suitable for general structural work, railroad shop, machine shop and boiler works purposes. They are of compact design and of simple construction, requiring very little floor space. Each side is independent of each other, but both sides can be operated together. The removable lower jaw on the punch side makes the machine very convenient for punching I-beams and channels.

The shearing capacity of the tool is for work up to 10 inches wide by 1 inch thick on flat stock, and 2 inches diameter for round stock. The capacity of the punch is for holes up to 1½ inch in diameter in 1-inch plate. The machine with a 26-inch throat weighs 18,000 pounds, and with the 32-inch throat 21,500 pounds.

UNIVERSAL HACK-SAW FRAME.

The adjustable hack-saw frame built by the West Haven Mfg. Co. of West Haven, Conn., has recently been improved, resulting in the design shown in the accompanying illustra-

tion. This form the builders call their "1908 universal hack-saw frame."

This frame has been designed to meet the demands for increased length and lightness. It is made of a high quality of crucible steel 3/4 x 3/16 inch in section, highly nickled and polished. The small parts are case-hardened. The special feature of the design is the provision for adjusting the length of the frame for different sizes of blades. An improvement in this new model is the accurate graduations provided for setting the frame for these adjustments. The spaces are all marked for different lengths so that the proper position may be obtained at once. Another special feature is the fact that the blade is held in place by a knurled nut, so that it is impossible for it to fall off the pins when the strain is relieved for the purposes of adjustment. The blade is arranged to cut in four different positions without removing it from the frame.

Adjustable Graduated Hack-saw Frame

The distance from the bottom of the frame to the cutting edge of the saw is 3⅛ inches. The handle is 1⅜ inch in diameter, and 4⅛ inches long. The list price is $1.00.

CUTLER-HAMMER MACHINE TOOL CONTROLLER.

We show herewith, in Figs. 1 and 2, a drum type machine tool controller which has recently been brought out by the Cutler-Hammer Mfg. Co., Milwaukee, Wis. The most noticeable feature of this controller is the fact that it is mounted in the same case with both the armature and field resistances, making unnecessary any special provisions for these pieces of apparatus, with the complicated connections which would otherwise be required, and which would have to be made after the apparatus is installed.

Fig. 1. Front View showing Armature Resistance.

Fig. 2. Rear View showing Field Resistance.

Fig. 1 is a front view of this new type of controller, and shows the removable resistance units mounted in the lower half of the frame with insulated wires running from each unit to metal contact fingers in the upper part of the device. These units constitute the armature resistance, and are employed for starting duty only. Fig. 2 is a rear view of the same controller, and shows another type of resistance unit, also removable, mounted in the back. The four units shown herewith constitute the field regulating resistance. They are each divided into five steps, giving twenty contact points in all, providing a range of variation in speed of from 2 to 1 to 3 to 1.

These controllers are made for both reversible and non-reversible motors, ranging from 1 to 7½ horse-power, and are designed for use on either 110 or 220 volt direct current circuits.

Garvin Machine Co., Spring and Varick Streets, New York. Milling machine with extra long feed, designed for work requiring long cuts; in other particulars similar to the No. 15 plain milling machine built by the same firm.

Henry Koch & Son, Nyack, N. Y. Test indicator suitable for general use in centering work in the chuck, lining parts in erecting machinery, testing workmanship, and other similar operations.

Williamson Vise Co., Bradford, Pa. Tilting drill press table for use in connection with any standard form of drill press. The square platen of this vise can be tilted at any angle from the vertical to the horizontal to permit the drilling of holes at any angle required.

H. A. Stocker Machinery Co., Chicago, Ill. The Rearwin emery wheel dresser having wheels with cutting blades arranged in spiral form so that they over-lap each other and make a continuous cut on the wheel. The teeth are said to be self-sharpening.

H. O. Costello, 87 Oakland Avenue, Providence, R. I. Quick adjusting micrometer in which, by means of a ratchet arrangement, the barrel is adjusted rapidly for position without requiring the thread to be screwed the whole length of the adjustment.

American Gas Furnace Co., 24 John Street, New York. Heating machine intended especially for tempering and coloring steel parts. It is made in the form of a tumbling barrel, uniformly heated, and provided with gas and air valves and a thermometer so that the temperature can be controlled accurately.

William P. Stein & Co., Rochester, N. Y. Surface grinding machine of the type in which the work to be ground is moved by hand over a flat table beneath the wheel; it is especially adapted to the sharpening of dies. The table is provided with grooves for catching loose emery.

New Departure Mfg. Co., Bristol, Conn. New Departure "Two-in-One" annular ball bearing. This bearing gets its name from the fact that it is designed to sustain both radial and thrust loads. In the compact type of double bearing, the balls are spaced by a sheet metal separator which preserves the relative position on all the balls in both races.

Baird Machine Co., Oakville, Conn. A tilted revolving barrel for drying small parts of wire or sheet metal in hot sawdust after being subjected to a wet tumbling or plating process. This barrel has double walls and is steam heated, the operation of emptying it being accomplished in the same way as with the builders' tilting tumbling barrel.

Higley Machine Co., 91 Liberty St., New York City. Revolving table type cold-saw, which may be set at any angle for cutting structural shapes, etc. It is provided with a friction feed which is so regulated as to automatically proportion the power of the cut to the resistance offered, thus saving the saw from being injured by a forced feed.

Rockford Tool Co., Rockford, Ill. Twentieth century balance tester for balancing pulleys, armatures and other rotating parts, in place of using parallel straight edges. The shaft is supported by four knife edge disks of large diameter, rotating on ball bearing pivots. The frames are adjustable to suit work of different lengths.

John B. Morris Foundry Co., 933 Harriet St., Cincinnati, Ohio. The Schellenbach lathe which we have previously il-

lustrated as the complete geared head type in our June, 1908, issue, but with the cone head and plain change gear mechanism substituted for the original geared changes. Otherwise, it has the same special features of taper attachment, improved carriage construction, etc.

Massey Vise Co., 176-178 S. Clinton St., Chicago, Ill. Parallel bar vise in which the parallel bars are fast to the removable jaw, and pass through widely spaced bearings in the stationary jaws, being connected by a yoke at the rear which slides on ways on a fixed guide attached to the movable jaw. This gives a support for the full length of the sliding jaw at all times.

Kinsler-Bennett Co., Hartford, Conn. Two new types of universal joints; one of these is a form of the regular double fork and central block type, provided, however, with a shell which covers and protects the joint. In the other the construction has been modified, the fork of one member having a closed end, encircling the block, while the other member is in itself a shell which serves to cover the mechanism.

Morrow Mfg Co., Elmira, N. Y. A ball bearing drill chuck. The jaws are forced down on the work by being pressed outward through a taper sleeve. The thrust of the tightening is taken by a ball joint, making it possible to get a very strong grip with comparatively little twisting action, as the work lost in friction is minimized by this construction.

E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. Large presses for making side seams in cylindrical work. This is a modification of the horn type of press; in this case, however, the horn is placed parallel with the crank-shaft of the double frame press, the work being inserted through an opening in the side of the press. It will press seams in work up to 30 inches in diameter and 40 inches in length.

F. E. Reed Co., Worcester, Mass. A special lathe for manual training and pattern work, driven by a motor mounted in the cabinet base. The motor has a 3-step cone mounted in the armature shaft which is bolted directly to the spindle cone, the bed being of such form as to make this possible. These lathes are furnished with a complete outfit of accessories necessary for manual training and pattern work.

Messrs. Edward Brown & Son, 311 Walnut Street, Philadelphia, Pa. A portable pyrometer of the type in which a thermocouple is applied at the point where the temperature is to be measured, and the leads are connected with a sensitive volt meter to indicate the temperatures. For low temperatures a couple of heavy nickel allow or tungsten is used. This has a fusing point of 2,700 degrees Fahr. At higher temperatures a platinum-rhodium couple is used.

Armstrong-Blum Mfg. Co., 113 N. Francisco Ave., Chicago, Ill. Marvel draw-cut hack-saw. Its characteristic features are the use of the draw-cut principle, and the provision of a spring tension appliance to bring pressure on the blade during its cutting stroke, which is relieved on the return. An automatic trip is provided for stopping the mechanism when the cut is finished. The machine has a strongly built frame and has a capacity for cutting stock up to 4 inches by 4 inches.

C. S. Bonney, Irvington, N. J. Automatic reversible taper for use in tapping small holes up to 5/16 or 3/8 inch. The device is used in connection with a drill press or lathe, and is operated in the same way as a friction-driven reversing tapping machine. The main spindle runs constantly in one direction, the reverse being provided for in gearing within the attachment itself. The stopping and reversing of the tap are automatically effected at any desired depth by the setting of the stop provided.

Western Tool & Mfg. Co., Springfield, Ohio. Champion combination tool holder. This holder is provided with blades and attachment which allow it to be used as a straight turning tool, side turning tool, boring tool, key-seating tool and in other combinations. The shank is a steel drop forging, case-hardened, as are the various other parts of the device. It is furnished complete for all the combinations of which it is capable, or with a selection of parts to make up any possible combinations desired.

Oesterlein Machine Co., Cincinnati, Ohio. Vertical milling attachment designed for use with the builder's No. 30 universal or No. 34 plain milling machines. It is designed to take as heavy a cut on the vertical spindle as can be taken on the main spindle, without chattering or other signs of distress. The attachment, which is adjustable to any angular position about the axis of the spindle of the machine, is strongly attached to the frame, being clamped both to the face of the column and to the overhanging arm.

Olney Machine Works, Philadelphia, Pa. An automatic cutter grinder for the grinding of either straight or spiral toothed end mills, cutters, etc. The machine incorporates provisions for automatically reciprocating the table and the work mounted on it, and for indexing the latter. The spiral attachment is very simple and easily adjusted, being made somewhat on the plan of the taper attachment for the lathe. The emery wheel may be set at any angle to suit the requirements of the tooth being ground.

John Steptoe Shaper Co., Cincinnati, Ohio. A motor-driven shaper of very compact arrangement, in which the working parts do not extend out beyond the space occupied by the ordinary cone-driven shaper. The machine was originally designed for use on a United States revenue cutter. A variable speed General Electric motor is used which is connected with the crank-shaft by a gearing which gives two changes, the range of strokes per minute being thus obtained partly by mechanical and partly by electrical means.

Potter & Johnston, Pawtucket, R. I. Line of screw shaving and turning machines made in three sizes, the largest of which takes 3 inches in diameter through the spindle quill. The collet is operated by a pilot wheel, making it possible for the operator to perform all the movements necessary without leaving his position, even on a machine as large as this. The carriage carries a cross slide on which are mounted two tool slides. Both cross slides and tool slides are operated by levers, and all the movements provided with stops. The carriage is adjustable on the bed by means of a hand-wheel and screw to suit work of different lengths.

Rockford Drilling Machine Co., Rockford, Ill. Portable engine lathe mounted on trucks and especially designed for fitting and erecting, or for any operation where it is most convenient to take the lathe to the work. A counter-shaft and electric motor are mounted beneath the bed of the lathe. A two-speed change is provided in the head-stock, giving a slow speed for turning and a higher one for filing and polishing. This in combination with the five-step cone pulley in the counter-shaft gives ten speeds. A turret tool post is provided on the carriage so that any one of four tools is instantly available for use.

Bullard Machine Tool Co., Bridgeport, Conn. Boring and reaming bar for finishing cored holes and special grinder for keeping the cutters in condition. This boring bar has two openings at right angles to each other, one of square stock for the single pointed cutters, and the other for the floating double-ended boring blades. As shown used, the first cutter is a chamfering tool which cuts the scale away to permit the following tools to cut true and even without being thrown out and dulled by the rough scale. Roughing and truing blades follow in succession, and then a sizing cutter of the double-ended type which floats in a slot in the bar is used for bringing the hole almost to the size of the finishing cutter, which acts as a reamer. This finishing cutter is provided with a slot and a taper hole by means of which its size may be adjusted as it wears. The grinding machine provides for grinding cutting edges of the proper angles for all of these cutters.

ANNUAL CONVENTION OF THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION.

The seventh annual convention of the National Machine Tool Builders' Association was held at the Hotel Imperial, New York, October 20 and 21. The association now has ninety-five members, four new concerns having been admitted since the June meeting. These are: C. H. Allen & Co., Barre, Mass.; Powell Planer Co., Worcester, Mass.; Barnes Drill Co., Rockford, Ill.; and W. E. Gang Co., Cincinnati, Ohio.

The matters of general interest to people outside the association, brought before the meeting were the papers: "A Review of the Department of Commerce and Labor's Report on the Conditions of the Machine Tool Industry in Continental Europe," by Captain G. L. Carden; "Different Plans of Paying Employes with the Advantages and Disadvantages of Each Plan to Employer and Employe," by Mr. Harrington Emerson; and "The Commercial Side of the Machine Tool Industry in Europe and a Review of European Conditions," by Mr. J. W. Carrel.

Captain Carden made a tour of European manufacturing plants during the past year, acting as special United States agent to investigate the conditions as regards foreign market for American machine tools. His paper was a general review of the situation and briefly summarized the articles published in the *Daily Consular Reports*, issued by the Department of Commerce and Labor, Bureau of Manufacturers, Washington, D. C. These reports will be prepared in monograph form later for general distribution. Captain Carden spoke of the strong competition rapidly developing in Germany, and emphasized that in his opinion Germany would be America's chief competitor in the manufacture of machinery and machine tools in the future. From being an importer of machine tools in large quantities, Germany has rapidly risen to the position where in 1907 it exported over 52,000 machine tools to twenty-three countries, reaching practically every country on the globe. He spoke enthusiastically of the great educational effect of the military training imparted in the German army service, and the resultant effect on industrial conditions. He earnestly advised the members of the association to take action with the view of providing for further stimulation of our foreign trade in machinery in every legitimate manner, and suggested that the policy of exporting men with the machines was one that should be followed more than it has been in the past. At the conclusion of this paper Mr. Doan, of the American Tool Works Co., Cincinnati, Ohio, made a motion to have a committee of twelve machine tool builders appointed to visit Washington and confer with department officials on the matter. This motion was carried.

Mr. Emerson's paper was the subject of warm discussion, there being the usual differences of opinion among specialists who have studied the production problem and reward for labor from the side of the manufacturers, devising ways and means by which workmen can be induced to produce more for a living wage. The sentiment was that the great difficulty confronting any scheme for fixing wages is the practical impossibility of determining what is a maximum day's production. The changes and improvements constantly developing in machine shop practice and machine tools makes a constantly changing state as regards labor and labor reward. For example, the introduction of high-speed steels in many cases reduced the time required for certain work to half or even a quarter the time required for the same operations using carbon steel.

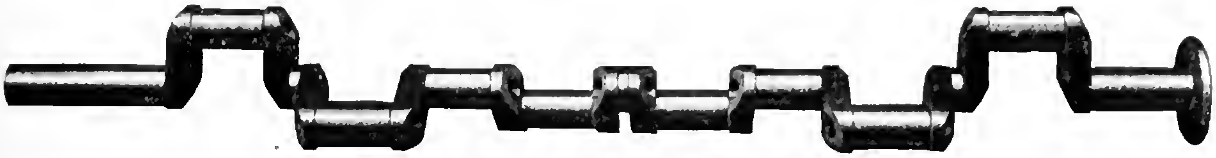
Mr. Carrel's paper was also a review of European conditions as seen by him on a tour of investigation in machine tool shops. The consensus of these reports, and of those furnished by Mr. Oskar Kylin in MACHINERY, seems to be that which practically all fore-sighted manufacturers had already seen, that is, European builders would eventually reorganize and equip their shops along American lines. So well has our example been imitated in certain cases that American competition already is almost hopeless when our high tariff, high wages, and ocean freights are considered.

All the officers were re-elected, being as follows: President, Fred L. Eberhardt, Gould & Eberhardt, Newark, N. J.; first vice-president, C. A. Johnson, Gisholt Machine Co., Madison, Wis.; second vice-president, E. P. Bullard, Jr., Bullard Machine Tool Co., Bridgeport, Conn.; secretary, P. E. Montanus, Springfield Machine Tool Co., Springfield, Ohio; treasurer, W. P. Davis, W. P. Davis Machine Co., Rochester, N. Y.

* * *

A NOTABLE CRANK-SHAFT JOB.

The illustration shows a six-throw crank-shaft, forged and finished complete at the Chester Works of A. P. Witteman & Co., Philadelphia, Pa. It was made for the Chadwick Engineering Works, and was installed by this concern in the racing launch built for Mr. Herbert Austin, of Boston, Mass.



Six-throw Chrome-nickel Crank-shaft forged with Bearing between each Pair of Crank-webs.

The forging was made from a 10-inch square chrome-nickel steel billet, the stock being thoroughly hammered and refined and then annealed for machining. The parts between the throws were then cut out and the forging twisted between each pair of crank webs, after which it was again annealed to relieve all the strains incident to the twisting operation. The shaft was then rough machined throughout and oil treated, following which it was finished and ground, all bearing surfaces being ground to limits of 0.0010 inch; that is, 0.005 inch above or below the given dimensions. The over-all dimension of the crank-shaft is 71¾ inches. The crank-pins are 2½ inches diameter, 4½ inches long, and the shaft bearings between the cranks are 2½ inches diameter and 4 inches long. The size of the crank webs is 6¼ × 2¾ × 1½ inch. The longitudinal holes through the crank-pins and bearings are 1⅛ inch diameter.

The crank-shaft was made for a six-cylinder engine, the cylinders being 8 inches stroke by 7 inches diameter, and developing 150 horse-power at 850 revolutions per minute. The weight of the engine complete with all attachments is only 1,400 pounds. Anyone familiar with the manufacture of multiple throw crank-shafts can readily see from the illustration that the design is something quite different from the usual form of six-throw crank-shafts. It will be noticed that instead of combining the two crank-pin bearings in the one throw, each crank-pin bearing has a separate pair of crank webs. This, of course, increases the difficulty of manufacture. It will be noticed that the space between the cheeks in the case of the two end throws is very narrow, being only ⅝ inch. A twist had to be accomplished within this narrow space. It is evident from this fact that the material is of great toughness and strength.

The boat for which the crank-shaft was built is 37 feet long over-all with a beam of 4 feet 6 inches. The reversing gear propeller shaft was also built for the Chadwick Engineering Works by the Chester Works of A. P. Witteman & Co., and particular attention is called to the fact that the total weight of the reversing gear and shaft was only 222 pounds. A test piece taken from the shaft showed the following physical properties due to the heat treatment:

Tensile strength, 143,500 pounds per square inch;
Elastic limit, 110,000 pounds per square inch;
Elongation, 18 per cent in two inches.

* * *

A lot of people think that they are climbing the ladder of success when they catch hold of the other fellow's coat tails.—*The Silent Partner.*

MACHINERY'S SIXTH ANNUAL OUTING.

On October 22, following the convention of the National Machine Tool Builders' Association, MACHINERY gave its annual outing to five hundred machine tool builders, mechanical engineers, machinery dealers and others interested in the machine tool business and kindred lines.

The outing this year differed materially from preceding ones, the chief feature being athletic sports, and the contestants, members of the trade; in the games requiring team play the East was pitted against the West. The steamer *Sagamore* took the party to Point View Island, on the Sound, which had been hired for the day, and on which was a large pavilion and athletic field well suited for the sports. Music was furnished by the Eighth Regiment Band, and luncheon was served in the pavilion, which had been appropriately decorated for the occasion.

The sports which followed the luncheon comprised a potato race, a baseball game between the East and West, a sack race, a three-legged race, and a push-ball game, the contesting teams being chosen from Eastern and Western territory.

There were fourteen entries in the potato race, as follows: Charles H. Besly, F. C. Billings, F. B. Doe, W. S. Gorton, R. B. Jacobs, E. A. Johnson, T. G. Meachem, C. H. Peirson, L. D. Rockwell, E. C. Smith, A. K. Spencer, Charles A. Strelinger, W. W. Totman and E. H. Waring. Referee, Charles F. Chase. After an exciting and laughable contest Mr. Peirson was declared the winner of the prize, which was a sterling silver berry spoon.

The ball game, which was confined to one hour and won by the Western team, was remarkably good considering that none of the players had any previous practice together, the score being 8 to 7. The captains were C. A. Johnson of the Gisholt Machine Co., Madison, Wis., for the West, and D. B. Bullard of the Bullard Machine Tool Co., Bridgeport, Conn., for the East, and the players were as follows:

EAST.		WEST.
D. B. Bullard	Pitcher	W. L. Schellenbach
F. E. Bocorselski	Catcher	David Hunt, Jr.
P. B. Gale	1st base	R. T. Lane
W. H. Taylor	2nd base	R. K. LeBlond
P. M. Brotherhood	3rd base	A. M. Watcher
A. R. Stedfast	Shortstop	C. A. Johnson
H. C. Warren	Right field	Rufus King
D. M. Wright	Left field	H. W. Kreuzburg
U. Eberhardt	Center field	G. H. Feltes
Frank L. Cogill	Umpire	Winthrop Ingersoll

The prizes were emblems similar to those worn on watch fobs, but attached to ribbons in the form of a badge marked with the position played by each of the winning team.

There were twelve entries to the sack race, as follows: C. L. Goodrich, A. W. Graham, D. Halstead, C. E. Holgate, R. B. Jacobs, J. Judd, D. R. McIntosh, C. A. Mackintosh, S. Robertson, C. T. Schmitt, E. Von Campe and N. G. Williams. Mr. Goodrich was the winner of the prize, which was a decorated stein.

Fourteen entered the three-legged race, as follows: W. C. Buell and A. W. Graham; A. E. Carpenter and A. T. Doud; E. Von Campe and C. E. Chapple; C. E. Watrous and H. A. Pratt; C. T. Schmitt and C. L. Goodrich; W. H. Miller and R. B. Jacobs; J. Judd and J. B. Anderson. Messrs. Carpenter and Doud won the prizes—twin flower vases of green glass decorated with gold.

The game of push-ball is played by eleven men on each side, on a rectangular field 50 yards wide and 120 yards long, with goal posts at the ends, 20 feet apart. The ball used in the game is 6 feet in diameter, the object being to push the ball over the bar between the goal posts, and the rules are much the same as in foot ball. The push-ball game proved to be the most popular game of the day, and after a hard-fought battle, in which every inch of ground was contested and neither side was able to make a goal, the East won out by a few feet. The game was limited to two ten-minute periods, with a resting interval of five minutes between. Someone remarked that if all the people on the ground pushed as hard for business, there would soon be a boom in the machinery trade.

We were unfortunately unable to obtain a complete list of the Western team, as some changes were made just prior to the game, and after it everybody left for the steamer. An accurate list will be given with the views of the games which we are now having reproduced.

EASTERN ELEVEN.
J. W. Bray,
D. B. Bullard,
E. Cramer,
Robert L. Crane,
James Coulter.
Oscar M. Flather,
L. P. Goodspeed,
R. B. Jacobs,
C. H. Kingsbury,
Marshall Prentiss,
Geo. J. Thompson.

WESTERN ELEVEN.
C. H. Besly,
——— Booth,
W. A. Greaves,
Oliver Henn,
D. Hunt, Jr.,
Winthrop Ingersoll,
G. E. Merryweather,
C. A. Strelinger.

Referee: Robert B. Luchars.

The push-ball prizes were similar to those for the baseball—one for each player—the ribbons being of a different color and the inscriptions appropriate.

The Push-ball Game—"Up in the Air."

The 1908 outing was generally considered to be the most successful of all those given by MACHINERY. In spite of the late date the weather was perfect, and all the events went off without a hitch. At the first outing, which was given six years ago, only twenty guests were present; while for 1908 nearly seven hundred acceptances and requests for invitations were received, although accommodations were provided for only five hundred, as a larger number would have caused overcrowding and discomfort to those who attended.

* * *

A paper presented by Mr. Thomas D. West, Sharpsville, Pa., before the American Foundrymen's Association was an appeal for the prevention of accidents in the foundry. While brief, the paper contained some valuable suggestions, which, if followed, would go a long way toward preventing the distressing accidents that are of frequent occurrence in foundries. He mentions indolence, smoking, drink, forwardness, stupidity, rashness, deliberate carelessness, independence of orders, callousness regarding the safety of others, and perhaps deliberate trickery or spite as causes, mostly on the part of operatives. Next in order are mismanagement, disorder, tyranny, particularly in the overseers, and absence of safety devices and intelligent control of the works on the part of the management. A point that prevents men in charge from exercising all possible precautions for safety, is the lack of credit they get for taking precautions from those higher up. It is desirable that foremen and sub-foremen should be encouraged to see that nothing but a good bolt, or sound and annealed chain is used for handling flasks and ladles; that the temper of sand is watched, and the ramming, venting, coring, clamping and other operations incident to the foundry are carefully attended to; to notice that the ladles are dry, and that no one sticks wet rods into the metal or spills water over the gangways and around the cupola. These matters may appear small and trivial, but they are important factors in causing foundry accidents.

COOPERATIVE IDEA OF JOHN DALY, TRIMMER BOSS.

Only one remains of the five coal dump piers of the Delaware, Lackawanna and Western Railroad, which reared their high and grimy fronts over the North River on the Hoboken side in the days when John Daly, the trimmer boss, used to ride down from the heights to his work in his carriage every morning. Less coal is brought by the road now to this port, and machines like the floating grain elevators lift it from the cars on flat piers.

One alone of the six black skeleton structures survives—one was built since the time of John Daly—and only there can a few old timers be found who remember the story of this man, a story full of suggestion to students of remedies for the woes of the workingman.

Away back in the '70s John Daly used to leave his little apartment in an old fashioned Hoboken tenement house, dinner can in hand, at a quarter of 7 every morning except Sunday, and hurry to the coal docks. Then when the whistle blew he would crawl on his back, shovel in hand, from the hatch of a coal barge, well back under the deck, and begin to push and pile up the coal beyond his head until it touched the deck. So, laboring hard in a strained position, he and some ninety-nine others worked in an eighteen-inch or two-foot space most of the time, for that is the way the coal trimmers work.

For this work they got 22 cents an hour while actually engaged in shoveling. Their pay did not run when boats were not in, but often they worked late into the night, and at the end of the month they sometimes had $75 each to bring home. And they brought it home, for they were not tipplers or drunkards. So it went, winter and summer, for years.

John Daly was a shrewd man—an ambitious man. He saw clearly that it would be hard to fill the places of himself and his fellows if they should decide to go on a strike. He talked to the others about it when they were waiting for boats, until he had persuaded them all to join him in a cooperative bid for the contract, which would terminate with the outgoing of the then superintendent.

The new superintendent came and the trimmer boss made his offer for the contract, to last during the incumbency of this superintendent, at the old rate. John Daly stepped up and said:

"If you give this man the contract he will not be able to carry it out, for we will not work for him and he cannot fill our places. Give us the contract jointly and we'll stay and do the work. We don't need him at all to boss us; we know our business."

The new superintendent thought the matter over, and in a few days agreed to John Daly's proposal, for, indeed, there was nothing else for him to do. John Daly was elected boss trimmer.

Thereafter the pay of each man was sometimes as high as $140 a month, and the trimmers are now princes among laboring men. Then old Matt Casey died.

The men held a meeting to decide what to do about a man for his place. Would it be right to admit a new comer at once to the sharing which they had slaved for years to attain and had taken the risk of discharge to secure? Surely not, they agreed.

"Hire him at 22 cents an hour," they told John Daly, "and after a time, when we see fit, we'll put him on an equal footing with ourselves."

A man was hired at 22 cents an hour.

Many more of the cooperative trimmers died as the years rolled around, some retired because of old age, some had to retire because John Daly gave them heart breaking, impossible tasks, to drive them away, as they believed, and some John Daly discharged for one offense or another, until of all the hundred cooperative trimmers not one was left but John Daly, now sole contractor, and he had working for him a hundred men at 22 cents an hour.

John Daly was known on many an occasion to spend only $5 for the trimming of a boat for which he got $145. These were the days in which he used to come down from the heights to his work in his own carriage. He owned real estate in Jersey City and Hoboken. He was believed to be rich.

A new superintendent, a Mr. Varian, came about 1883, and a new contract had to be made with him. History repeated itself. The men demanded a contract as a cooperative body and the utter elimination of John Daly.

Mr. Varian would not deal with them as a cooperative body. They struck then for 25 cents an hour, and a settlement was made by which there should be no contract, but all the money which a contract would bring them would be divided among them fairly by Mr. Varian himself.

Again did the tenements rejoice in $145 as a month's pay instead of $90, and this condition lasted all through the superintendency of Mr. Varian. He was succeeded a few years ago by a Mr. Johnson, who, thinking that a couple of honest contractors would treat the men fairly, while relieving his office of a burden of care that did not rightly belong to it, gave the contract to Thomas Connelly, who used to be weighmaster in the old days, and a man named Miller, one of the old-timers who worked for Daly. They are the bosses there to-day, employing about ninety men, the new machinery making up the difference, and the pay of the men is 22, 25 or 30 cents an hour, according to the valuation the bosses put on their work. The pay averages about $45 every two weeks.

But what of John Daly? He went West, with plenty of money to enjoy himself, and he died about ten years ago, far from home and friends, and they say, on the lone, high black pier, without a penny to his name.

So did the selfishness inborn in humankind battle and win against the altruism necessary to the success of cooperation, and so did its triumph spell the ruin of the winner at last.—*New York Sun.*

* * *

MISCELLANEOUS FOREIGN NOTES.

German Machine Exports.—The exports of machine tools from Germany have been on the increase during the first five months of 1908, in spite of the business depression. The exports during 1908 amounted to 19,486 metric tons, as compared with 13,798 metric tons for the first five months in 1907.

Extensions of the Krupp Works.—Some time ago it was announced that the Krupp firm, of Essen, Germany, was about to establish a branch in Roumania in order to supply the army with ordnance, and it was expected that the arsenal would be handed over to the firm for a period of years, and also that the firm would obtain a monopoly of governmental orders for iron and steel. The proposition, however, met with public disapproval, and has therefore been dropped for the present.

German Motor Car Industry.—It appears that at the present time greater attention than ever is given in Germany by the automobile manufacturers to small motor cars, many simply intended for a single passenger. In spite of the depression in the automobile business there is, even at the present time, a great demand for small and inexpensive cars, and many German firms are confident that they will be able to maintain the industrial stability of the motor trade by attending more to the production of vehicles for popular and business uses.

British Machine Tool Trade.—Reports from England indicate that the machine tool trade in the London district is comparatively good, considering the general depression in various other branches of engineering trades. As an indication of the fact that the depression in the machine tool trade in Great Britain is not so acute or general as in the United States, it may be mentioned that the firm of Henry Pels & Co. has enough work on hand to keep double shifts busy for several months, and is contemplating considerable extensions. This firm is building heavy tools in particular.

Iron and Steel Industries in Germany.—At a recent meeting of the National Association of German manufacturers of iron and steel, it was stated, according to report by Consul H. J. Dunlap, of Cologne, that the industry has been unusually prosperous during the past year, and that the output has been materially increased, caused, principally by the home demand. The financial panic in the United States, however, had an unfavorable effect on all industrial undertakings in the country, and caused a hesitancy in placing orders. However, the iron and steel industry in Germany is as yet fully employed.

One difficulty experienced has been that of shortage of railroad cars, an experience not altogether unknown also in the United States.

The Development of Russian Industries.—The South Russian iron and steel works are giving a great deal of attention to the production of the finer qualities of iron and steel. These works have not been in the habit of turning out higher grades of tool steel, but of late they have commenced with this manufacture, and some works turn out various qualities of high grade steel at a moderate cost. It is stated that Russia may become independent of foreign industries for the supply of high-class metals, and that Russia in general, is forging ahead industriously. It is noteworthy of the progress of Russia along industrial lines that several Russian works have been competing with considerable success with other European engineering firms for contracts for the Roumanian state railways. Thus, a large consignment of rails, locomotives and freight cars have been supplied by Russian works for Roumania.

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PERSONAL.

L. B. Marks, New York, and J. E. Woodwell, Washington, D. C., have opened a consulting office in the Terminal Building, 41st Street and Park Avenue, New York.

J. G. Matthews, until lately with the Cleveland Twist Drill Co., Cleveland, Ohio, is now instructor in the mechanical drawing department of the Cleveland Technical High School.

H. P. James, formerly electrical engineer of the Bryant Electric Co., is now sales manager for the new line of push button specialties recently placed on the market by the Cutler-Hammer Mfg. Co., Milwaukee, Wis.

G. K. McMullen, for over ten years past sales manager of the Fox Machine Co., Grand Rapids, Mich., will sever his connection with that company November 15 to engage in business for himself. Announcement of the nature of the new venture will be made later.

Stanley H. Hodgkin of the Pulsometer Engineering Co., Ltd., Reading, England, is in the United States to make contracts with concerns desiring to manufacture patented machines in Great Britain in order to conform with the requirements of the new British patent law.

* * *

OBITUARY.

Bennett H. Brough, a well-known British metallurgist and secretary of the Iron and Steel Institute, died at Newcastle-on-Tyne, England, October 3.

S. R. Stokvis, managing director and chairman of R. S. Stokvis & Sons, Rotterdam, died after a short illness, September 14. Mr. Stokvis was the son of the founder of the house, R. S. Stokvis, and was in his eighty-first year. A brief account of the activities of the company was published in the May, 1908, issue.

William Keuffel, president of the Keuffel & Esser Co., New York, died at his home in Hoboken, N. J., October 1. Mr. Keuffel was born at Walbeck, Germany, 1838, and was educated in the public and private schools of his birth-place. At the age of fifteen he left school and became an apprentice in a general merchandise store where he remained four years, receiving a severe but thorough mercantile and business training which fitted him for his successful career of later years. He then entered a large hardware house in Hanover, Germany, and several years later went to Birmingham, England. In 1866 he emigrated to the United States, where in 1867 he founded, together with his friend Hermann Esser, the firm of Keuffel & Esser. Drafting at that time was in its infancy in this country, but Mr. Keuffel appreciated its coming importance, accompanying the development of American manufacturing and engineering enterprise. To supply all the requirements in office and field of the surveyor, engineer, architect and draftsman was the purpose of the new concern, and Mr. Keuffel can well be called the pioneer in this line, because at the time of the founding of his business, drafting supplies had not been carried exclusively by any house in the United States. The company now has a large factory in Hoboken, covering about five and one-half acres of floor space, and employing about 1,000 people. The new plant was opened July 20, 1907, forty years after the inception of the business. (See Machinery, August, 1907.) Mr. Keuffel is survived by a widow and four children, of whom Mr. W. G. Keuffel is the vice-president of the company.

William Keuffel.

* * *

COMING EVENTS.

November 10.—The November meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th St. Mr. Franklin Phillips, president of the Hewes & Phillips Iron Works, Newark, N. J., will make an address: "The High Powered Rifle and Its Ammunition—Instruments of Precision," Illustrated by lantern slides. Mr. Phillips is an expert marksman, and in 1903 won the position as first alternate on the International Rifle Team to England. He was, for many years, chairman of the committee on Rifle and Pistol Practice in the National Guard of New Jersey and is now Ordnance Officer of the Second Infantry of that state. Tests of rifles and ammunition at Sea Girt, N. J., by men connected with the N. J. National Guard have led to marked improvement in arms and ammunition and to an entire change in the powder used by the government, thereby greatly increasing the accuracy of the shot. The improvement has been extended to large guns and instead of 2 per cent hits which were made at Santiago, 80 per cent is now the average in some ships. Mr. Phillips has actively participated in this work and as he is primarily a mechanical engineer, as well as a marksman, he will explain to his audience the practical bearing of his investigations upon the construction of arms and the elements entering into ammunition.

November 19-21.—Annual meeting of the National Society for the Promotion of Industrial Education, Atlanta, Ga. James P. Haney, 546 Fifth Ave., New York, secretary.

December 1-4.—Annual convention of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York City. C. W. Rice, 29 W. 39th St., New York, secretary.

December 10.—Mr. M. A. Loeb, secretary and treasurer of the Rock Island Battery Co., Rock Island, Ill., has issued a call to the manufacturers and dealers of gas and gasoline engines, and dealers and manufacturers of accessories thereto, to attend a preliminary meeting at the Auditorium Hotel, Chicago, December 9, 1908, with a view of discussing and formulating plans for the formation of an association. Officers are to be elected and a committee appointed for the purpose of arranging for a national convention to be held at some time and place decided upon by the executive committee.

December 31-January 7.—Ninth annual show of the American Motor Car Manufacturers' Association at Grand Central Palace, New York City.

January 16-23.—Ninth annual show of the Association of Licensed Automobile Manufacturers at Madison Square Garden, New York.

NEW BOOKS AND PAMPHLETS.

Annual Report of the State Geologist of the Geological Survey of New Jersey. 192 pages, 5½ x 9 inches. Published by the state geologist, Henry B. Kümmel, Trenton, N. J.

Modification of Illinois Coal by Low Temperature Distillation. By S. W. Carr and C. K. Francis. 48 pages, 6 x 9 inches. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill.

Reports of Committees, 16th Annual Convention of the Traveling Engineers' Association, Detroit, Mich., August 25, 1908. 84 pages, 6 x 9 inches. Secretary, W. O. Thompson, New York Central and H. R. R., East Buffalo, N. Y.

How to Build Up Furnace Efficiency. By Jos. W. Hayes. 47 pages, 3½ x 6¼ inches. Published by Jos W. Hayes, 601 Hartford Bldg., Chicago. Price 50 cents.

The pamphlet is a dissertation on furnace efficiency, and the facts that are to be learned by analyses of flue gases. It is of interest to all concerned with economical power production and smoke prevention.

Lighting Country Homes by Private Electric Plants. By T. H. Amrine. 35 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This is Bulletin No. 25, issued by the University of Illinois. There are special sections of the bulletin devoted to selection of fixtures and planning of lighting, the design of plant, estimated cost of plant, operation and care of apparatus, and cost of operation.

MACHINERY.

December, 1908.

THE HINDLEY WORM AND GEAR.

JOHN EDGAR.*

THIS article, on the subject of the Hindley worm and gear, was prompted by an editorial (February, 1908) asking for data, and by certain hazy ideas that seem to prevail regarding the nature of contact between the thread and teeth.

This type of worm gear was first used in Hindley's dividing engine, and was by him considered superior to the ordinary type, in wearing quality. Investigation has practically settled that the nature of contact between the worm thread and the teeth of the ordinary worm-wheel is that of line contact, extending across the tooth on the pitch line. It has also been fairly well proved in practical examples that the contact is of a broader nature on account of the elasticity of the materials used in the construction. The convex surfaces of contact are flattened considerably under pressure and thus for practical purposes make actual surface contact. The contact in the ordinary worm and worm-wheel type is limited to two teeth of the wheel and worm-thread at most.

Comparison of Ordinary and Hindley Worm Gearing.

The conditions are much different in the case of the Hindley worm, and it is the intention in this article to show wherein the difference lies. As this style of gearing is uncommon to most of us, a few words regarding its construction will not be out of place. Fig. 1 is a sketch of the Hindley worm, showing the theoretical form. This worm is not of cylindrical shape, but is formed somewhat like an hour-glass, after which it is sometimes named. The worm blank being made smaller in diameter in the middle than at either end, conforms to the circumference of the wheel with which it meshes. The worm thread is cut by a tool which has motion in a circular path about a center identical with the axis of the wheel with which it is to mesh, and in the plane in which the axis of the worm lies. The process is similar to ordinary thread cutting in the engine lathe, except for the difference in the path of the tool, the tool having a circular instead of a straight path.

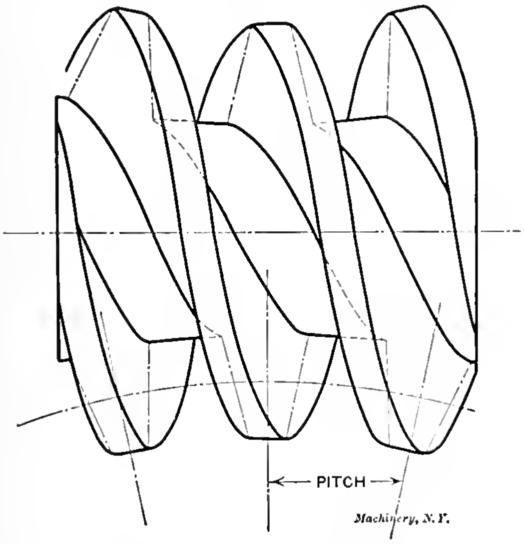

Fig. 1. The Typical Hindley Worm.

It is evident that the worm shape is dependent on the particular wheel with which it is to run, and Hindley worms are not interchangeable with any other but an exact duplicate. That is, a worm cut for a Hindley gear of 50 teeth cannot be used successfully with a wheel of 70 teeth, although the pitch of the tooth is exactly the same. In the ordinary type of worm gearing, one worm may be made to run with any number of diameters of wheels of the same pitch, and hobbed with the same hob.

In action the two styles of worm gear differ greatly and both diverge widely in action from the case of a plain nut and screw, which may be taken to represent a worm and worm gear, the latter of infinite diameter and with an angle of embrace of 360 degrees. In studying the action between the thread and teeth of the ordinary type of worm gear, we must comprehend odontics, rolling contacts and the theory of tooth gearing, in general, in order to understand the action of the ordinary worm gear. But, in studying the action of the Hindley type, we are concerned with no such theories, as the action is purely sliding and devoid of rolling contact. In the ordinary worm we have an axial pitch which is constant from top to root of the thread, while in the Hindley worm we have a section in which the pitch of the thread varies from top to bottom.

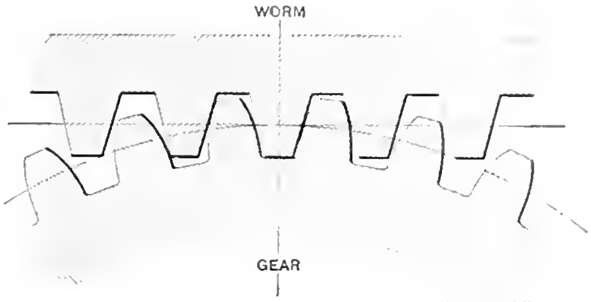

Fig. 2. Section of Common Worm and Worm-wheel on Middle Plane.

Interference as found in the ordinary type of worm gear is absent from the Hindley, and the consequent undercutting and weakening of the teeth, therefore, is a feature with which the designer of the Hindley worm gearing does not have to contend. For this reason we are not limited in the length of teeth, by interference, as in the ordinary case. This fact permits the wide latitude in the choice of tooth shape and proportions. In most examples we will find that the depth of thread is much greater in proportion to the thickness than in the ordinary worm gear in which the height is limited by reason of the interference at the top and root of the teeth.

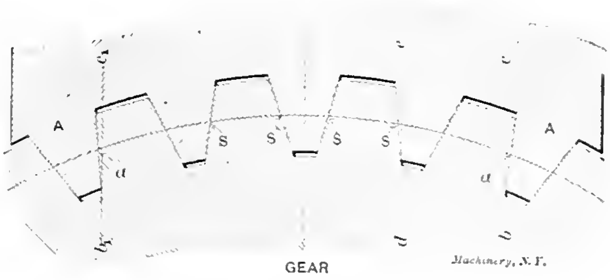

Fig. 3. Section of Hindley Worm and Gear on Middle Plane.

Nature of Contact of Hindley Worm Gearing.

The general idea of the Hindley worm gearing is that there is surface contact between the worm and gear, and that the contact is generally over the whole number of teeth in mesh. If such were the actual conditions, the Hindley type would surely be an ideal mechanism for high velocity ratios, but that such is not the fact is the purpose of this article to point out. That the contact is of a superior nature we will not deny, nor that it is much nearer a surface contact than exists in the ordinary worm gear. As a means of comparison,

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* Address: 7 Webster St., Hyde Park, Mass.

Figs. 2 and 3 are shown. Fig. 2 shows an axial section taken through the worm and gear of the ordinary type, while Fig. 3 shows a similar section through the Hindley worm and gear. The "airy" appearance of Fig. 2 as compared with Fig. 3, indicates a vast difference in the nature of contact, and gives the advantage to the Hindley type, wherein is the origin of certain false ideas in favor of the latter. These illustrations also show peculiar differences in the action of the two types. The absence of rolling action in Fig. 3 is the most prominent, and it shows the similarity between this type of gear and a screw and nut.

From an inspection of Fig. 3 we may feel sure that the contact on the axial plane is as shown, but as to the nature of contact in a plane either side of the middle plane we are in the dark so far as the drawing illustrates. Mr. George P. Grant has this to say concerning the contact of the Hindley worm and gear: "It is commonly but erroneously stated that the worm (Hindley) fits and fills its gear on the axial section. . . . It has even been stated that the contact is between surfaces, the worm filling the whole gear tooth. . . . It is also certain that it (the contact) is on the normal and not on the axial section, and that the Hindley hob will not cut a tooth that will fill any section of it. The contact may be linear on some line of no great length, but it is probably a point contact on the normal section."

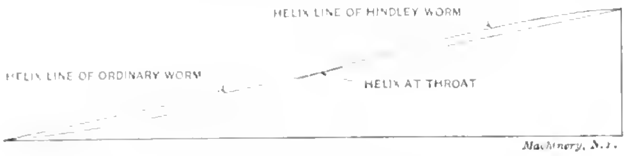


Fig. 4. Development of Ordinary Worm and Hindley Worm Spirals on a Plane.

It is not clear what reason Mr. Grant had for saying that the contact is normal instead of axial; but there is every reason to believe that the contact is on the axial section since it is on this section that the teeth of the hob have a common pitch. The teeth have not a common pitch on any section at an angle with the axial section. For what reason would one expect to find contact on the normal section in this case any more than in the case of the ordinary worm? Since both styles of worm-wheels are hobbed with a revolving hob which lies in a plane perpendicular to the axis of the worm-wheel, the contact could hardly be on a normal section.

Prof. MacCord states that he considers the contact to be line contact on the axial section, and he gives directions for obtaining the exact nature of the contact and also the thread and tooth sections. These directions, on account of the complicated nature of the method, are hard to follow. Much, however, can be found out by simple methods. In what follows, describing these simpler methods, the results, of course, are of an approximate order, but they nevertheless give a means of comparison and a material basis for the line of argument.

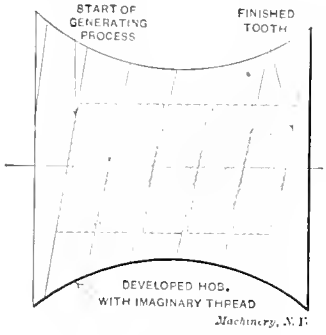


Fig. 5. Successive Steps in Shaping Hindley Worm.

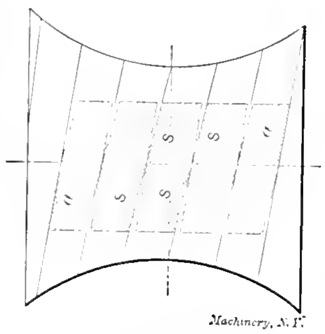


Fig. 6. Surfaces of Contact of Hindley Worm.

The Ideal Case Considered.

It is assumed that we are examining an ideal Hindley gear in which the worm and wheel are theoretically correct in shape and that the surfaces are perfectly smooth and inelastic. From the nature of the worm, the helix angle varies from mid-section to the ends, decreasing as the thread approaches the ends of the worm. The thread is spiral as well as helical. This change in the thread angle is caused by the increase in diameter at the ends of the worm and by the fact that the axial pitch of the thread decreases as it reaches the ends. The decrease in axial pitch is due, of course, to the circular path of the threading tool. If we take a development on a flat surface of a line scribed in the spiral path on the worm blank, as shown in Fig. 4, the change in the angle becomes noticeable.

In the operation of forming the teeth of the gear, the blank is rotated, each portion of the hob working the tooth into shape so that it will pass the corresponding portion of the worm thread without interference, permitting a smooth transmission of motion. If each portion has a different shape or is placed in a different relation, the shape of a gear tooth will be a compromise between the extremes, and this is what is actually the result, as we shall see later.

The progressive steps of the process are shown in Fig. 5; the successive positions of one tooth are shown, beginning at the left and ending at the right-hand position where each tooth is given its final shape. The nature of the process is shown in Fig. 6, the shaded portions representing the gear teeth. Here we have a representation of the contact of the thread and teeth; it shows that surface contact is impossible on any but the heavily shaded portions of the teeth, it being confined to the mid-section and the extreme end sections of the worm. Line contact is obtained throughout the length of the worm on the axial plane. This figure also shows that no advantage is gained in surface contact by making the worm of greater length. The location of the contacts are shown in Fig. 6 at *a*, *s*, *s*, *s*, *s*, *a*, but it must be remembered that they lie on opposite sides of the cutting plane. From this it is apparent that the worm does not entirely fill the space between the teeth of the gear and that the contact is not wholly a surface contact.

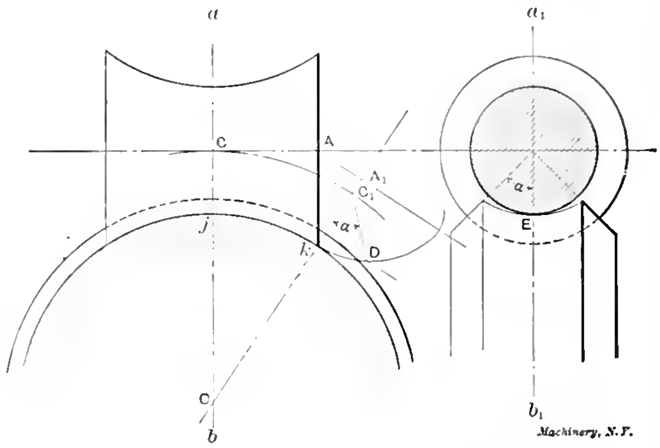
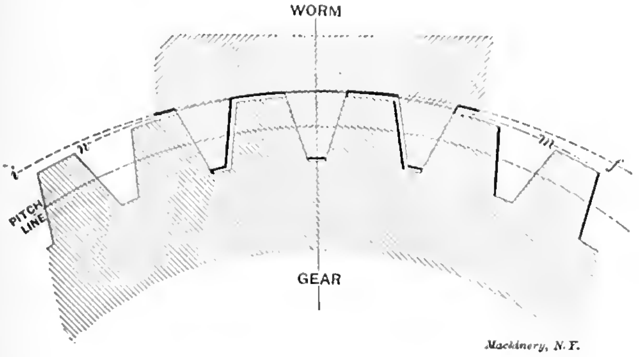


Fig. 7. Effect of Hour-glass Shape on Worm-wheel Contact.

Let us investigate still further and see whether the conditions are not modified by other irregularities: Fig. 7 is drawn to represent a worm and gear of the Hindley type, in mesh, the teeth of which have no depth. As before mentioned, the peculiarity of this type of worm is its hour-glass shape. The hob and worm may be treated as identical in form. In the process of generation, the tooth has a pitch line curvature that changes with corresponding positions in relation to the thread portion acting upon it. The tooth must necessarily be modified from what it should be for any particular location in its contact with the worm thread. It is quite clearly shown that if the tooth is to fill the worm thread or *vice versa*, it must be formed in strict accordance with the thread at that particular point. Thus if at *j* the tooth fills the thread, that tooth must be formed by the thread at that point, while the tooth at *k* must be formed by the thread at *k*. Now, since each tooth must pass from *k* to *j*, its form must be such that it will do so without interference. It is evident that the radial section of the gear at *k* must be the same as at *j*. Since the worm is largest in diameter at *k*, the curvature of the tooth on the radial section is dependent on the thread at that point. The curvature of the tooth at *k* evidently is that of an ellipse whose major axis is $A\,A_1$. Now, since the thread is made with angular sides, the hob could

hardly act on the teeth of the gear the same at all points from k to j except on the axial plane where the relative shape of the hob thread is the same for any position along the line of action (see Fig. 3). This is evident from Fig. 7 at E, which point only touches at the mid-section of the worm. Therefore we still have the line contact from top to bottom of teeth on the axial plane, but the construction, Fig. 7, shows that the surface contact s, s, s, s, Figs. 3 and 6, does not actually exist, but that the surface contact at the ends of the worm remains undisturbed.

From the above we may safely conclude that the hob at j has but little effect on the actual shape of the tooth, and that its influence increases until k is reached. Fig. 7 also shows a good reason why the contact may be considered axial instead of normal, by the mere fact of the differences in curvature of worm and wheel at any point other than k. In practice the contact may appear to be surface contact, but this, no doubt, is due to the influence of the lubricating oil and the fact that materials of construction are distorted to some extent in form when subjected to pressure. This distortion permits the worm thread to imbed itself into the worm-wheel teeth, somewhat broadening the contact for the time being. The conditions as stated in the above discussion, would be met in the case of a hardened worm and gear with surfaces finished by lapping. In practice the worm and gear are ground together, sand and water being used as the abrasive. This grinding wears down the roughness of the surfaces and tends to correct irregularities in form that develop in the hobbing process.



Machinery, N.Y.

Fig. 8. Effect of the "Second Cut" on Contact.

Objections to the Hindley Gear.

The objections to the Hindley type of worm gear are many and are widely known. It must be set up accurately, the alignment being made perfect. End play is a feature that must be avoided, as any longitudinal displacement of the worm will cause the gear to cut. These peculiarities are the greatest drawbacks to the use of this gear and because of them I feel that it will not come into common use, at least not so common as the worm drive of the ordinary type. This feeling is strengthened by the fact that we have become so much more familiar with the latter type as to be able to design and construct drives that work satisfactorily in every respect.

Modifications of Hindley Worm Gear Practice.

Some modifications have been made in the process of manufacturing the Hindley worm gear. One that is probably of first importance is that known as the "second cut," this practice being generally credited to Mr. Albro of Philadelphia, but the credit for it is in dispute. The effect of the second cut is indicated in Fig. 8. From this sketch one would be likely to say that the part of the second cut was to remove the points of contact. Whether this is the reason or not, it is a fact that it does remove considerable of the contact from all but the mid-section of the worm. This second cut is made by enlarging the diameter of the circle in which the threading tool travels when cutting the worm. It is said to have advantages that add to the wearing quality of the drive, but just what these advantages are is not apparent, and since the process is considered more or less a trade secret, it is difficult to obtain authentic reasons for its use. The second cut is mentioned here in the hope that someone knowing the reason for its use may respond with a full account. This he may be sure will be appreciated generally by the readers of MACHINERY.

The limiting length of the worm is dependent on the shape of the thread. In Fig. 8 the worm is shown with three sections in mesh, while Fig. 3 shows five. Fig. 3 shows a case that would be impossible in practice on account of the undercut sections A which lock the worm in mesh. The side of the thread must fall inside the line bc to permit the worm and gear to be assembled. Following are the conclusions which I derived from my investigation regarding the Hindley type of gear:

1. The contact is purely sliding contact.
2. The nature of the contact is linear, closely resembling surface contact.
3. Linear contact extends from the top to the root of the tooth.
4. The contact is on the axial section.
5. The thread section fills the tooth space on the axial section only.
6. The mid-portion of the hob has little or no effect in shaping the teeth of the gear.
7. Surface contact exists on opposite sides of the axial plane at the end of the worm thread and is intermittent in nature, because the end of the thread passes out of contact with the tooth in the revolving of the worm. This contact is on a plane normal with the thread angle.

In practice it is usual to allow considerable back-lash between the thread and the tooth of the worm and gear. This play tends to counteract bad workmanship, either in construction or erection.

[The foregoing article is, we think, a sound and unprejudiced exposition of the theoretical Hindley worm gear, but should be regarded as not applying strictly to this type of worm gearing as actually manufactured. The commercial Hindley gear differs considerably from the ideal form, as intimated by Mr. Edgar in the part where he speaks of the "second cut" process, but this difference is not all. The shape produced in the manufactured gear so differs from the theoretical type that comparison really is unfair. The "grinding in" of the worm and gear with sand and water or powdered glass and water, has much more significance than is ordinarily given it by those unfamiliar with the process. It is more than a mere smoothing process, it being claimed that it actually shapes the worm teeth to a form that cannot be duplicated with a cutting tool by any known process. It appears also that there is a misconception about the rigid requirements of location of the worm and its gear. Hindley worm gears have been made, and are in successful use, in which considerable longitudinal motion of the worm was provided for on account of the need for such motion; and from an investigation of the manufacture, we are inclined to believe that the matter of location in other planes is not much more important than with the ordinary worm gear type, notwithstanding a previously expressed opinion to the contrary.—EDITOR.]

* * *

Various writers on the work of wood seasoning have called attention to the merits of lumber sawed from logs long submerged. They do this by speaking of the distinct advantages gained by soaking the logs or the sawed lumber in water as a preliminary step to the air seasoning. It is pointed out that in Japan logs are kept in brackish ponds for several years before being worked up. To this treatment is ascribed the peculiar freedom from warping found in woodwork from Japan, and especially in the wood carvings which are common in that country. The warping of woodwork is due to a change in dimension caused by the wood adjusting itself to the moisture condition of the surrounding air. In damp air wood swells, but shrinks as the air becomes drier. This property of wood can not be overcome entirely, but the search continues for methods of reducing it and retarding it so as to lessen its damage. Soaking does decrease the tendency to warp, but by no means overcomes it entirely. The effect of soaking as a remedy for warping, however, is less than can reasonably be expected from some methods of steaming. As a commercial practice the soaking of logs or lumber to remedy warping of the finished product is not to be recommended, except when it can be done during storage or transportation, because of the time required to produce results that fall far short of what is usually claimed.

AEROPLANE-TYPE FLYING MACHINES.

A REVIEW OF WHAT HAS BEEN ACCOMPLISHED TOWARD HUMAN FLIGHT.

HARRY WILKIN PERRY *

Nineteen-hundred-and-eight will undoubtedly go down in history as the year of the actual accomplishment of human flight. Many successful flights were made by experimenters before this year, and the Wright brothers really flew for thirty-eight minutes in one trial near their home in Dayton, Ohio, as long ago as October, 1905, but the fall of the present year appears to have been the culminating period for the public demonstration of man's mastery of the unstable atmosphere. The skeptical world is convinced at last that the dawn of a new era in transportation has arrived and that it is only a question of manufacturing activity and practice under competent instruction, for the time to come when many men will be doing all that a very few are doing to-day—and more. Even as this is written, lessons in operation of the aeroplane are being given to army officers and others in France by Wilbur Wright, and the pupils unanimously assert that the operation is extremely simple and can be learned in a few lessons. Contracts have been signed for the sale of the French patents held by Wilbur and Orville Wright, and for the manufacture of fifty machines on the same model as the ones that have been so successfully demonstrated at Le Mans in France and at Fort Myer in Virginia. So it appears that the long era of experimentation is finally drawing to a close and the commercial period of actual manufacture and use of flying machines is about to begin.

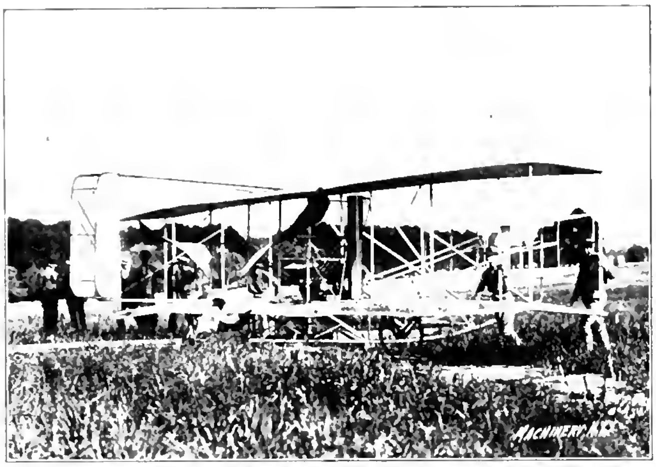


Fig. 1. Orville Wright's Aeroplane at Fort Myer, Va. Soldiers placing Machine on Rail preparatory to Launching.

Fig. 2. Wilbur Wright's Aeroplane in Flight at Le Mans, France, August, 1908.

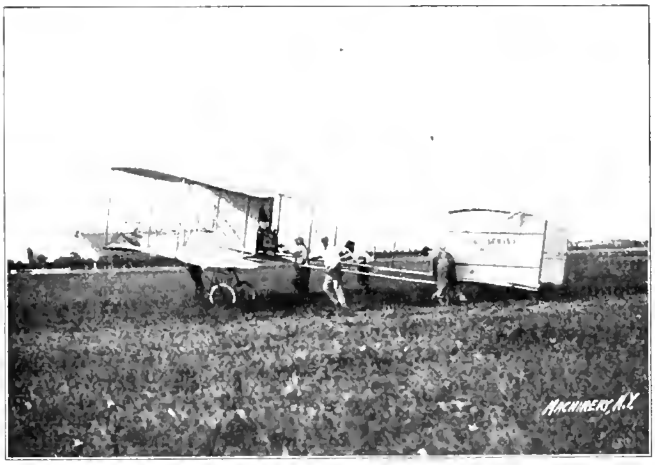


Fig. 3. Henry Farman's Aeroplane at Brighton Beach Race Track, Coney Island, N. Y., August, 1908.

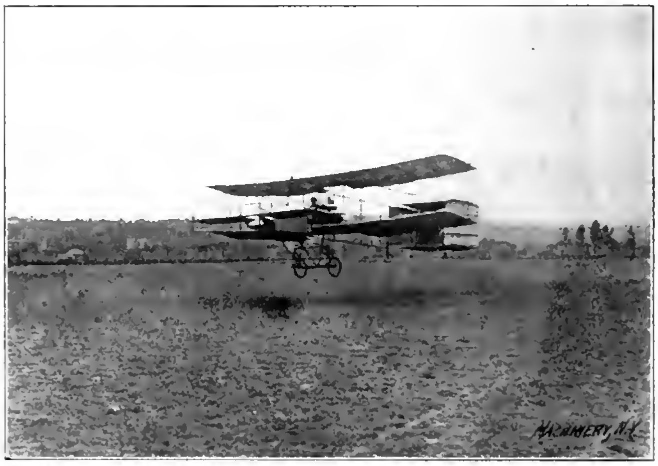


Fig. 4. Farman's Aeroplane in Flight at Issy-les-Moulineaux, France.

While all credit must be freely given to the Wright brothers for their success, and particularly for the improvements they have devised for controlling the movements of their aeroplanes, the fact is not to be lost sight of that in principle, form and construction their machines follow closely the gliding machines used experimentally many years ago by Octave Chanute and A. M. Herring, and that many of the laws of aerostatics and aviation were worked out by Prof. S. P. Langley through a long series of experiments, and by Lilienthal, Pilcher and Maxim. The only types of heavier-than-air machines that have been developed to a stage where they can be called successful are those that follow closely the forms originated by these pioneer investigators. These are the so-called biplanes, having fixed wings arranged in two parallel planes one above the other, or monoplanes, having a series of supporting surfaces disposed in approximately the same horizontal plane. Because they have given only slight promise of success, it is possible to eliminate from consideration the machines that come within the classification of helicopters (from the Greek words meaning spiral and wing), in which the weight is lifted by two or more propellers revolving in a nearly horizontal plane; and also those known as ornithopters (meaning bird wing), which are designed to fly by reason of a mechanical simulation of the motion of birds' wings. We can also pass by the tetrahedral and a variety of other curious forms with which experiments have been made.

It is needless here to recount the long series of successful flights by Wilbur Wright in France and his brother Orville at Fort Myer during August, September and October of this year. These are common knowledge, and the deplorable accident at Fort Myer on September 17, which resulted in the death of Lieut. Thomas E. Selfridge and the serious injury of Orville Wright, from which he only recovered sufficiently to leave the hospital on October 31, in nowise detracts from the convincing demonstrations that have been given. Only four days after the accident to his brother, Wilbur Wright broke all records by a flight of 1 hour 31 minutes 20 seconds, during which he covered a distance of 60.85 miles, flying in an elliptical course over the military grounds at Auvours, his elevation varying at will from 25 to 80 feet. He was awarded the gold medal offered as a prize by the Aero Club of France for the flight of longest duration made before October 1, 1908. Subsequently he again broke all records by flying for 1 hour 4 minutes 26 1-5 seconds with one

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* Address: 25 West 42d St., New York.

passenger aboard, on October 6, thus fulfilling the conditions of the $100,000 contract entered into with Lazarre Weiller for the French patent rights, and proving his ability to meet the requirements of the United States government contract to fly for one hour with a passenger. He has flown in winds up to eighteen miles an hour and remained aloft for more than an hour in gusty and uncertain winds, part of the time after dark. Remarkable mastery of the machine has been shown in turning, in ascending and descending, in righting the machine after a sudden gust of wind, in meeting unexpected emergencies and in alighting without perceptible jar.

The general appearance and construction of the Wright biplane are well shown in Figs. 1 and 2. The "wings" or main supporting surfaces measure 40 feet from end to end by 6½ feet wide, affording nearly 520 square feet. They are made of muslin cut on the bias and stretched over wood ribs that give a concave form to the under side of the "planes"—a form that hundreds of experiments have shown to give the best lifting effect and greatest stability. A pair of long, stout spruce runners carry the weight when resting on the ground and serve to alight upon when the aeroplane comes to earth. These runners project forward and curve upwardly to provide support for the front horizontal rudder which is of biplane form and hinged along a longitudinal axis. The front edges of the main planes are made stiff and rigid, the 40-foot wood strips being spaced apart by 6-foot vertical wood bars and stayed by piano wires stretched taut diagonally from corner to corner in both directions, in cantilever manner. But unlike other biplanes, the rear edges and corners of the wings are purposely left flexible. The vertical bars are connected by flexible joints with longitudinal strips placed to the rear of the center line, and to the upper and lower rear corners are attached small steel cables that pass diagonally downward and upward to pulleys secured to the rigid part of the frame and thence to one of the operating levers in front of the aviator's seat.

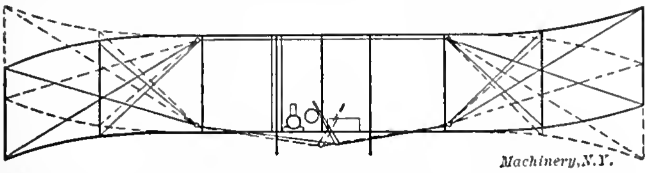

Fig. 5. Diagram Illustrating Method of Twisting the Wings of the Wright Aeroplane. Dotted Lines Indicate Alternating Positions of Wing Ends, and Operating Wires.

This construction, it should be noted, is of first importance in the manipulation of the aeroplane and forms the subject of all claims in the patents issued in the United States and France to the Wrights on May 22, 1903, and January 27, 1908, respectively. In the words of the patent, the object is "to provide means for maintaining or restoring the equilibrium or lateral balance of the apparatus." The four rear corners, Fig. 5, are so connected together and to the control lever that a sidewise movement of the lever draws downward the two rear corners of the wings or planes on one side and raises the corresponding corners on the opposite side to the same degree. This gives a helicoidal twist to the planes, causing them to present varying angles of incidence to the air, and tending to elevate the side of the machine on which the wings are twisted upward. The degree of twisting can be regulated to a nicety by the operator, enabling him exactly to counteract the effect of all air movements. In order to secure the desired effect, however, it was necessary to arrange a vertical rudder to act in conjunction with the wings and hold the machine to its course; otherwise it was found that instead of rising as intended, the wing presenting the greater angle of incidence would be retarded and would drop, while the opposite wing, presenting diminished resistance, would shoot ahead and rise, the machine being swung sharply out of its path. This, in fact, is what occurs when the aviator wishes to make a turn. Before reaching the turning point, he moves the lever to deflect the corners and rear edges of the planes, so that the ends of the wings on the inside of the turn drop, and those on the outside rise, canting the whole machine at a decided angle before the vertical rudder is moved to make the turn. Thus, the aeroplane has a bank of air against which to make its turning movement and does not slide sidewise, just as an automobile does not skid at high speed on the turn of a sufficiently banked track.

The Wright aeroplanes and their success have dispelled some illusions that have been held almost universally up to the present time. The most important of these is the belief that the weight of the machine and that of the engine must be cut down almost to the irreducible minimum and the power increased to the maximum. Beside the admirable workmanship of the best foreign aeroplanes and aeronautical engines, the Wright productions seem crude and unworkmanlike. The framing of the machines is heavy and almost roughly finished, and the engine looks more like an ordinary marine motor than one designed and built solely for use on a flight machine for navigating so light and unstable an element as the atmosphere. The whole aeroplane weighs 800 pounds without operator aboard, which, it is true, is some 200 pounds less than the Delagrange and Farman machines weigh with their wheeled attachment for starting and alighting, but Wilbur Wright has flown for periods of four and seven minutes with passengers aboard weighing 200 pounds and more, and he has attained speeds of forty to forty-three miles an hour, all with a slow-running engine of his own design and construction, weighing 170 pounds and developing only 25 to 30 horse-power, whereas the engines used in the Voisin Fréres aeroplanes as built for Delagrange and Farman develop 50 horse-power. The cylinders of the Wright engine are cast separately and bolted onto a broad, flat base that forms the crank chamber. They are water cooled and have a bore of 4 inches and stroke of 4½ inches. Turning at its normal speed of 1,100 revolutions a minute, the engine should develop 30 horse-power. The Wrights, as is well known, do not depend upon the motor for starting, but utilize the energy of a weight of 1,700 pounds that is raised to the top of a steel derrick and, in descending, "launches" the aeroplane from a single wooden rail placed on the ground. By the time the machine reaches the end of the rail it has attained a velocity sufficient to enable it to rise, and the propellers take up the work of keeping it in the air.

Two propellers are used, placed one-third the distance from center to the ends of the wings on either side, and with shafts slightly above the horizontal center. Each propeller has two peculiarly-shaped blades made of wood, and is driven by a bicycle chain running over sprocket wheels. To prevent lashing, long chain cases of bicyble tubing are made for the chains to run in. The engine is mounted to the right of the longitudinal center to balance the weight of the operator, who sits on the left; consequently, one of the driving chains is longer than the other. In order that the two propellers may turn in opposite directions and so balance each other when in action, the longer chain is crossed, reversing the direction of rotation of the propeller. A longer set of propellers, providing greater thrust, is fitted when an extra passenger is to be carried than when the aviator flies alone. These have a diameter of 7½ feet and are geared to the crank-shaft in a ratio of 10 to 33, by the use of large sprockets, so that the propellers revolve about four hundred times a minute. No clutch or change speed gearing is interposed between the engine shaft and the propellers, and the engine is started by turning the propellers over by hand.

No carbureter is fitted to the engine, the fuel being forced directly into the intake to each cylinder, by a geared pump, at a predetermined rate that cannot be altered when in the air. Consequently, the engine runs at constant speed and the operator pays no further attention to it after getting started. When it is desired to bring the machine to the ground, the ignition is cut out simply by touching a string that short circuits the current from the high-tension magneto, causing the engine to stop at once.

The Farman and Delagrange machines, Figs. 3, 4 and 6, built by the Voisin Fréres, are constructed after the same model. In actual performances, they are second only to the Wright machines. Up to the end of October, 1908, Henry Farman was the only aeroplanist who had flown straight across country instead of merely circling over open military grounds. On October 30 he flew direct from the grounds in Mourmelon to Rheims, a distance of sixteen miles, rising to

heights varying from 120 to 300 feet, passing over the tops of trees and across fields and streams. A rather strong wind blew from behind, but did not interfere with the steering. The time of the flight was about twenty minutes. Delagrange, on September 17, broke the European record by remaining in the air for a few seconds less than half an hour, though Orville Wright had flown for more than one hour at Fort Myer only the day before, and four days later Wilbur Wright stayed up more than an hour and a half.

The wings of the Farman and Delagrange aeroplanes are rigid along both front and rear edges; and there is no arrangement for restoring lateral equilibrium. The center of gravity is brought very low, however, by the weight of the wheeled attachment which hangs below the lower plane. The "wings" are 40 feet from end to end and 6 feet wide. They are spaced 6½ feet apart and are set at an angle of 15 degrees from the horizontal when the machine is at rest on the ground. A single-plane horizontal front rudder is used, 16½ feet from end to end, and 39 inches wide. Its angle of inclination is controlled by a rod that extends directly back to a connection by universal joint with the shaft of a steering wheel like that of an automobile.

To give increased longitudinal stability, a large "tail" is attached at the ends of four rearwardly-extending rods. It is cellular, having canvas sides as well as upper and lower planes. The planes have the same form as the main planes and are 6 feet broad by 10½ feet from end to end at the rear edge and 8 feet at the front. A vertical rudder is mounted in the center of this tail and its movements are controlled by wires connected with the steering wheel.

A 50-horse-power Antoinette special aeronautical engine, Fig. 7, weighing with attachments 250 pounds, drives a single two-bladed propeller that is attached directly to the crankshaft. This turns at the same rate as the engine—1,200 revolutions per minute. The eight cylinders of the engine are arranged in two lengthwise rows set at an angle of 90 degrees to each other. They are water cooled and have a bore and stroke of 5½ inches. Direct injection of the fuel is employed in this as in the Wright engines, the gasoline being pumped to a distributor in the head of each cylinder, where it remains until the suction stroke. This engine is mounted on wooden bars almost in the geometrical center of the biplane, directly back of the operator's seat.

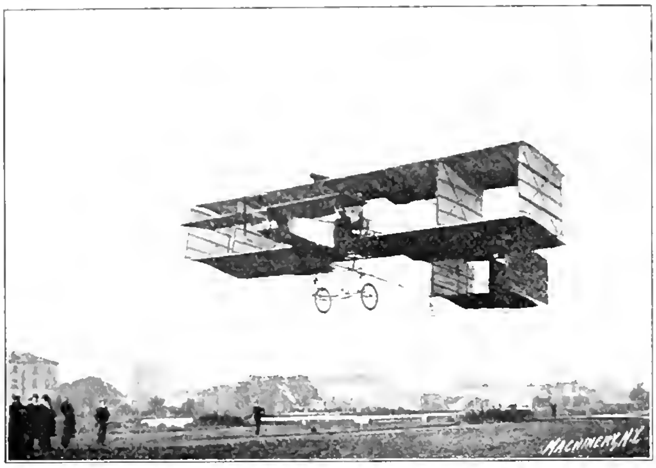

Fig. 6. Delagrange's Aeroplane in Flight at Issy-les-Moulineaux, France.

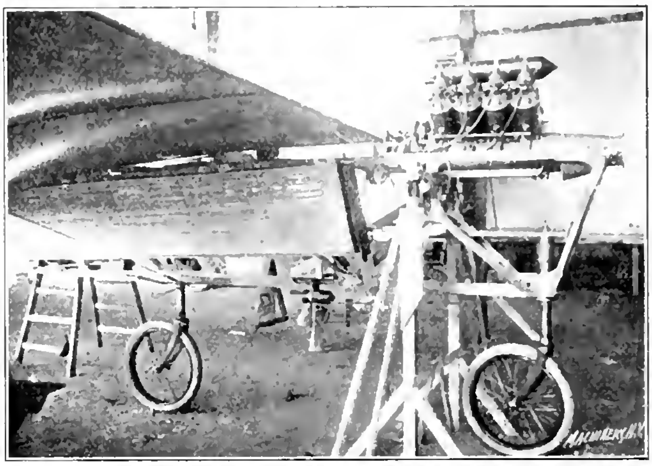

Fig. 7. Antoinette 50-60 H.P. Eight-cylinder Aeronautical Motor.

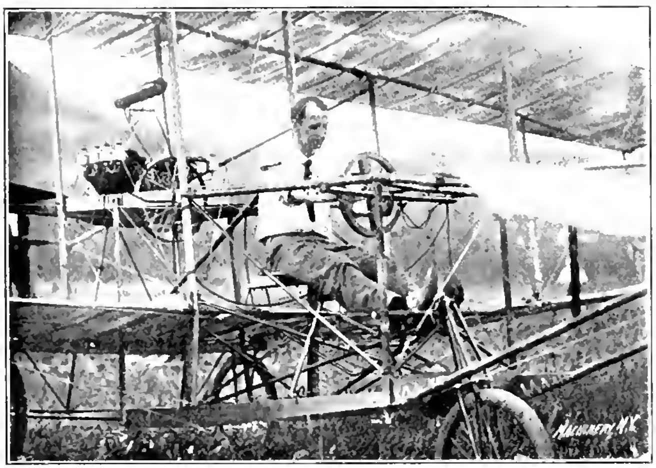

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Fig 8. Power Plant and Operating Mechanism of Curtiss' "June Bug."

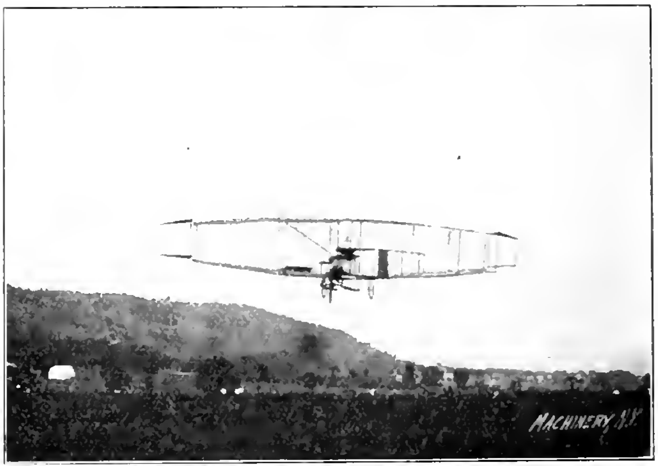

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Fig. 9. The "June Bug" in Flight at Hammondsport, N. Y.

Of numerous other aeroplanes of the biplane type that have flown short distances, the one of most interest to Americans should be the "June Bug," built and flown at Hammondsport, N. Y., where it won the international trophy last July. This machine is very light, weighing but 430 pounds, including the tricycle upon which it runs on the ground. The framing is of tough woods and bamboo, and the covering of the wings is silk, varnished. The wings, which are tapered and curved toward each other at the ends, present a supporting surface of 408 square feet, so that with the operator at his post, each square foot has to lift only about 1½ pound, whereas the Wright machines have lifted 2½ to 3 pounds per square foot. A Curtiss air-cooled engine of 30 horse-power is used. It has eight cylinders of 3⅝ by 3¼ inches bore and stroke, with normal R.P.M. rate of 1,800, and is, like the Antoinette, of V type. The engine is bolted to a pair of parallel wood bars directly behind the head of the operator and almost in the exact center between the two superposed supporting planes of the machine. The power plant and operating mechanism are supported on a tricycle having bicycle wheels, which has been driven on the road, with the aeroplane wings and tail removed, at a speed of forty-five miles an hour simply by the thrust of the propeller blades in the air. Going to the other extreme from the designers of the engines previously described, Curtiss fitted a carbureter to each of the eight cylinders.

Movements of the "June Bug," Figs. 8 and 9, in the air are controlled by means of a single-plane horizontal rudder in front, a single vertical rudder in the rear, and by a system of movable tips on the ends of the wings. The rudders are manipulated by a wooden steering wheel having an outer peripheral groove in which lie a pair of small cables that extend to little pulleys on the framework at either side and

thence backwardly to the rear rudder. To elevate or depress the front rudder, it is required merely to push or pull on the wheels whose shaft is connected with levers that move the rudder. The wing tips are moved almost involuntarily by the operator in his instinctive leaning of the body away from the side of the machine that begins to restore lateral equilibrium: Wires connected with the tips pass through small pulleys and are attached at their ends to a light cradle made of steel tubing which fits around the shoulders of the aviator when seated. Thus, movement of the trunk of the body to one side elevates one set of tips and decreases the resistance on that side, and depresses the tips on the opposite side to the same degree, increasing the air resistance.

Of the many monoplanes that have been built on the principles evolved by Professor Langley, those of Louis Bleriot, Santos-Dumont and Messrs. Gastambide and Mangin have given the most promising results. As a class, the single plane machines seem to lack the stability and structural strength of the biplane. A number of accidents have occurred through the collapse of the wings, the plunging of the machines to the ground, and their complete capsize. In many respects the monoplane of Santos-Dumont (who has built and tried about a score of flying machines and airships) is most worthy of attention. It is the only one that up to this time of writing has flown more than 100 yards and alighted safely. Bleriot on June 29, 1908, flew 300 feet with his new monoplane driven by a 50-horse-power engine and having a wing spread of 36 feet and a total length fore and aft in excess of this; but on November 18, 1907, Santos-Dumont drove his monoplane, in Paris, 450 feet at a height of about 20 feet from the ground. The machine is very small, having a pair of wings with a spread of only 16¾ feet and a width of 6 feet, giving a supporting area of 107 square feet. The wings are mounted, together with the engine, on a tricycle, the complete apparatus weighing only 123½ pounds. It is driven by a two-cylinder opposed air-cooled engine of 17 to 20 horse-power, weighing 48½ pounds and mounted at the extreme front above the operator's head, where it drives a two-bladed propeller. Movements of the monoplane when in the air are governed by combined horizontal and vertical rudders attached by universal joint at the end of a 20-foot bamboo pole stayed by wires, and also by a horizontal rudder in front and a pair of kite-shaped vertical rudders secured to the sides of the tricycle under the wings. All of these rudders are controlled by a single operating handle.

While it is unsafe to prognosticate with regard to the development of so new a form of invention, one cannot but feel that the practical flight machine of the future will tend toward much smaller horizontal dimensions than those of most present aeroplanes, have a larger factor of safety, and positive means of maintaining lateral and longitudinal equilibrium that will enable any person with due caution to avoid absolutely a sudden dash to earth. At first we may expect that they will be built small and light for individual use, but later increase in capacity to two or four persons as the public grows accustomed to their use. They will be less expensive than automobiles and will be extensively used for private pleasure and for racing, as well as for scouting and other military purposes.

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The Association of Licensed Automobile Manufacturers has tentatively adopted a design of quick detachable rim for automobile pneumatic tires. It is the desire of the mechanical branch of the association to settle on a standard design which will meet general approval, and which will do justice to all concerns that have developed detachable rims. The tentative adoption of one style was for bringing about conformity of action, and is in no sense a final adoption. The final adoption is contingent upon other than mechanical questions. This is the substance of a statement made by Mr. Albert L. Pope, chairman of the tire committee. The importance of a quickly detachable rim in the automobile trade is so great that it seemed necessary to take a decisive step that would lead to uniformity of design. It is probable that the detachable rim will become almost universally used because of the convenience and quickness of repair of punctured tires, made possible by this construction.

THE LAWRENCE INDUSTRIAL SCHOOL.[*]

The Lawrence Industrial School opened October 19 with a registration of over 900 students, and resumes its classes with the most brilliant prospect of another year of success. This school is the only independent industrial school in Massachusetts, with independent buildings, and with an independent board of five trustees. It was established under the industrial school act, and opened last year with evening and day classes for those already engaged in the trades. This school represents a new phase of education; namely, a practical education by which the industrial worker may meet his daily needs. Industrial superiority depends upon industrial training and education, and this training and education can be accomplished best, not by the necessarily rude methods of the mill and shop, but with those methods supplemented by industrial education. It was such a school that Lawrence lacked until a few years ago. The deficiency has been supplied with a speed and on a scale of which no one dreamed. What has been accomplished reflects great credit on the enthusiastic, far-sighted, and energetic trustees: Dr. M. F. Sullivan, president of the board of trade; James Barnes of the American Woolen Co.; Walter H. Summersby, agent of the Atlantic Cotton Mills; A. X. Dooley, attorney at law; John B. Cameron of the Central Labor Union; and the principal and chief executive officer, William H. Dooley. Principal Dooley has made an extensive study of industrial school methods in nine European countries. The result is that Lawrence and the surrounding cities and towns are now provided with the means of educating in a systematic manner their large number of textile and metal workers. No entrance examinations are held, the only qualification being that the applicant for admission be an operative. The school is free. Text-books are edited by the instructors, and printed by the commission. The problems, drawings, and notes are practical, the drawings and notes coming from the shop, so that the school keeps in touch with the industries. These notes and problems are obtained by means of a question box. The instructors are practical men, working in the industries and conversant with the needs of the operatives.

Practical Instruction in Reading and Making Drawings.

The evening instruction appeals to the student immediately at the beginning of his work. For example, a young machinist had received a reprimand from his foreman because he could not read a working drawing with sufficient skill to do his daily work properly. He enrolled in the mechanical drawing course in the evening drawing school, thinking this course would meet his deficiency. He found that the first two lessons were concerned with lettering plates, the next three with drawing straight and curved lines and the handling of instruments, and that the remainder of the term was spent on the projection of points, lines, surfaces and solids. During all this time he was receiving in his daily work the same reprimands, and was therefore debating in his own mind the value of the drawing course. It is undoubtedly true that the drawing course this teacher had outlined in the drawing school is a proper one for teaching mechanical drawing for those who are to be draftsmen, but the average apprentice machinist, as well as this young man, does not see the direct application of this instruction to his work. He enrolled in the drawing school for a definite purpose. To be sure it was a narrow one, but nevertheless it had economic value to him. As the result of this young machinist's experience, the principal immediately offered a course in blue-print reading and arithmetic for machinists. This is one of the most popular courses in the school.

The first lesson begins with some elementary instruction in the reading of simple drawings; to teach him in five lessons where to look for the dimensions denoting length, breadth, and thickness; to show him the principles of simple sectional drawings and have him comprehend the laying out

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[*] For additional information on this subject see the following articles previously published in MACHINERY: Evening School of Trades—Rindge Manual Training School, Cambridge, Mass., July, 1908; Can a Boy Learn a Trade in a School? April, 1908; Promoting Industrial Education, May, 1907; A Step Toward Increased Facilities for Industrial Education, December, 1906; An Experiment in Industrial Training, September, 1906.

of holes for drilling. Instead of leaving school at the fifth lesson with no instruction which appealed to him, the students have received enough in those five lessons to fit them to meet the needs of their foreman, and are anxious to continue and receive the more definite and thorough instruction in the theory of mechanical drawing so as to be able to make sketches of machines and parts by means of a ruler and compass. It is not the aim of this course to teach the students to make pretty picture drawings.

Practical Mathematics.

The instruction in the various branches of mathematics is adapted to meet the needs of the mill operative, the machinist and the steam engineer. The terms used in the class room savor of the shop and mill. For example, the method of finding the heating capacity of a boiler does not appeal to the weaver in the mill, and, on the other hand, finding the size pulley for a certain loom does not awaken the interest in the steam engineer as much as the problem involving the same operations dealing with work in the boiler room.

Students Classed by Vocations.

All our students are classified into vocational classes according to their trade. For example, there is a class in arithmetic for engineers and a separate class in the same class for boiler firemen. Again the textile designers have a class in arithmetic called cloth calculations and the loom-fixers a class called loom calculations. This idea carries out the plan of the old workingman's guilds. Each guild was formed for the purpose of social intercourse and mental stimulus. Each trade had its own guild. The daily trade experiences of each member became the property of all members. Discussion relating to the practices of their chosen trade occupied their attention. So, to-day, workingmen have common trade interests. Our evening students are grouped according to their occupations and in this way have an opportunity to talk over these interests. The teacher acts as a leader and draws out the students in telling their trade experiences and, through the expression of these various opinions of the work, practical solution of the particular problem at hand is obtained. It is difficult to get students to recite and express themselves at the blackboard. A free discussion of the point at issue makes the student lose his self-consciousness and before he is aware of it he is at the board illustrating his particular method of solution. Of course such discussions are under the wise guidance of the teacher.

Provision for Irregular Attendance.

Provision is made for students who cannot attend but once or twice a week. It is quite common for students to stay away because they cannot attend "regularly." This applies to a great many textile workers. In prosperous times the mills are run evenings and the employes are expected to work overtime. But they can usually get away for one night in the week during such times. They cannot always tell definitely what nights they will be called upon to work. Students who are working overtime are allowed to attend any night during the week after the work is fairly started. Such a plan is feasible. Boiler firemen alternate in working day and night. A fireman who works days this week will work nights next week, and so on. The week he works nights he attends the day classes, and the next week he attends the evening classes.

Scope of Instruction.

A certificate is awarded each person completing a course. Day classes are formed for the convenience of those who are unable to attend the evening sessions. The school is in a position to compete with any of its kind, over $32,000 being represented in its up-to-date woolen, worsted, cotton and steam machinery. Classes in the following subjects will be formed for both day and evening pupils: Woolen and worsted spinning, woolen and worsted weaving, woolen and worsted finishing, dobby and jacquard weaving, cotton spinning, cotton weaving, loom fixing and loom calculations, mill arithmetic and mill bookkeeping, elementary and advanced textile designs, elementary and advanced cloth calculations, industrial and commercial electricity, steam engineering for firemen, steam engineering for engineers, arithmetic for firemen and engineers, blue-print reading, machine drawing and arithmetic for machinists, shop arithmetic, industrial and commercial chemistry, experimental and practical dyeing and dressmaking for working girls.

The courses of woolen and worsted manufacturing are arranged to meet the daily needs of those working in these industries. Instruction is given in all the various processes employed in adapting the wool fiber to cloth, namely: Sorting, scouring, carding, combing, spinning, designing, weaving, dyeing and finishing.

Cotton Course, Dyeing and Chemistry.

The cotton courses are designed to meet the needs of the men working in these industries—to make better workers of them and to train them to think and take an interest in their work. If a sufficient number registers, classes will be formed in picking, carding, drawing, roving, spinning, combing, designing and weaving. In connection with this work a course in knitting is offered. The equipment of the department is of the best up-to-date cotton machinery.

Experimental laboratory, dye house and industrial chemical laboratory work is carried on in a building located in an ideal spot for a dye house. It is situated on the banks of the Merrimac just above the falls, away from the class rooms and dwellings. It is modeled after one of the most practical experimental laboratories in the country.

Steam Engineering and Electricity.

One of the strongest departments of the school is the course in steam engineering and electricity. The course consists of lectures by practical men who are specialists in their respective branches; arithmetic and practical mathematics for engineers, firemen, etc., and laboratory practice in steam engineering. The steam engineering laboratory is one of the best equipped laboratories in the country, consisting of different types of boilers, steam heating apparatus with appurtenances, different pumps in sections, sectional valves and gages, all the boiler accessories, steam engines, generator and many other machines. In addition to all these, pictures, blue-prints and sketches of the above apparatus and other machines are on the wall for study. All the lectures, classes and demonstrations are carefully planned to meet the needs of those working in the trades. Classes are formed afternoons for those working nights, and evening sessions are conducted for those laboring days. This is the first free engineering laboratory in this country.

Limitations of Present Schools.

The purpose of most of our present technical and textile schools is to give the highest possible instruction in science, and to give this knowledge to the operatives of the industry. In order to enter these schools, the student must be a graduate of a high school and have received a thorough preparatory training. Most of the present textile and metal workers have never received over four years schooling and this was before twelve years of age, and the average boy cannot afford to remain unproductive beyond the age of seventeen. Hence the schools fail to provide an education for the great mass of our future industrial workers. The education received in these schools often exceeds the real needs of the metal and textile industries. Hence there is a loss of time which could be better devoted to obtaining practical skill. Then again most of our boys cannot afford to pay $150, the tuition necessary to enter our present textile and technical schools. Neither are there free scholarships provided. In consequence of these considerations, there is found to be need of an industrial or technical school somewhat less pretentious in its course of study, somewhat lower in its requirements, and giving instruction of a character more directly vocational or more directly industrial. This is the aim of the proposed secondary industrial school in Lawrence—a school much needed in every industrial community. A canvass has been made in the city of Lawrence and over five hundred boys have signified their intention of attending such a school, a school to provide a three years' learning for a boy in either the metal or textile industries.

* * *

More people fail from lack of confidence in themselves than from lack of ability.—*The Silent Partner.*

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS—4.

WILLIAM P. SARGENT.*

DEFINITE PLANNING.

The general plan for a works designed to employ 1,500 men has already been presented, and we are now ready to take up the definite planning. The more designing, subject to approval, that the construction engineer can have done by outside parties, the quicker and better the plant can be built. This policy is recommended for the reason that no one person can have that definite knowledge of all subjects possessed by those who specialize in a certain line. The designers belonging to the plant can be more profitably employed on work which cannot be carried out except under the engineer's constant supervision.

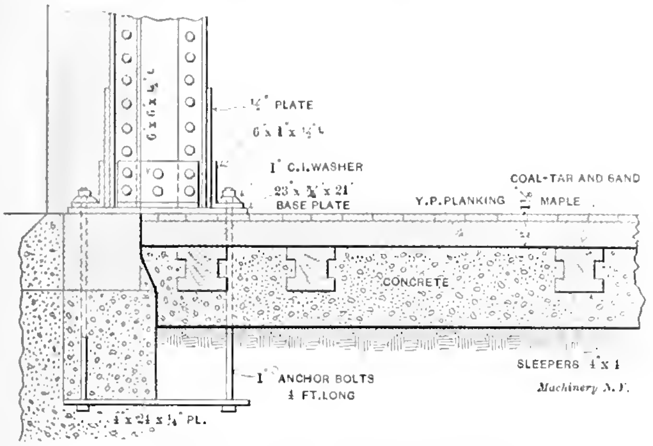

Fig. 28. Section of Flooring, Ground Floor.

An architect should be employed for the buildings, and the engineer should give general instructions and follow up the designs of the buildings; by acting in an advisory capacity the general ideas of the engineer can be closely incorporated. The architect should be made to understand that shop buildings are for use and not for ornament, and should be required to take the responsibility of the accuracy of the figures embodied in his plans. The engineer and the architect should work up the steel design sufficiently to arrive at the tonnage in order to give the steel companies the information required for making bids; it is good policy to permit the steel companies to make the detail design of the structural work, and to enter bids at a tonnage price, the prices being based on an approximate tonnage erected within a given time. The engineer has control of the tonnage on account of the detail construction being subject to his approval.

Data for the Architect.

The following data should be furnished the architect:

1. The block plan and cross sections, already made up.

2. The cost range, within which the buildings are to be designed. For present prices, this should be from $1.50 to $1.65 per square foot for the main buildings.

3. The column spacing determined by considerations of actual necessity and of economy in the cost of steel work: for the erecting shop No. 6, 25 feet, to tie with the span of the wing shops; for the machine shops Nos. 1, 2, 3, and 4, and forge shop No. 5, 16 feet, because of economy and the fact that the bents in the old shops are 12 feet and are almost wide enough; for the foundry No. 8, 20 feet. For the pattern storage building No. 9, 16 feet is suggested, but the previous caution, respecting the laying out of the pattern rack system and the window spacing, should be considered.

4. The bearing power of the soil (obtained from actual tests) and the nature of the foundations proper. Concrete is almost universally used. The cheapest type of foundation consists of a footing 12 to 18 inches thick, for the column piers, and a plain foundation wall uniform in thickness, about two feet deep, between the piers. Reinforcement is used in the footings to prevent breaking in the corner where the pier starts, and in the bottom of the wall to prevent cracking. This type of foundation requires no forms for the footings, and but a plain form for the wall and piers.

5. The loads for which the steel work should be designed. The snow load varies with the latitude, and there is plenty of data to govern. With a gravel roof laid on plank sheathing, 40 pounds per square foot of projected area is often assumed for the total load on the trusses, in the Central States. For the floor loads for the machine shop galleries, 250 pounds live load is sufficient for the class of work to be done. Anyone who has not studied the weight on loaded floors will be surprised at the amount of material and machines required to load a floor to even 150 pounds; in this case we need extra rigidity to reduce the vibrations caused by rapidly moving cranes. For the sand floor, the steel work should be designed for a safe load of 400 pounds and the concrete floor should be designed for a safe load of 600 pounds. The sand will often come in wet and may be 8 to 10 feet high at times, equivalent to a load of 1,000 to 1,500 pounds. For the pattern storage assume a load of 120 pounds, based on an equivalent of 4 feet of patterns solid on the floor. It is well to design this building for the addition of another floor in the future, as this added space can thus be obtained at less price than by building on the ground.

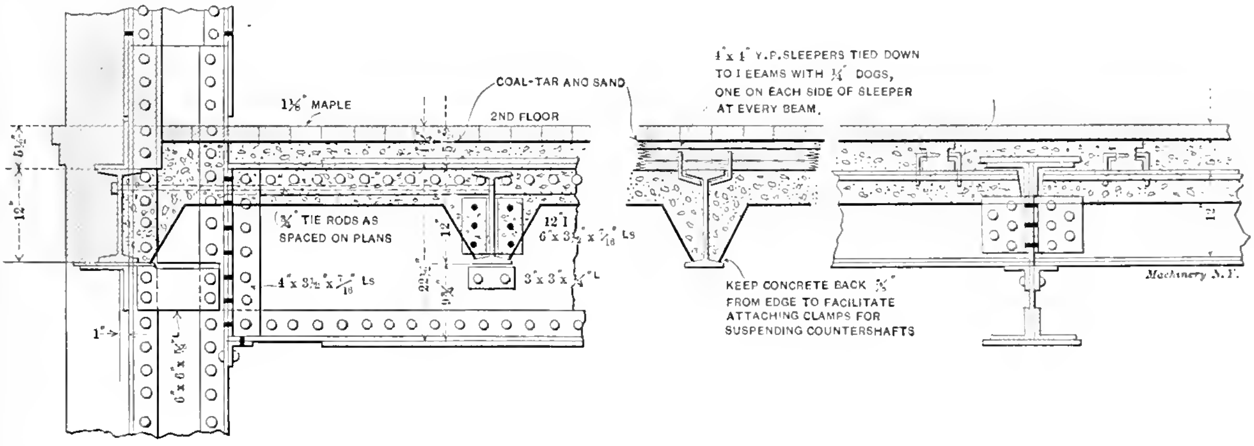

Fig. 29. Section of Flooring in Galleries.

6. The maximum wheel loads of the cranes and the distribution of the wheel loads on the crane girders. The table given on page 19 of Ketchum's "Mill Buildings" is representative for the loads of most cranes. Often the wheel load is taken as equal to the rated capacity of the crane. This is very safe.

7. Brick curtain walls 8 inches thick are sufficient, if built between the columns and well supported by the horizontal members of the steel work. An 8-inch brick wall will conduct nearly 45 per cent more heat than a 12-inch wall, but there is such a small percentage of brick surface that this factor of heat loss will not justify the expense of a wall thicker than 8 inches.

8. Window data. There should be swinging windows as close to the ceiling as possible, and part fixed sash, and part sliding sash, below these to within 4 feet 6 inches of the floor,

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* Address: 315 South First St., Rockford, Ill.

except where crane girders and intervening brickwork interrupt. The frames, sash, and glass should be standardized to a few types and sizes.

9. Steel rolling doors for the larger openings, and sliding doors for the openings through which freight cars do not pass, should be provided. There should be a wicket door in each sliding door, and enough other small doors to permit of going from one shop to another, in winter, without opening up the large doors.

10. Floors should be made as follows: 6 to 12 inches of gravel concrete with 4 x 4-inch sleepers embedded; then a layer of fine sand and coal-tar; then 2-inch tongued and grooved yellow-pine planking which is spiked to the sleepers. The sleepers should be on 24-inch centers. On the planking is laid a 1⅛ x 4-inch square edge maple top floor. This floor will cost from 22 to 30 cents a square foot, according to the thickness of the concrete. The contract for the floors in buildings where machine foundations are to go in, should be let separately on a square foot basis. This avoids laying out the tools at an early time, and gives the shop officials time to decide on a satisfactory layout. Fig. 28 shows section of ground floor, and Fig. 29 gallery floor.

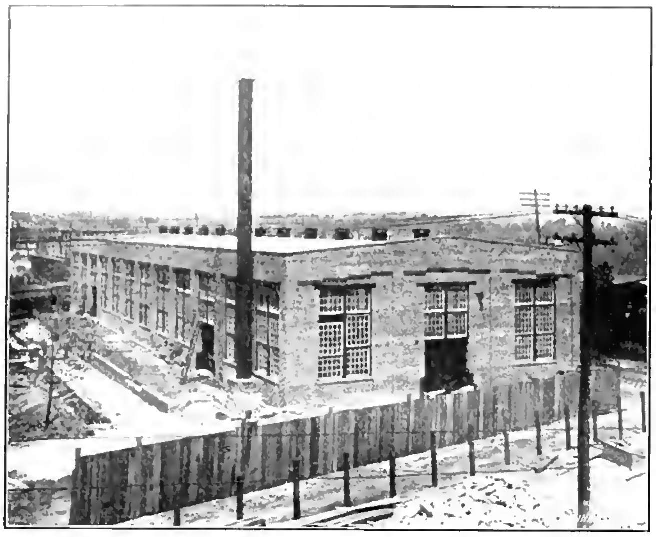

Fig. 30. General Appearance of Shop Building such as Specified.

11. Fire-proof vaults should he provided in No. 8 building, foundry office, and on all floors of the No. 9 building.

12. Locating wash rooms and closets in large works is always a problem; placing them on the mezzanine floors, wherever possible, is about the best solution; and this is possible with the headroom that we have provided.

Fig. 30 shows the general appearance of the type of design outlined above.

General Work for the Engineering Force.

While the architect is working up the shop building plans, the power plant should be designed complete, under the engineer's supervision. The drawings should be prepared early, as deliveries on power apparatus are long, even in dull times. Standard apparatus should be used if the conditions permit.

At about this point in planning shop improvements, the need of a detailed list of the matters requiring consideration, becomes apparent. A good way to get up a reasonably correct list at the start is for the engineer to sit down with some one of his men, conversant with the general plan and experienced on construction work; then with the survey plat, block plan and photographs of the site before them, they list, independently, every item that comes to each man's mind. The two lists when combined should agree fairly well.

The following list gives the main headings that, in general, would enter into such a list. Besides the building numbers of the block plan, the yard space North is designated by the letter *A*; the space East by *B*; the space South, inside the fence, by *C*; the space South, outside of the fence, by *D*; the yard spaces between the wing shops by E_1, E_2, E_3; between the machine shops and foundry by *F*; and between the foundry and pattern storage building by *G*.

Suggested Itemized List of Details Necessary to Complete the Plant.

Required definite planning, securing bids and prices, contracting and purchasing, constructing or executing of the following: Clearing the site, selection of grades for floors, tracks, etc., staking out buildings, tracks and fences.

Underground Work.

Sewers.—Storm sewers, to take care of roof drains and surface water in yards.—Sanitary sewers, to reach all buildings, excepting Nos. 10 and 11.

Water Service.—Fire and sprinkler mains, to reach all buildings and hydrants in yards.—Shop service, to provide drinking water, for flushing, and for wash rooms.—Condenser main from steam and discharge pipe.

Power Mains.—Heat to all buildings excepting Nos. 10 and 11.—Steam to forge shop No. 5 and dry-kiln No. 10.—Air to all main buildings.—Oil to No. 5 and No. 8.

Foundations.—Building foundations.—Holes in building foundations for service mains and for power tunnel.—Machine foundations in shops and in power plant.—Crane runway foundations in yards.—Pits in erecting shop and foundry.—Power tunnel between buildings.

Work Above Ground.

Lighting.—All shop interiors, the yards between the shops, all gateways and main avenues within the works.

Power.—To all shops and yard cranes.

Plumbing.—Air piping.—Water piping.—Sprinkler system.—Gravity tank.

Tracks and Equipment.—Tracks, switches.—Track scale.—Scale house.—Locomotive shed.—Watchmen's sheds.—Switch engine.—Locomotive crane.

Telephone system.

Structural Steel.—Roof loads, floor loads, crane loads, column loads.—Provision for extensions, for attachment of jib cranes, for support of counter-shafts and line-shafts, for fireproofing, for attachment of trolley hoist runways, for support of top end of window-frame, for support of pipe coils.—Elevator guides and framing, railings, anchor bolt diagram, anchor bolts, plates and column foot-plates.

Concrete Floors.—In all buildings excepting No. 5, No. 8 and No. 11.

Cement Floors.—For all wash rooms, boiler room, pattern storage rooms.—Treads for stairs, stair landings.

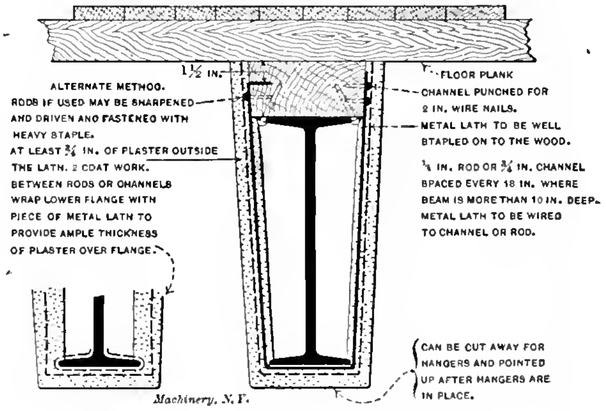

Fig. 31. Fire-proofing of Steel Beams.

Fire-proofing.—Fire doors in all fire walls.—Metal frames and wire-glass windows at junction of wing shops and No. 6 building, on foundry side of boiler house, on either side of fire walls.—Concrete or mortar protection of exposed steel work in No. 9 building. (Fig. 31 shows an economical method of protecting beams and columns, suggested by the Associated Factory Mutual Insurance Company.)

Concrete Roofs.—Over charging floors, over dry kiln.

Walls.—Brickwork, anchors, pilasters, parapets, coping, wood for lumber shed.

Windows.—Widths, heights of frames, size of sash, size of glass, pivot windows, balanced sash, weighted sash.

Doors.—Rolling, sliding, wicket, and small doors.

Roof.—Gravel, sheathing, wood purlins, saddles, strainers, downspouts flashing and counterflashing, ladders.

Floors.—Under planking, top floor, troughs for piping, industrial tracks.

Miscellaneous.—Stairways, vaults, core-ovens, offices, elevators, cranes, trolley hoists, traveling jib cranes.

Power Plant Equipment.—Engines, generators, switchboard, boilers, stokers, ash and coal handling apparatus, feed-water heaters, water softeners, condensers, feed-pumps, fire-pump, compressors, receiver, engine room crane.

The preceding list does not enumerate the details, as each building has its own characteristics. Each building should be taken separately and the general heads enlarged upon according to the conditions. The listed items should be checked off, as soon as the drawings required are under way. Consulting with the various foremen of departments will constantly add to the list, as various improvements are suggested. These little things bring the cost up amazingly, and that is the reason why the engineer should hold to a broad range in his original estimate.

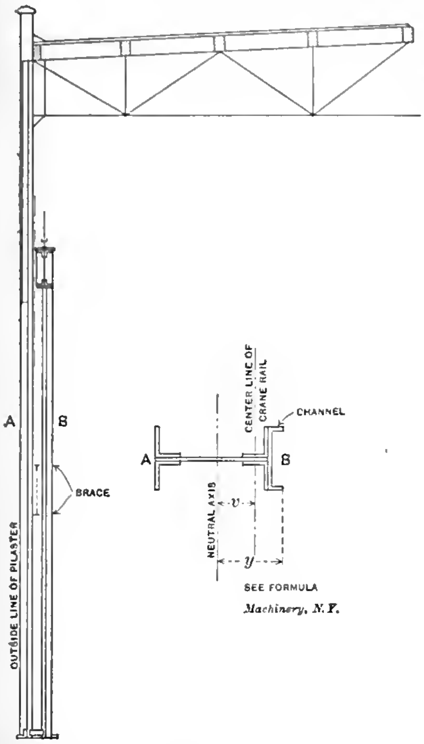

Fig. 32. Economical Form of Truss and Column.

Time Chart to Govern Work.

After listing the details of the work, a time chart can be made out, to be used in controlling the commencement and completion of the various details. This time chart or schedule is the most important record used in completing a series of improvements within a definite time. It is as important, as a train schedule is to a railroad.

The construction of a large plant, naturally, is separated into divisions, each complete in itself. The time chart should be divided accordingly, for instance, machine shop No. 1, machine shop No. 2, etc., and into general divisions which cover the work that cannot be charged to the separate buildings.

We should have a chart for each division, and each class of work for each division should have columns as follows: Drawings, dates of commencement and completion; account number, against which to charge cost; name of contractor; date of order or contract; date when work should be commenced; date when commencement is promised; date of promised delivery; date of delivery; date when work should be completed; date of promised completion; date of actual completion; estimated cost; actual cost; notes. Each item of work should have three lines, so that revisions can be made without erasing the original dates. Revisions generally are necessary, as a spell of bad weather, or a strike, can throw out of gear the best laid plans. The dates should be adhered to, and the contractors should be held to their promises irrespective of the state of subsequent work. The following instance shows the importance of this latter statement. The general contractor on a certain building, was delaying the completion of the foundations, giving as a reason *that the steel work was not in sight*. At the same time, investigation developed that the steel company was delaying *because the foundations were not completed.*

Foundations.

The depth of the foundations will depend upon the depth of excavation required to reach a soil with a minimum bearing power of two tons per square foot. The figures given in "Trautwine" are safe for estimating, but actual tests should give the data for specific cases. The footings should be proportioned to sustain the actual dead load of buildings and an average of the added loads on the building superstructure, omitting the snow load. For the crushing strength of the concrete piers, 250 pounds per square inch should not be exceeded for plain concrete, and 700 pounds per square inch for reinforced piers. The area of the footings will be about 7.5 times as great for a gravel subsoil as the area of steel column foot plates. The total weight bearing on the foundations will approximate 300 pounds per square foot of ground floor space for gallery shops, such as Nos. 1, 2, 3, 4, and 8; 250 pounds for high shops without galleries, such as No. 6; and 200 pounds for low shops without galleries. These loads will require, respectively, 1/50, 1/60, and 1/90 cubic yard of excavation, and 1/75, 1/90, and 1/135 cubic yard of concrete per square foot of ground floor space. The foundation wall for carrying the weight of brick work between the columns, if made about 2 feet deep and reinforced, will cost only half as much as foundations that are carried down to the level of the column footings.

Structural Steel Details.

In order to secure sufficient strength of steel work at a low cost, the following points should be watched, either in the design or in the checking. Crane loads and concentrated loads on the trusses add complexity to an otherwise simple proposition.

Trusses.—The stress diagrams should first be checked. The stresses in the upper and lower chords can be found approximately by the formula:

$$\text{Maximum stress per square inch} = \frac{W \times L}{8 \times D},$$

in which W = the total weight on both columns (including the weight of the truss); L = the length of the span between columns; D = the average depth of the truss in feet. The writer has compared the weight of a number of trusses for flat pitch roofs, for column spacings of 16 and 20 feet, with plank roofs and wood purlins, and none exceeds 5 pounds per square foot of projected area of roof. Calculations based on a total load of 40 pounds per square foot of projected area should be safe for the latitude of Chicago and the South, and 50 pounds for New England. One of the leading structural firms in the Central West recommends for flat roofs the form of truss shown in Fig. 32, the height in the center being about one-tenth of the span. Angle sections are used and the price, erected, in the vicinity of Cincinnati is about $60 per ton (October, 1908). The height specified requires about 25 per

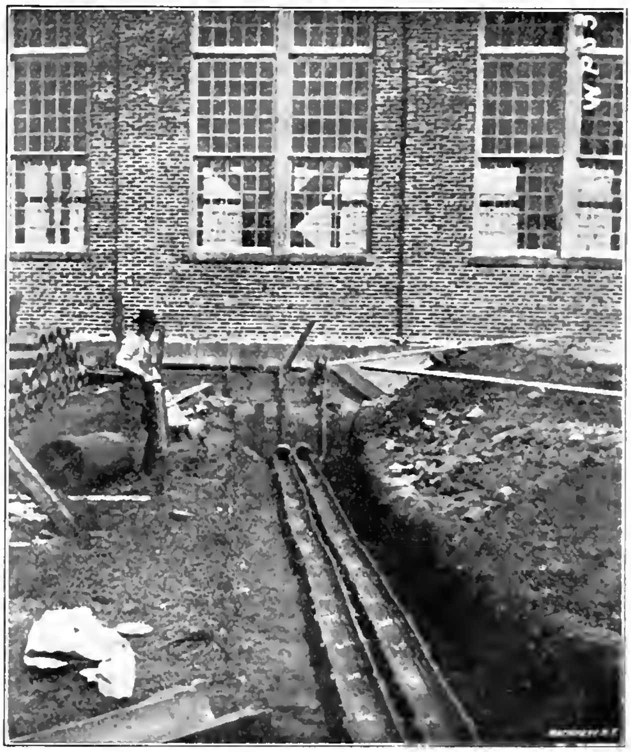

Fig. 33. Laying Split Tile Pipe for Running Pipes Underground.

cent more metal than if made one-eighth of the span, but the added cost, at $60 per ton, for the shallower truss is less than the added cost of the brickwork in the walls for the higher truss; and it will not take any more time to erect the heavier truss, but will require more time to build the higher wall. The allowable stress per square inch of the various truss members can be found in Kidder's "Architects and Builders' Pocketbook," pages 463 to 470, or on pages 143 and 144 of the Cambria, or on page 209 of the Jones & Laughlin handbook.

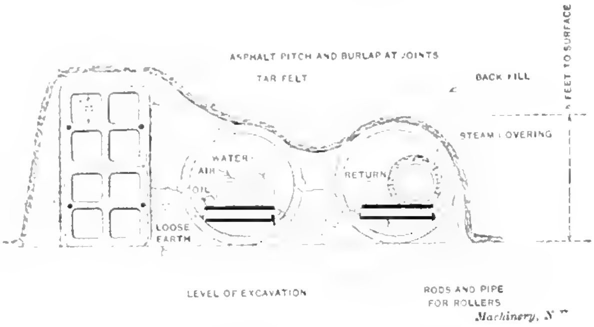

Fig. 34. Section of Conduits shown in Fig. 33.

Columns.—Many different forms of columns are used to support roof and crane girders. The column, shown in Fig. 32, is probably as economical as any. In a general way, the angles on the girder side (sometimes reinforced with a channel) are designed to support the crane loads, and the angles on the other side are designed to carry the roof. This form of column will cost from $65 to $70 per ton erected, at the present time. The area of section required for this form of column is found by the formula

$$A = \frac{I}{p}\left(P + \frac{3\,V P_e}{y}\right)$$

in which A = area of column section,

p = maximum allowable stress per square inch,

P = total load, both eccentric and concentric,

P_e = eccentric load,

V = distance of eccentric load from neutral axis of the column,

y = distance of extreme fiber from the neutral axis on the loaded side.

The number of formulas giving values of p are many, but the values given in the steel companies' handbooks are a good basis, as they are tabulated. Increasing these values about 7 per cent will give the allowable stresses according to the Chicago building code. Increasing them 11 per cent will give approximately the stresses used by the steel companies in calculating the safe loads for their special forms of columns.

For columns for very light loads, built into walls, single I-beams can be used, costing about $56 per ton, erected. Short columns, made up of four angles, laced, require the least area of section for light loads, and will cost about $75 per ton, erected.

Crane Girders.—These should preferably be made of angles and plates with a generous depth, as deep girders help to stiffen the columns, and minimize the effects of the longitudinal thrust of the cranes, which is a great deal more than generally assumed. From records of current consumption of 30 ton cranes, starting with load, the thrust on each girder is equal to 40 pounds multiplied by the number of tons load and the total weight of the crane.

Lintels—Channel girders with cast iron separators are the cheapest for a given load, but lintels made up of an I-beam, with a plate riveted to the bottom flange, are neater, as the steel is not exposed to view. In general, sections less than ¼ inch should not be used, and in forge shops a sixteenth of an inch should be added, as the extra thirty-second on a side is better protection against the destructive action of the gases than any paint, although the paint should be there too.

Stairs.—These should be formed of channels for horses, and the treads of channels with flanges turned up, and filled in with cement and cast-iron chips mixed. Pipe railings should be better secured to the channel horses than by the usual means of malleable fittings, as these are rather too weak.

Elevator Towers.—Where hydraulic plunger elevators are not used, towers made up of angles diagonally braced should be built from the ground up, thus relieving the floors of this load. The hatchway should be 2 inches longer than the desired length of platform and about 2 feet wider, to provide for guides, counterweights and cables. The tower should have a platform at least 15 feet above the upper floor for the winding engine. It is a mistake to merely provide openings for an elevator and to leave the means of support as an after consideration.

Anchors, etc.—Holes should be provided in columns and girts for anchors for the brickwork, and in lintels for attaching the window frames. A light angle on either side of the frame and extending down to the next lintel or girt, with holes punched at intervals of 4 feet, will permit of erecting the frames in advance of the brickwork and will obviate the use of jamb-blocks (wooden blocks built into brickwork and nailed to the frames).

Relation of Types of Construction to Insurance Rates.

The following table shows the basing rates of one of the Inspection Bureaus of the Central States, and the modifying factors, as applying to industrial plants.

RATE IN CENTS PER $100 PER YEAR, ON BUILDINGS AND CONTENTS.

	Machine Shops.	Foundries, Non-combustible Cupola Platforms.	Pattern Storage.
Two-story mill construction, 10,000 square feet area on each floor	100	135	85
Steel or brick construction	85	115	70
Reinforced concrete or fireproofed steel construction, buildings	25-50	30-65	20-45
Reinforced concrete or fireproofed steel construction, contents	50-75	65-100	45-65

When sprinklers are installed in any of the above classes, the rate on buildings is within a range of 20 to 35 cents, where there is from 50,000 to 75,000 square feet of sprinkled area. Additions to basing rates are made for more than 20,000 square feet in one area ground floor, and more than 10,000 square feet on second floor, and when cupola is less than 10 feet above roof. Defective wiring carries a charge of 10 cents, and when there is no city fire protection 25 cents is added to all rates. Rates are modified for A. D. T. watchman service, stand pipe and hose, chemical extinguishers, etc. In large plants, where a blanket policy covers, the insurance companies are not always strict about enforcing underwriters' rules, but it is to the owner's interest to make the plant safe and avoid as far as possible the loss due to interrupted business caused by a serious fire. Therefore, preventative means, such as enclosed elevator hatchways, stairways with metal lath and plaster, wire glass windows, fire doors, etc., are well justified.

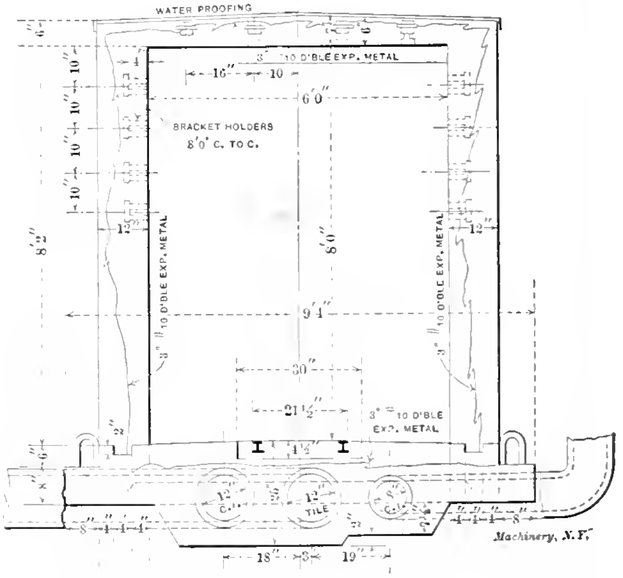

Fig. 35. Section of Tunnel for Pipes and Electric Conductors and Transportation of Castings.

Power, Steam and Water Distribution.

Electric Mains.—The private plant has a choice between overhead work and underground conduits or tunnels. The advantages of overhead distribution are first cost and efficiency. For underground distribution there is a choice between multiple tile ducts having spaces for four or six conductors, and tunnels used also for steam and water and air pipes. This is objectionable as it is difficult to keep the wires away from the hot or warm pipes at all points.

Pipe Mains.—Underground work is the most natural means of distribution. The general method is to group all piping and wiring into a tunnel. This gives perfect accessibility, but the expense is hardly justified unless the tunnel is necessary as a means of communication between various parts of the plant. A compromise method of distribution is by means of split, or lidded tile pipe. There is not the accessibility, as in a tunnel, but the difference in first cost is so greatly in favor of the split tile, that the expense for occasional excavating and repair of a leak is well justified. The pipe mains, laid in split tile, can be tested as severely as desired before putting on the lid and back-filling. A leak in a steam pipe is easily found on account of the heating of the ground in the vicinity of the leak. Fig. 33 shows two runs of this pipe, ready for the pipes. Fig. 34 is the cross-section of this line and shows the simplicity of this means of underground distribution. A tunnel must be necessarily large enough for added pipes and for men to work. Fig. 35 shows a cross-section of a tunnel for both power and transferring castings, and Fig. 36, a tunnel for power distribution alone.

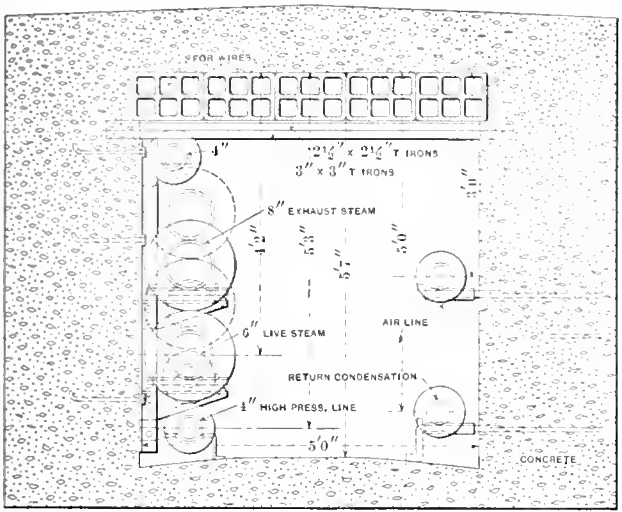

Fig. 36. Cross-section of Tunnel used for Pipes and Electric Conductors only.

The work shown in Figs. 33 and 34, for a distance of 260 feet, actually cost, in 1907, per lineal foot, complete, ready for use, with steam, water and current, $3.30, excluding the cost of the copper cables; all labor and material, excepting cables and wrought iron, $2.00. These costs were within 5 per cent of the estimate. In comparison, the estimated cost of a tunnel 4 feet by 6 feet inside was about $7.00 per foot, ready for piping and wiring. Adding to this figure the actual cost of piping, and labor of installing, $1.30, and the cost is $8.30 as compared with $3.30.

* * *

The Schlick gyroscopic apparatus for preventing the rolling of ships at sea has lately been installed on the British passenger steamer *Lochiel*. According to *Engineering*, the apparatus has proved a success in actual use, and decreased rolling of a total angle of 32 degrees to a roll from 2 to 4 degrees, an amount which is barely perceptible to the passenger. The apparatus has previously been tried in England on an experimental basis, but this is the first time that it has been installed in a British passenger steamship. The gyroscope is driven electrically, and requires very little attention. The design has been simplified, is more compact than the previous one, and takes up a comparatively small space in the steamer. It can be easily thrown in or out of action according to the requirements.

INVENTORS VS. EMPLOYERS AND ASSOCIATES.*

E. C. SMITH †‡

"What did *you* invent?" This question was propounded to one of two alleged joint inventors by an astute attorney. It developed, as the attorney expected, that the interrogated party had no part in the conception and development of the device invented, but merely a pecuniary interest therein. Therefore the patent at issue was void, because it had been falsely sworn to, one of the parties to the patent application having taken oath that he was a co-inventor when he was not.

A misconception, considerably widespread, exists concerning "invention"—the mental conception, and the embodiment of the mental conception—and the title "inventor." The embodied invention possesses property value which can be secured for a term of years by "letters patent." This property value, or right and title in and to a patented invention, is transferable. It can be shared with others or disposed of in toto, but only by assignment.

The title to inventorship is not transferable, for the simple reason that the mental process or act of inventing is not transferable.[1] The astronomer who discovers a new star is *the* discoverer. The discovery is his act and though he may see fit to attribute a share in the discovery to another, the statement is false unless that other was directly instrumental in the discovery. It is not sufficient that he was with the discoverer at the time. Even though he provided the instruments with which the discovery was made, he is not the discoverer or a co-discoverer. In the same way, the inventor may not share his title to inventorship with his friend as a courtesy, or with him who finances his efforts as a measure of security to the latter's property rights in the invention. Notwithstanding the simplicity of the foregoing proposition, its dictates are frequently transgressed, and the following actual examples indicate various forms in which the transgression takes effect.

"I want *B* to go in with me on this patent. He has helped me out a lot of times, and I want him to share the credit and profit of this thing with me."

Again: "*C* has worked on this thing with me and I am going to let him in on the patent as one of the inventors, to encourage him. He hasn't really invented anything, but has made some good constructions. It's good policy to call him one of the inventors."

The third case is piratically startling. A skilled mechanic was employed and paid to develop a certain machine. He, in turn, delegated a skilled designer to the work, leaving it in the designer's hand and devoting no attention to it personally, whatever. The designer made some patentable improvements and his employer blandly told him to prepare the requisite patent application drawings, and he himself would apply for the patents. The designer, however, knew his own status in the matter and insisted that the application should be filed in his own name, which was proper under the circumstances.

The first two cases are by no means uncommon, and well illustrate how a desired end may be defeated by improper procedure. The third example is also of a not uncommon practice, and it illustrates a peculiar condition, *viz.:* the attitude of certain employers who seem to think modern employment is akin to feudal servitude or vassalage, and that the wages and salaries they pay accord a lien on the

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* For previous articles on patents, inventions, etc., see MACHINERY, June, 1908, Patents and Inventors, and previous matter there referred to.

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‡ Edwin C. Smith was born in Elizabeth, N. J., 1869, and received a technical education in the Massachusetts Institute of Technology. He has been employed by the Union Hill Trimmer Co., Boston, Mass., Lockwood, Greene & Co., Boston, Mass.; Universal Winding Co., Providence, R. I., and the Mossberg Wrench Co., Attleboro, Mass., with which concerns he has been draftsman, assistant superintendent, and manager. He had charge of the obtaining of patents, both domestic and foreign, for the Universal Winding Co., and has made patents and patent law a special study. Mr. Smith has had extended experience with economical interchangeable manufacture and special tools required therein.

[1] Robinson on Patents, § 363[1]: "No concession, on the part of the real inventor, that someone else is the inventor or the first inventor, can either change the fact, or confer upon the latter the right to patent the invention as his own."—Hammond vs. Pratt (1879), Vol. 16, Official Gazette, p. 1235. "Parties have no right, by contract, falsely to concede priority of invention."

body, mind, and spirit of each of their employes. Referring to the first two examples, they are subject to the same conditions as are cited in the opening paragraph. Whether one attempts to share inventorship in acceptance of a proffered courtesy, or as a means to protect his financial interest, by subscribing to a patent as inventor, he not only fails of his purpose, but wrecks the whole patent value as well, annulling the rights of the real inventor as well as his own.

The third example is of two types, one of the employer who does not know his own status with reference to inventions made by his employes; the other, of the employer who does know, but takes long chances through lack of knowledge on the part of his employes. In either case, the employers should realize that their interests can be best protected by specific contracts or agreements whereby the employe binds himself to turn over to his employer whatever invention he may make during his employment, which pertains to the business. This is fair, because the stimulus to improve and invent is frequently derived from the atmosphere of invention existing in the particular shop where the employe works; but the fact that one is an employe does not bind him to turn his inventions over to his employer, unless some contract or agreement exists whereby he is compelled to do so.

Employment to make a specific invention or improvement constitutes such an agreement.[2] If one is especially employed to invent, develop, or perfect a device for a given business, obviously, whatever is derived from this work belongs to the proprietor of the business, so far as it pertains to that business. But the proprietor cannot subscribe to a patent application as inventor, unless he himself actually created the patentable improvement. If initiated by the designer, then he alone is the inventor.

On the other hand, mere constructive work is not invention. An invention may be made by one having no experience in construction or in the operation of machines or manipulation of implements. He may be unable to make a correct working drawing. He must, however, have in mind a definite construction which he can so impart to a skilled mechanic, that the latter can produce a working construction. It may be necessary to impart his idea orally, dictating the forms and arrangement of parts, or by sketch or some model, however crude and lacking in the attributes of workmanship or sound constructional embodiment. The information or instruction so imparted must, however, comprise and convey *means* for attaining the end desired. An employer recently claimed to be inventor of a device produced by one of his employes because, he contended, the invention had been made at his own instance. It developed that "his own instance" consisted only in seeing a certain insufficiency in some apparatus of which he was proprietor. He had tried to overcome the deficiency, and had ceased from trying. Months after, an employe who was not a constructive mechanic had, without hint or help, solved the problem simply and satisfactorily. In this case, the employe was the inventor and subscribed as such to the patent application.[3] It is well established that recognition of a need of improvement or advantage of a change is not invention.[4] To constitute invention, the mental process which recognizes the deficiency must develop into a mental act of discovery or determination of specific means to supply the remedy for the deficiency.

The relation of an inventor to his associates requires consideration. The development of any substantial invention and many smaller ones usually requires the concurrent application of many minds. The inventor's work is frequently that of a pioneer. His roads into new fields of endeavor are frequently only blazed trails. Draftsmen, pattern-makers and skilled constructors follow the paths he makes, developing his crude embodiments of accomplishment into permanent structure or fabric. An experienced inventor has remarked, "An inventor is rarely a skillful mechanic. Nervous anxiety to 'see the wheels go round,' precludes that patience and concentration demanded in fine work."

Because of this fact, there are frequently heard on the part of an inventor's associates, such invidious remarks as: "That was really my idea"; or even: "It's really my invention. He had only a crude idea. I constructed it so it was practical." Such individuals lose sight of the consideration of their employment; *i. e.*, knowledge and skill given in the highest degree in their power.

Those who have associated with others in the work of inventive development can readily recall instances where two or more have "thought of the same thing at the same time." The stimulus of the inventor's creative thought seems to permeate and fructify the mental processes of those about him. It being usually impossible for an inventor to personally carry out all the details of his invention, it is inevitable that his associates who further and develop his ideas shall produce creations having the attributes of invention, but it is fair to conjecture as to the extent of their progress, had he not imparted the first impulse by his primary inventive act. This view is recognized by the courts, and such inventions, termed ancillary inventions, are considered as having been engendered by the parent conception or stimulated by concordant effort on the part of associates or of others operating under the inventor's supervision. Being, therefore, considered a part of the parent invention, they are deemed to belong to the inventor himself so far as title to inventorship is concerned, and the right to subscribe its inventor to the patent applications.[5]

This is manifestly fair, for otherwise an inventor would be at the mercy of the cupidity and covetousness of unfair and mercenary associates. Without such consideration for the inventor's rights, he would be obliged to dispense with associates, and the delay entailed by his efforts to personally and alone work out an invention in all its details would defeat the spirit and purpose of the patent establishment, ***viz.:*** prompt public disclosure for advantage to industrial advancement. Care should be exercised, however, to distinguish between primary and ancillary invention. Unless the individual who devises an improvement is distinctly associated with the development of the machine or invention to which his improvement pertains, the chances are that he himself is the inventor of the improvement devised and should subscribe to the patent application.

For example, a maker of milling machines has in hand the reconstruction of his index head. While he is developing a new construction, one of his milling machine operators who has no knowledge of the development work in process but who recognizes the deficiency of the existing index head, invents a new index head embodying the very ideas on which his employer is working. Assuming that the milling machine operator first conceives and completes his index head, he

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[2] Joliet Mfg. Co. vs. Dice I 11,649 (1883); "When a workman is hired to invent, the employer will own the inventions which fall within the scope of the contract, while the others will belong to the employe."—Robinson, Vol. 2, p. 637: "If he (the employer) contracts for his employe's inventive skill, for its exercise in his behalf, he may thereby become the equitable owner of the inventions which result, and be entitled to an assignment of the patents when they are obtained."

[3] Pressed Steel Car Co. vs. Hansen, 137 F 403: "An employer has no right to the patent for an invention made by an employe, in the absence of an express contract or agreement of specific employment to make the invention."—Agawam vs. Jordan, 74 U. S. 583,602: "No one is entitled to a patent for that which he did not invent, unless he can show a legal title to the same from the inventor or by operation of law."

[4] Robinson on Patents, § 394-1: Collar Co. vs. Van Deusen: "Evans, the assignor of the plaintiffs, was a manufacturer, and claimed to be the inventor, of paper collars. He * * * employed various paper-makers to experiment toward the production of such a paper as he required. As they presented to him, from time to time, the fruits of their experiments, he pointed out to them the particulars in which their papers were still deficient but gave them no information as to the ingredients to be used or the methods to be employed in arriving at the necessary results. It was held that he was neither the inventor of the paper finally produced, nor of the process by which it was made; that he had merely pointed out an end to be obtained, not the means of its attainment, and was not entitled to appropriate the discoveries of the paper-makers as his own invention."

[5] Robinson on Patents, § 414 Ref. Annin vs. Wrenn. "An employe hired to assist an inventor in making improvements and to use his inventive skill for that purpose cannot claim, hold or transfer to a person having knowledge of such contract, any invention so made against his employer, but the inventions are the property of the employer, and if patented by the employe, a bill to compel their conveyance will lie."—New England Motor Co. vs. B. F. Sturtevant Co., 140 F 866 (N. Y. 1905): "When an employe discloses an invention to his employer who reduced it to practice, the employer is nevertheless entitled to be considered the inventor, especially where he diligently files an application therefor."—Knag vs. Green, Official Gazette, Vol. 127, p. 1581: "Where one conceives the principle or plan of an invention and employs another to perfect the details and realize his conception, though the latter may make valuable improvements therein, such improved result belongs to the employer."—Official Gazette, Vol. 128, p. 3291: "Inventors are often compelled to have their conceptions embodied in construction by skilled mechanics or manufacturers, whose practical knowledge often enables them to suggest and make valuable improvements in simplifying and perfecting machines or devices. Those are things they are employed and paid to do."

alone is the inventor, and not only can he alone subscribe to the patent application as inventor, but unless he is under an appropriate contract or agreement, he is not bound to turn the invention over to his employer.

On the other hand, suppose the proprietor turns the matter of improvement over to an employe, but imparts no data other than a statement of the insufficiencies to be overcome; and further that whatever improvements made are the products of the employe's creative thought. Then the employe is the inventor, and he only can properly subscribe to the patent application; but inasmuch as he is specifically employed to do this work, he is bound and can be compelled to assign the patent to his employer.[2]

But again, suppose that besides the mere statement of insufficiency the proprietor perceives the general form which the improvements must assume and imparts these by sketches, notes or otherwise to the employe, then the latter's creations, even though they attain the dignity or possess attributes of invention, are only ancillary, and the employer properly subscribes to the patent application as inventor.[5]

* * *

DEVELOPMENT OF A HIGH-SPEED MILLING CUTTER WITH INSERTED BLADES.*

While during the last few years the milling machine has been developed for high power and speed, the milling cutter has not advanced as rapidly. The user is thus confronted by the unsatisfactory condition of having the output of his milling machine limited by cutters of inadequate capacity. This refers in particular to inserted blade cutters. In order to eliminate the faults existing in present designs of such cutters, and permit an increase in their capacity, the authors of the paper abstracted have developed a new design which will be described below.

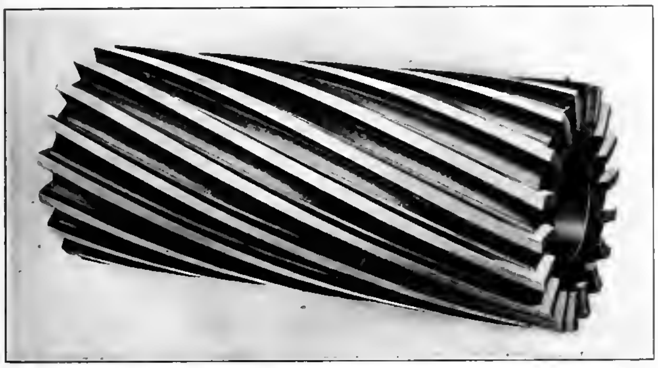


Fig. 1. Inserted Blade High-speed Milling Cutter with Helically-bent Blades.

Investigations showed that there was no existing standard governing the construction of inserted teeth milling cutters, nor any record of exhaustive tests made for determining the most effective pitch, clearance angles, or front slope and lip angles to be employed. The first point considered in constructing the new cutter was, therefore, the shape of the blade, and the conclusion was arrived at that in order to maintain a prescribed slope and lip angle throughout the entire length of the blade, it must be bent to form a helix. On blades so shaped it is possible to provide a continuous cutting edge with a constant lip angle. The most effective angle of the lead or helix of the blade was found to be about 20 degrees. For facilitating computation a formula (diameter × 9 = pitch) was adopted, which gives 19 degrees 15 minutes as the angle of helix

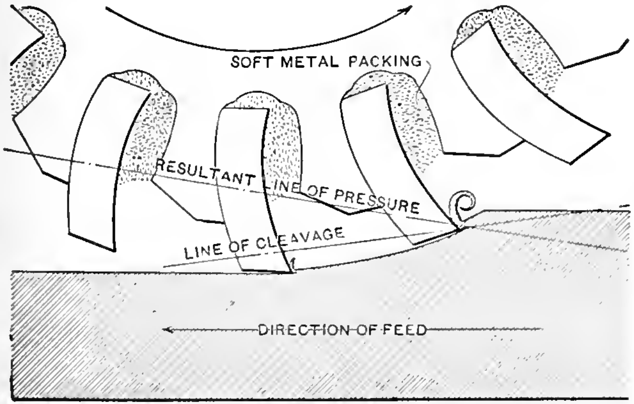
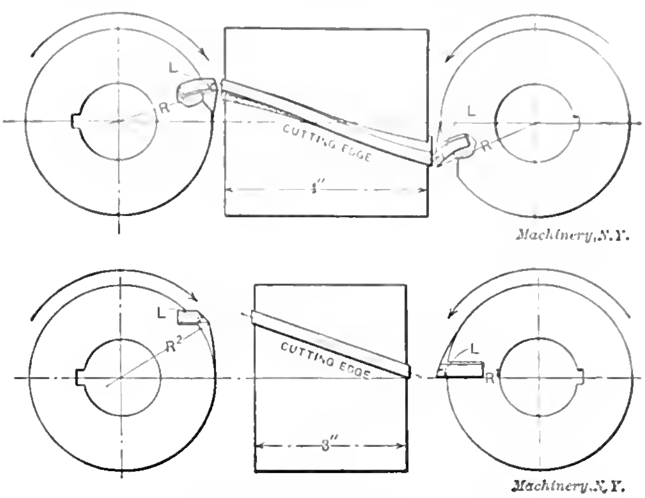


Fig. 2. Method of Inserting Blades in Cutter Body.

The next point to consider was the form of the grooves in the cutter body. Ordinarily these are planed approximately rectangular in section with a slight amount of undercutting to hold the blade in place. It was conceived, however, that this grooving of the cutter body could be done better and faster by milling than by planing, and that an undercut groove might be produced at one setting by a saw set in a certain relation to the cutter blank. In order to form the blades accurately to the shape of the groove, it was necessary to design a bending machine of great power, capable of squeezing the blades at once to proper form, not only as regards the helix, but also as regards the correct curvature in a direction normal to the helix, the grooves being curved in this direction also.



Figs. 3 and 4. Comparison between Lip Angles obtained with Helically-bent Blades and Straight Blades.

The final point considered was the method of securing the blades. It was found that ordinary mechanical fastenings were not desirable both because of excessive cost and on account of inability to withstand vibration and remain rigid. Experiments were therefore made with various alloys until a proper combination was obtained, capable of flowing freely, of cooling without shrinkage, of withstanding great strains without crumbling, and of permitting quick removal of the blade.

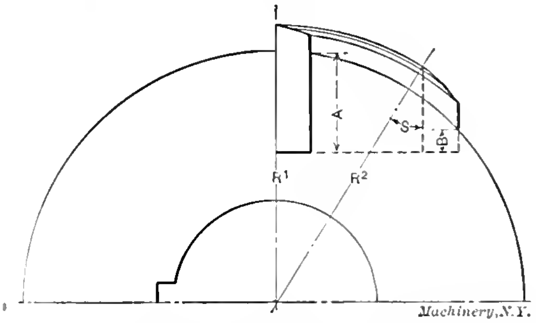


Fig. 5. Cutter with Straight Inserted Blade, seen from the End. Note changing Cutting Angle.

A device was designed for compressing the alloy in the slot after it had been poured, and a device was also made for removing the alloy when replacing the blades. With the alloy compressed in the slots, the blades are so firmly secured that they may be broken off by force without affecting the binding qualities of the alloy.

The cutter developed along the lines outlined above is shown in Fig. 1. The claims made for this cutter are that it can be made of moderate diameter, although having inserted blades; that a greater number of blades may be provided than in regular cutters of this type; and that the cutter's capacity for removing metal is equal to the requirement of high power milling machines.

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* Abstract of paper by Wilfred Lewis and Wm. H. Taylor, read before the American Society of Mechanical Engineers, December meeting, 1908.

RESULTS OF EXPERIMENTS WITH HIGH SPEED MILLING CUTTERS WITH INSERTED HELICALLY-BENT BLADES.

[illegible]	[illegible]	Depth of Cut, Inches	Width of Cut, Inches	Material Removed.			Duration of Test.		Speed of Cutter.		Electrical Readings.			Horse Power per cubic inch of Metal Removed.
				Cubic Inches per minute	Pounds per minute	Pounds per Hour.	Min.	Sec.	Revolutions per Minute	Feet per Minute.	Ampere	Volts.	H.P.	
11	0.01785	3/16	18	31.61	8.96	537.81	1	17	35	73¼	190	220	56.03	1.77
11	0.01785	5/16	18	63.28	17.92	1075.62	0	11	35	73¼	......	......	......	......
6	0.01041	[illegible]	18	43.03	12.19	731.41	1	30	34	71	300	195	78.41	1.82
[illegible]	0.01080	[illegible]	18	47.25	13.38	801.15	1	26	36	75½	400 +	180	96.51	2.04
7	0.00925	[illegible]	18	47.25	13.38	801.15	2	51	42	88	370	187	92.74	1.96

The line engravings will give a clear idea of the actual construction of the cutter. Fig. 2 illustrates the form of the slot and blade, and shows also the space occupied by the bonding alloy or "metal packing." Figs. 3 and 4 show the difference between the lip angles obtained with cutters made according to the principles laid down, with a helically-bent blade, and with cutters made with straight blades as is the common but objectionable practice. In Fig. 3 the angle is constant, no matter how long the blade, while in Fig. 4 the lip angle changes constantly from maximum at R_1 to minimum at R_2. In Fig. 5 the actual conditions of a cutter having straight inserted blades and seen from the end are still further exhibited. That the cutting action of such a cutter differs for every point on the blade is plainly in evidence.

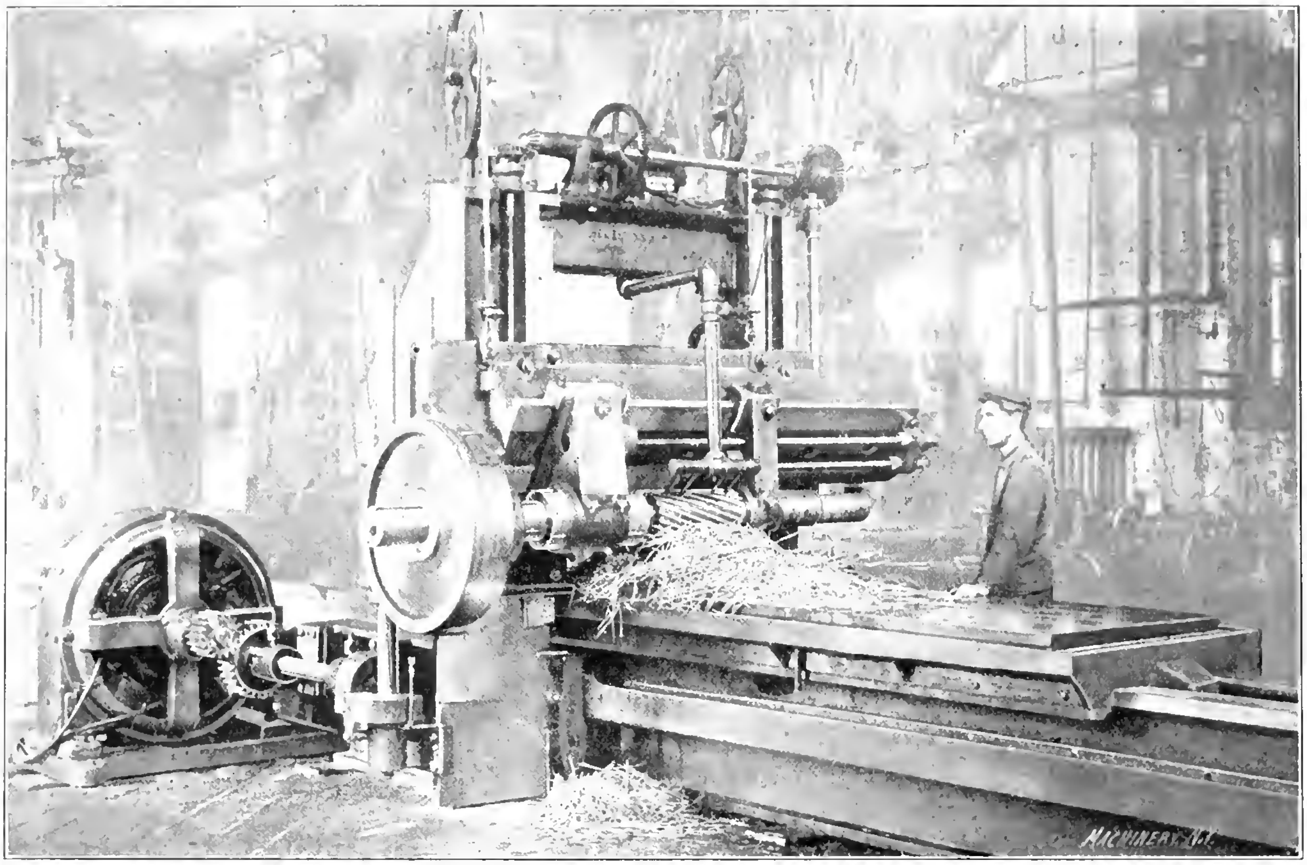


Fig. 6. High-speed Milling Cutter in use on High-power Milling Machine of the Planer Type.

Fig. 7 shows some of the chips cut by the cutter described, and in Fig. 6 the capacity of the cutter is well illustrated by the amount of chips removed by a single cut across the surface of the work.

In the paper under review, attention is called to the fact that experiments have conclusively demonstrated that nicking the blades of milling cutters does not constitute an altogether desirable feature. The part of the blade behind the nick which covers the gap formed by the nick in the blade preceding must take care of double the feed of the remainder of the tooth; this causes chatter and produces an uneven machined surface.

Much stress is laid on the use of lubrication during milling. A copious stream of lubricant falling at slow velocity should be thrown directly upon the chip at the point of removal. Heat generated by the pressure of the chip is the chief cause of wear; it softens the lip surface, causing it to crumble off. It was conclusively shown by experiments made that 33 per cent in cutting speed can be gained in milling steel and wrought iron, and 15 per cent in milling cast iron, by throwing a heavy stream of lubricant upon the cutter the entire length of its cutting edge.

A table is appended showing some of the actual results obtained in the experiments undertaken. The machine used in the experiments recorded was a 42-inch Bement-Miles milling machine, driven by a Westinghouse constant-speed 40 H.P. motor. The material cut was 30 per cent carbon steel. The cutter was 8 inches in diameter, 18 inches face, and of the type described.

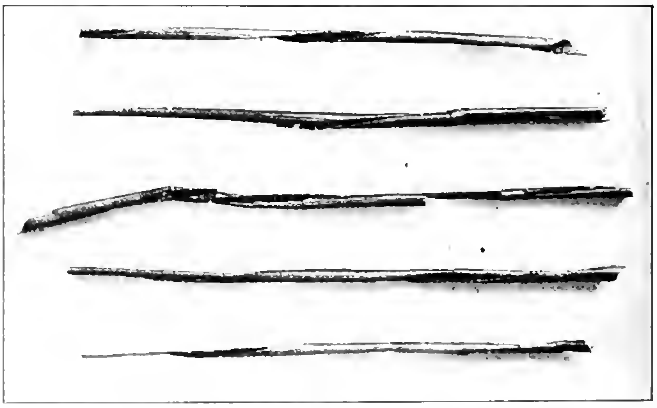


Fig. 7. Chips produced by the Cutter described.

KEYWAY GAGING IN SHAFTS AND HUBS.

Z. Y.

But little attention seems to have been given in the technical press to the gaging of keyways. The necessity for this work being inspected and gaged led to the devising of the appliances illustrated and described in this article.

A standard size of key had been previously adopted for each shaft, of which particulars are given in Table II, the key being square at the large end, and for shafts from 3/4 inch to 2 inches, inclusive, advancing by even eighths, the key was one-fourth the diameter of the shaft. Reference to the table will give the other dimensions, but it may be noticed that the depth of the key in the shaft was to be half the width of the key, this depth to be taken at the edge of the groove.

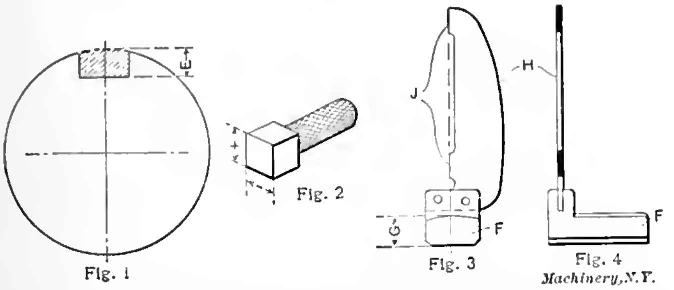


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Fig. 1. Undesirable Method of Gaging Keyway Depth. Fig. 2. Limit Gage for Width of Keyway. Figs. 3 and 4. Gage used in Conjunction with Center-head, Fig. 5, for Determining Depth of Keyway and Parallelism of Sides with Radial Line through its Center.

After these points had been decided, the question arose as to the best way to indicate these dimensions on the drawings and how to measure the finished work.

With regard to the shafts, it would be an easy matter, with a micrometer depth-gage or other means, to measure the depth of the groove from the full diameter of the shaft, as at *E* in Fig. 1; but there was an objection to this, *viz.*, the difference there might be between the diameter of the shaft and the bore of the hub, although both were nominally the same diameter; for if the diameter of the shaft varied say by 0.002 inch or 0.003 inch, then this variation would also become apparent in the space available for the key, when assembled. The same argument applies to hubs, and on this account the method of dimensioning as shown in Table II was adopted, which was to measure what remains of the shaft after cutting the keyway, and to measure the keyway across the bore in the case of hubs, this latter measurement being taken at the deep end of the groove. If the keyways are correctly cut in accordance with these rules, then the dimension *B* subtracted from the dimension *A* should equal the thickness of the key at a certain predetermined distance from the head. The advantage of this system of measuring the depth of a keyway is apparent, for, as has been explained, the keyway space will not vary even though there be slight variations in the diameter of the shaft or bore of the hub, providing, of course, the work of cutting the keyways is done accurately; consequently, the time spent in fitting keys can be reduced to a minimum as they can be machined practically to a finished size.

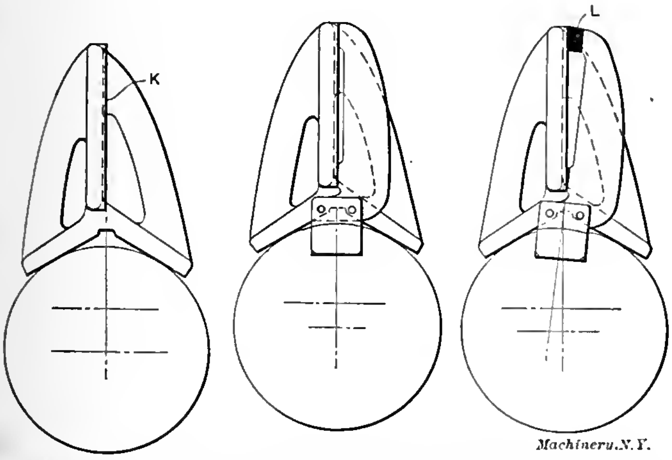


Fig. 5. Center-head used with Gage shown in Figs. 3 and 4. **Fig. 6. Keyway with Sides Parallel with Radial Line through its Center.** **Fig. 7. Keyway with Sides not Parallel with Radial Line through its Center.**

The permanence and stability of wheels upon their shafts depends very largely upon the fitting of the keys in their keyways, and this fitting, in turn, depends upon the keyway itself. If, for example, the keyway in the shaft is not parallel with the shaft's axis, or if the sides of the keyway are not parallel with a radial line passing through its center, the key, though it may seem tight enough when it is first driven in, will have such a poor bearing that the wheel or pulley will soon work loose. Therefore it was deemed advisable to gage the keyways in both shaft and hub as outlined in Table I.

TABLE I.

For Shafts.	For Hubs
(1) Width of groove.	(5) Width of groove.
(2) Depth of groove.	(6) Depth of groove.
(3) If sides are parallel with a radial line through center.	(7) If sides are parallel with a radial line through center.
(4) If groove is parallel with axis of shaft.	(8) If parallel with axis of hub.
	(9) Angle of taper at the bottom of the groove.

Quite a number of gages of different kinds were considered which would properly gage one or more of the points required, but those considered best for the various purposes are those shown in the following: Commencing with the gaging of the shafts, and taken in the same order as tabulated in Table I, the following were the methods adopted:

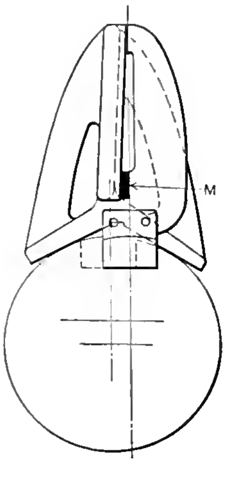


Fig. 8. Keyway not Parallel with Axis of Shaft.

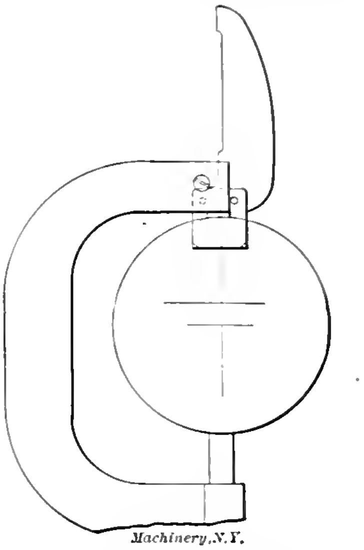


Fig. 9. Testing Depth of Keyway.

Gaging the Shaft.

1. Width of groove. This did not call for any special gages other than those in use, an ordinary rectangular limit gage as Fig. 2 being quite suitable.

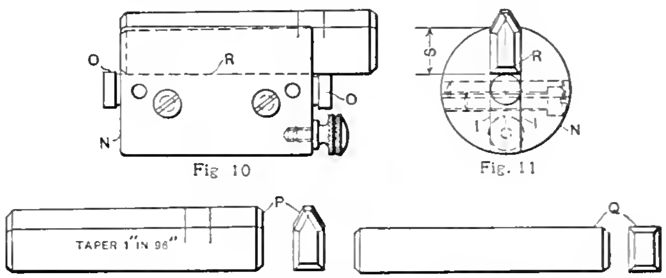
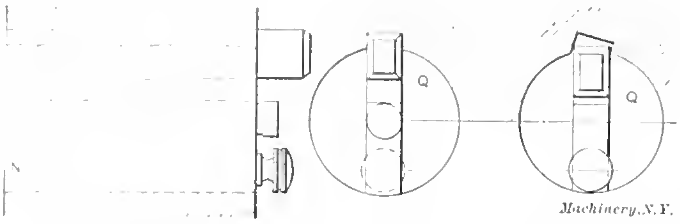


Fig. 10 Fig. 11 Fig. 12 Fig. 13

Figs. 10, 11, 12 and 13. Gages for Testing Depth, Parallelism of Sides with Radial Line through Center, Parallelism with Axis, and Taper of Keyway in Hub.

2, 3, and 4. The device used for (2) was also used for (3) and (4), and can best be described by reference to the illustrations. Fig. 3 shows an end view and Fig. 4 a side view of one of the gages, one such gage being required for each different width of groove. They are used in conjunction with the center-head, Fig. 5. The block *F* is a steel key, hardened and ground, the width being the same as the small width of

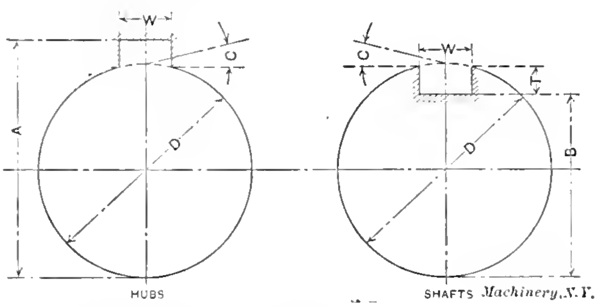
the limit gage Fig. 2. The length is twice the width, and the dimension *G* equals the nominal diameter of the shaft minus the figures in column *B*, Table II. Attached to one end of the key is the blade *H*, which is also hardened. After being attached to the base, the edge *J* was ground so that it was exactly central between, and parallel to, the sides of the key. The center head, Fig. 5, is of cast iron, the V base being finished to an angle of 120 degrees. The face *K* is carefully finished so that it lies in a plane bisecting the angular base, and therefore, when the base is placed on a shaft, the face *K* will always be in a plane passing through the center of the shaft.



Figs. 14 and 15. Gage for Testing Keyway in Hub, and Exaggerated Illustration of Keyway which is not Parallel with a Radial Line passing through its Center

Now, if when gaging a keyway it has been found correct for width, the gage Fig. 3 can be placed in the groove, and by placing the center-head on the shaft, and bringing it up against the blade, it can be seen at once if the groove is correct, for, if it is, the edges *J* and *K* will coincide as in Fig. 6. If the gages are used at both ends of the groove, the gaging can be done for both (3) and (4); for, should the groove be correct at one end, but not parallel with the axis of the shaft, the gaging will indicate, as shown exaggerated in Fig. 8. If the sides of the groove are not cut parallel with a radial line, but the groove is parallel with the axis of the shaft, the gaging will show as in Figs. 7 or 8 at both ends of the groove. By using feelers at *L* or *M*, any inaccuracy can be measured, and if this is found to be within the limits allowed, it then remains to gage for (2). This is done by using the gage Fig. 3, and measuring the diameter of the shaft by micrometer in combination with the gage, as in Fig. 9. If the depth of the groove is correct, the resulting dimension should equal the nominal diameter of the shaft.

TABLE II.



D = nominal diameter of shafts.

W = width of key $= \dfrac{D}{4}$ or nearest $\frac{1}{32}''$ less, up to and including $2\frac{1}{2}''$ or nearest $\frac{1}{16}''$ above $2\frac{1}{2}''$.

T = depth of groove measured at edge $= \dfrac{W}{2}$.

$C = D \times 0.0159$ when $W = \dfrac{D}{4}$.

Key groove in hub tapers 1 inch in 96 = $\frac{1}{8}''$ per foot.

A' = depth of groove measured across bore at wide end.

Key groove in shaft is uniform in depth.

D	A	B	W	T	D	A	B	W	T
$\frac{3}{8}$	0.409	0.322	$\frac{3}{32}$	$\frac{3}{64}$	$1\frac{5}{8}$	1.792	1.396	$\frac{13}{32}$	$\frac{13}{64}$
$\frac{7}{16}$	0.471	0.384	$\frac{3}{32}$	$\frac{3}{64}$	$1\frac{11}{16}$	1.854	1.458	$\frac{13}{32}$	$\frac{13}{64}$
$\frac{1}{2}$	0.548	0.430	$\frac{1}{8}$	$\frac{1}{16}$	$1\frac{3}{4}$	1.931	1.503	$\frac{7}{16}$	$\frac{7}{32}$
$\frac{9}{16}$	0.610	0.492	$\frac{1}{8}$	$\frac{1}{16}$	$1\frac{13}{16}$	1.993	1.566	$\frac{7}{16}$	$\frac{7}{32}$
$\frac{5}{8}$	0.686	0.538	$\frac{5}{32}$	$\frac{5}{64}$	$1\frac{7}{8}$	2.070	1.611	$\frac{15}{32}$	$\frac{15}{64}$
$\frac{11}{16}$	0.748	0.600	$\frac{5}{32}$	$\frac{5}{64}$	$1\frac{15}{16}$	2.131	1.673	$\frac{15}{32}$	$\frac{15}{64}$
$\frac{3}{4}$	0.825	0.644	$\frac{3}{16}$	$\frac{3}{32}$	2	2.208	1.718	$\frac{1}{2}$	$\frac{1}{4}$
$\frac{13}{16}$	0.887	0.707	$\frac{3}{16}$	$\frac{3}{32}$	$2\frac{1}{8}$	2.333	1.843	$\frac{1}{2}$	$\frac{1}{4}$
$\frac{7}{8}$	0.963	0.752	$\frac{7}{32}$	$\frac{7}{64}$	$2\frac{1}{4}$	2.485	1.933	$\frac{9}{16}$	$\frac{9}{32}$
$\frac{15}{16}$	1.025	0.814	$\frac{7}{32}$	$\frac{7}{64}$	$2\frac{3}{8}$	2.610	2.058	$\frac{9}{16}$	$\frac{9}{32}$
1	1.102	0.859	$\frac{1}{4}$	$\frac{1}{8}$	$2\frac{1}{2}$	2.763	2.148	$\frac{5}{8}$	$\frac{5}{16}$
$1\frac{1}{16}$	1.164	0.921	$\frac{1}{4}$	$\frac{1}{8}$	$2\frac{5}{8}$	2.888	2.273	$\frac{5}{8}$	$\frac{5}{16}$
$1\frac{1}{8}$	1.240	0.966	$\frac{9}{32}$	$\frac{9}{64}$	$2\frac{3}{4}$	3.040	2.363	$\frac{11}{16}$	$\frac{11}{32}$
$1\frac{3}{16}$	1.303	1.028	$\frac{9}{32}$	$\frac{9}{64}$	$2\frac{7}{8}$	3.165	2.488	$\frac{11}{16}$	$\frac{11}{32}$
$1\frac{1}{4}$	1.379	1.074	$\frac{5}{16}$	$\frac{5}{32}$	3	3.317	2.577	$\frac{3}{4}$	$\frac{3}{8}$
$1\frac{5}{16}$	1.442	1.136	$\frac{5}{16}$	$\frac{5}{32}$	$3\frac{1}{8}$	3.442	2.702	$\frac{3}{4}$	$\frac{3}{8}$
$1\frac{3}{8}$	1.518	1.1813	$\frac{11}{32}$	$\frac{11}{64}$	$3\frac{1}{4}$	3.596	2.794	$\frac{13}{16}$	$\frac{13}{32}$
$1\frac{7}{16}$	1.580	1.244	$\frac{11}{32}$	$\frac{11}{64}$	$3\frac{3}{8}$	3.721	2.920	$\frac{13}{16}$	$\frac{13}{32}$
$1\frac{1}{2}$	1.656	1.288	$\frac{3}{8}$	$\frac{3}{16}$	$3\frac{1}{2}$	3.872	3.007	$\frac{7}{8}$	$\frac{7}{16}$
$1\frac{9}{16}$	1.719	1.351	$\frac{3}{8}$	$\frac{3}{16}$	...	......	......	..	..

Gaging Grooves in Hubs.

5. Width of Groove. As in the case of shafts, the limit gage, Fig. 2, is used.

6, 7, 8 and 9. For these steps the gages Figs. 10, 11, 12, and 13 are used. These consist of plugs *N* and two keys *P* and *Q*. These plugs were made up of three main parts each and hardened and ground on the faces before finally assembling, the face *R* being ground parallel to the center of the plug, and the width between the jaws being the same as the small width of the limit gage Fig. 2. The bosses *O*, at the end of the center part, are ground to this size, and then the faces *I* and *R* ground to these bosses. After assembling, the outside diameter is ground to the small end of the cylindrical limit gages in general use. One such plug is required for each different bore. The keys *P* and *Q* are also of steel, hardened and ground, and are a good sliding fit between the jaws of their respective plugs. The sides of the key *Q* are parallel to each other, and are slightly less than *S* in Fig. 11. The key *P* had its edges ground so that the angle between them was the same angle as the keyway taper, *viz.*, 1 in 96, or ⅛ inch per foot.

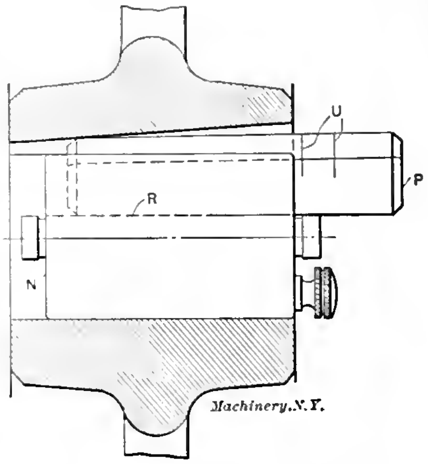


Fig. 16 Testing Angle of the Taper.

For gaging a keyway in a hub, if it has been found correct for width, the plug *N* can be placed in the bore, and if the groove is correct for (7) and (8) the key *Q* will freely pass out of the plug jaw into the groove in the hub, as in Fig. 14; but if incorrectly cut, then the key cannot enter to the full depth in the groove in the hub, this being shown exaggerated in Fig. 15. Of course it is possible for the groove to be apparently correct for (7) at one end of the bore, but if not correct for (8), it will be impossible to enter key *Q*. If the groove is correct for (7) and (8), then for the angle of taper (9) and depth of groove (6) the key *P* is used in a similar manner to key *Q*. By making this key separate from the plug, it is easy to feel if the groove is the correct taper on the bottom, for if the angle to which the groove has been cut is too great, the key will touch at its small end as in Fig. 16, or *vice versa*, a slight difference being easily felt. By making marks on the key *P*, as at *U*, any desired limits for (6) can be set.

* * *

An interesting method of insulating wire is mentioned in the *Brass World*. Some metallic oxides such, for instance, as the oxide of chromium, are insulators. Use is made of this fact in making and using resistance wire, containing nickel, iron manganese and chromium. The wire is heated, and an oxide forms on the surface, consisting of a mixture of all the metals. If treated with sulphuric acid, all the oxides, except the chromium oxide, are dissolved, and in this way a film of chromium oxide is obtained on the wire, which acts as an insulator.

* * *

Good enough is the deadly enemy of best.—*Speed.*

JIGS AND FIXTURES—9.

EINAR MORIN.[*]

EXAMPLES OF CLOSED OR BOX JIGS.

In the previous installment of this series, the development of a closed or box jig was treated. In the present installment a number of examples of closed jig designs will be shown and described. As was pointed out in the first installment in the April issue, when reference was made to different classes of jigs, there is no distinct division line between open and closed drill jigs, so that in many cases it is rather inconsistent to attempt to make any such distinction.

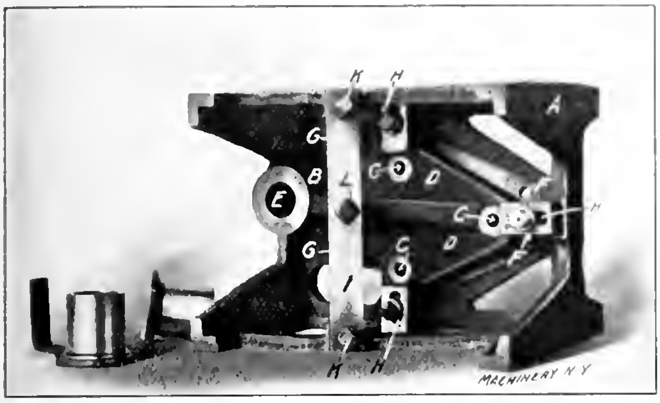


Fig. 97. Box Jig which Resembles the Open Type.

In Fig. 97, for instance, is shown a box jig which looks like a typical open jig. The jig body *A* is made in one solid piece, cored out as shown, in order to make it lighter. The piece to be drilled, *B*, shown inserted in the jig, has all its holes drilled in this jig, the holes being the screw holes *C*, the dowel pin holes *D*, and the large bearing hole *E*. The bosses of the three screw holes *C* are also faced on the top, and the bearing is faced on both sides while the work is held in the jig. The work is located against two dowel pins driven into the holes *F*, and against two lugs at *G*, not visible in the engraving, located on either side of the work. In these lugs are placed set-screws or adjustable sliding points such as described in the June issue. It may seem incorrect not to locate the bracket in regard to the hole *E* for the bearing, so as to be sure to bring the hole concentric with the outside of the boss. This ordinarily is a good rule to follow, but in this particular case it is essential that the screw holes be placed in a certain relation to the outline of the bracket in order to permit this to match up with the pad on the machine on which the bracket is used. Brackets of this shape may be cast very uniformly, so that locating them in the manner described will not seriously interfere with drilling the hole *E* approximately in the center of its boss. The work is firmly held in the jig by the three straps *H*, care being taken in designing the jig that these straps are placed so they will not interfere with the facing tool.

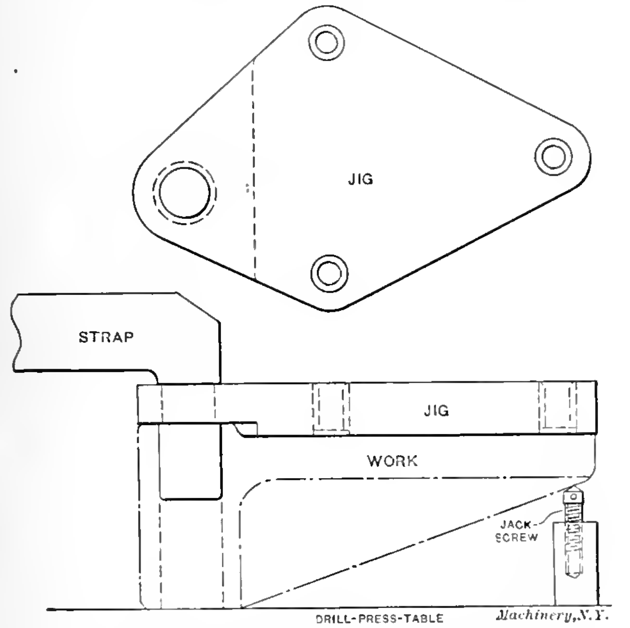


Fig. 98. Simple Form of Plate Jig for Drilling Bracket shown in Fig. 97, after Hole E has been bored in the Lathe.

The swinging strap *I*, which really is the only thing that makes this jig a closed jig, serves the sole purpose of taking the thrust of the heavy cutting tools when drilling the hole *E* and of steadying the work when facing off the two ends of the hub. The two collar-head screws *K* hold the strap to the jig body and the set-screw *L* bears against the work. This strap is easily swung out of the way simply by loosening one of the collar-head screws, a slot being milled at one end of the strap to permit this. Stationary bushings were used for the screw hole and dowel holes, but for the bearing hole *E* three loose bushings and a lining bushing are employed. The hole *E* is first opened up by a small twist drill, which makes the work considerably easier for the so-called rose-bit drill. The latter drill leaves 1/16 inch of stock for the rose reamer to remove, which produces a very smooth, straight and concentric hole. The last operation is the facing of the holes. The holes just drilled are now used to guide the pilots of the facing tools, and as the operation is performed while the work is held in the jig, it is important that the locating or strapping arrangements are not in the way.

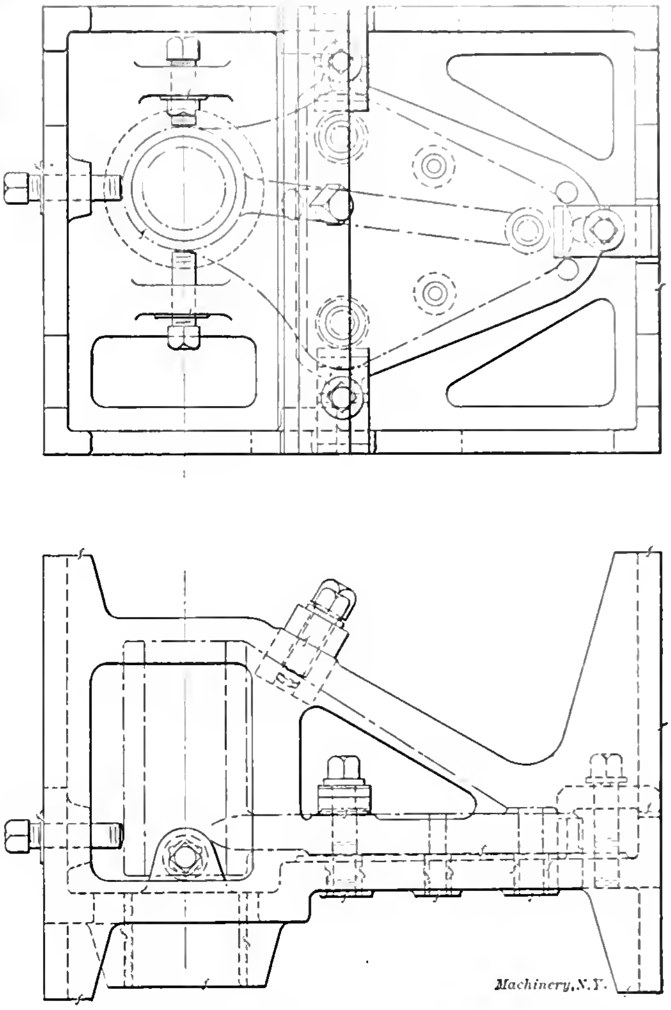


Fig. 99. Plan and Elevation of the Jig shown in Fig 97.

In connection with the opening up of a hole with a smaller drill, it may be mentioned that it is not only for large holes that this method of procedure will save time, but even for smaller holes, down to ¼ inch in diameter, drilled in steel, time will be saved by opening up the hole with a still smaller drill.

The use of lubrication in jigs is a very important item, the most common lubricant being oil or vaseline, but also soap solution is used. The objection to the latter is that unless the machine and tools are carefully cleaned, it is likely to cause rusting. Using a lubricant freely will save the guiding arrangements, such as the drill bushings, the pilots on coun-

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terbores, etc., to a great extent. The line drawing of the jig in Fig. 97 is shown in Fig. 99 and a clear idea of the design of the jig will be had by studying this line engraving. The bracket *B*, in Fig. 97, could have been drilled in a different way than described, which will sometimes be an advantage. It could be held in a chuck, and the hole *E* reamed and faced in a lathe, which would insure that the hole would be perfectly central with the outside of the boss. Then a jig could be designed, locating the work by a stud entering in hole *E*, as indicated in Fig. 98, additional dowel pins and set-screws being used for locating the piece sidewise. The whole arrangement could be held down to the table by a strap and bolt, a jack screw supporting it at the overhanging end.

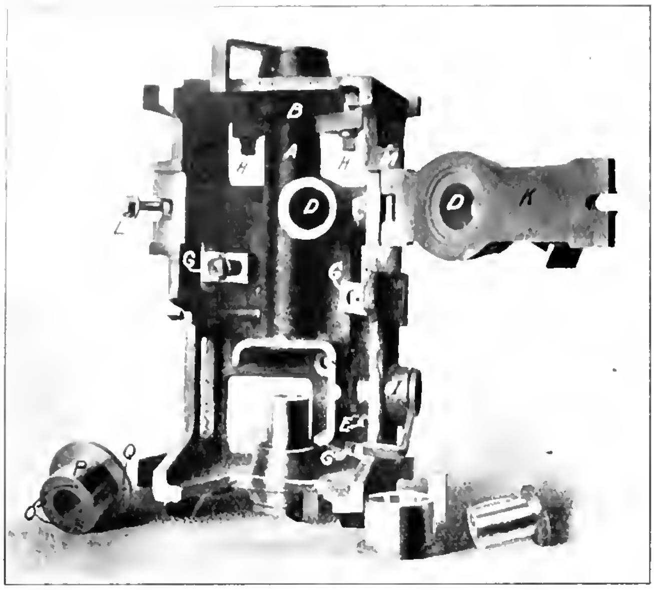


Fig. 100. Box Jig for Casing drilled from Five Directions.

Fig. 100 shows another jig of the closed type, with the work inserted. The piece *A* is a casing, and the holes to be drilled vary greatly in size. The casing rests on the flat, finished bottom surface of the jig and is brought up squarely against a finished pad at *B*. It further locates against the finished lug *C* in order to insure getting the proper amount of metal around the hole *D*. At the bottom it is located against the sliding point *E*, the latter being adjustable because the location of the work is determined by the other locating points and surfaces. The work is held against the locating points by the long set-screw shown to the left. This clamping arrangement, however, is not to be recommended because this screw must be screwed back a considerable distance in order to permit insertion and removal of the work. An eye-bolt used in the manner described in the installment in the August issue would have given better service. The three straps *G* hold the work against the bottom surface, and the two straps *H* hold it against the finished surface at *B*. There is not a long finished hole through the casing, as would be assumed from its appearance, but simply a short bearing at each end, the remaining part of the hole being cored out. For this reason the hole is drilled and reamed instead of being bored out, as the latter operation would be a slower one. While the two short bearings are so far apart, the guiding bushings come so close to these bearings that the alignment can be made very good. The screw holes and dowel pin holes at the bottom of the casing are not shown in the half-tone, as the inserted casing is not yet drilled. The hole drilled from bushing *I* is a rather important hole, and the bushing required a long bearing in order to guide the drills straight when drilling. When this jig was made, the projecting lug which was provided solid with the jig body, to give a bearing to the jig bushing, came so much out of the way in the rough casting for the jig that half of the lining bushing would have been exposed. It was therefore planed off and a bushing of the type shown in Fig. 9 in the May installment inserted instead, in order to provide for a long bearing.

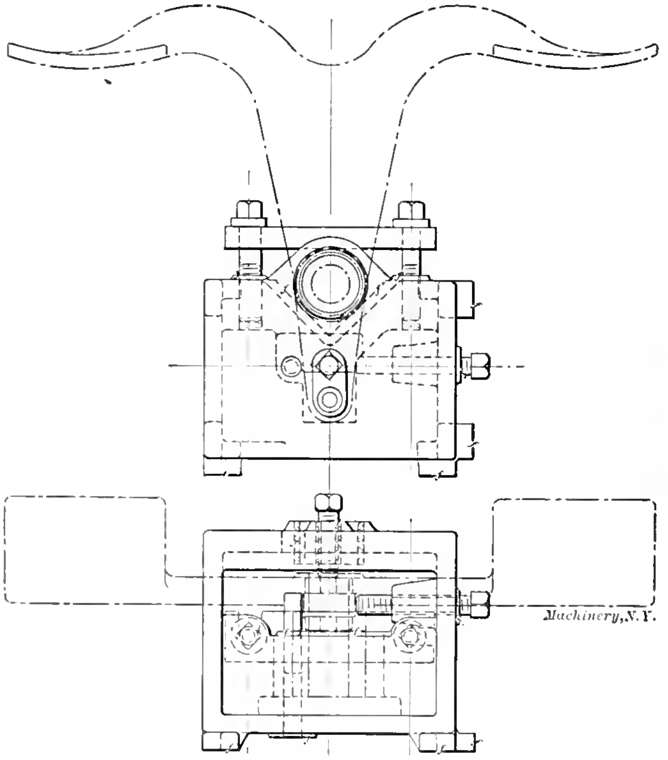


Fig. 101 Box Jig for Drilling Work shown in Dash-dotted Lines.

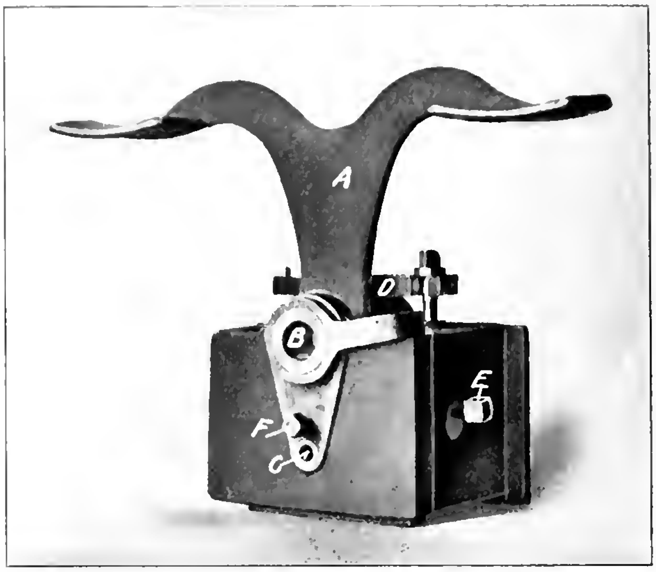


Fig. 102. Jig shown in Detail in Fig. 101.

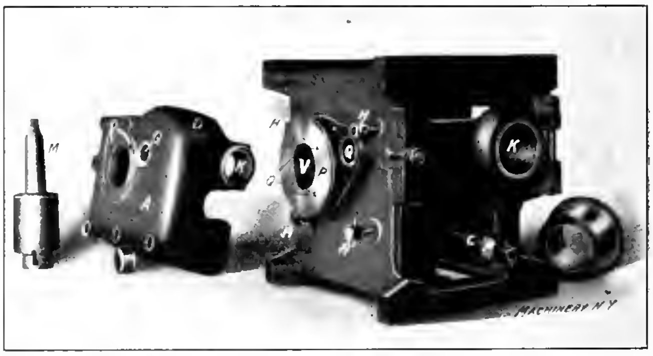


Fig. 103. Jig of Typical Design, and Work for which it is used.

Leaf *K*, which carries the bushings for drilling the hole *D*, fits into a slot planed out in the jig body and is held down by the eye-bolt *L*. Two lugs *M* are provided on the main casting for holding the pin on which the leaf swivels, the construction being of the same type as illustrated in Fig. 50, July installment. Around the hole *D* there are three small tap holes *O* which are drilled by the guiding afforded by the bushing *P*, which is made of cast-iron and provided with small steel bushings placed inside as illustrated in Fig. 16, May installment. In the bushing *P* is another hole *Q* which

fits over a pin located in the top of the leaf and which insures that the three screw holes will come in the right position. It should be noted that large portions of the jig body are cored out at top and bottom in order to make it light and easy to handle. Of course some metal is also saved by the construction of jigs in this manner, but comparing the price of cast iron with the total price of a finished jig of this type, the saving in this respect is so insignificant that it is not worth while mentioning. The leaf K is also made of cast iron, being of particularly large size, and it is planed at the places where it has a bearing on the jig body.

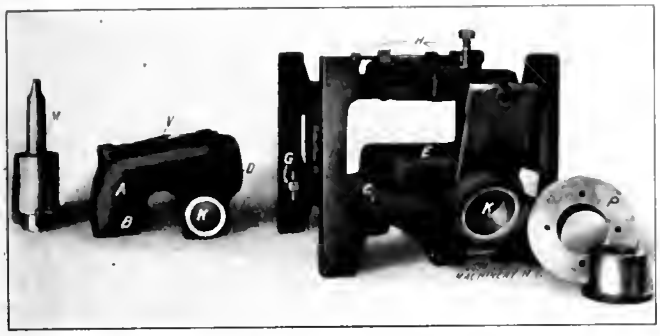
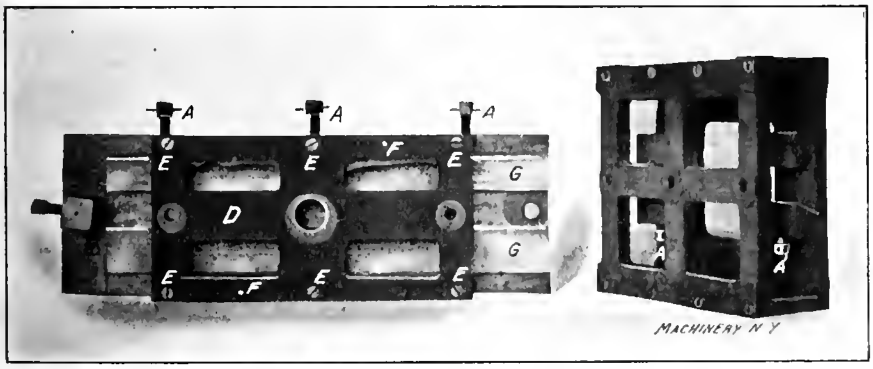


Fig. 104. Another View of the Jig in Fig. 103.

Fig. 102 shows a closed jig about which there can be no doubt that it should be classified as a box jig. The piece of work drilled, the foot trip A, has two holes B and C which are drilled in this jig. The cylindrical hub of the work is located against V-blocks and held in place by a swinging strap D. The work is further located against a stop pin placed opposite the set-screw E. The trip is located sidewise by being brought against another stop by the set-screw F. One-quarter of a turn of the collar-head screw on the top of the jig releases the swinging strap which is then turned out of the way; this permits the trip to be removed and another to be inserted. Half a turn or less of the set-screws is enough to release and clamp the work against the stops mentioned. A line engraving of this jig is shown in Fig. 101 which gives a better idea of some of the details of the construction.

In Figs. 103 and 104 are shown two views of another type of closed drill jig. The work A, to be drilled, is shown at the left in both illustrations, and consists of a special lathe apron with large bearing holes, screw holes, and dowel pin holes to be drilled. The apron is located in the jig column in the same manner as it is located on the lathe carriage, in this case by a tongue which may be seen at B in Fig. 104. This tongue fits into the slot C in the jig, care being taken in the construction of the jig that the slot is deep enough so as to prevent the tongue from bearing in the bottom of the slot. A good solid bearing should be provided, however, for the finished surface on both sides of the tongue. The surface D should also have a solid bearing on the surface E in the jig, the difference in height between the two bearing surfaces in the jig being exactly the same as between the two bearing surfaces on the lathe carriage where a lathe apron is to be fitted. The work is brought up against, and further located by a dowel pin at the further end of the slot by the set-screw in the block F, Fig. 103. As it is rather difficult to get the tongues on all the pieces exactly the correct width for a good fit in the slot, this latter is sometimes planed a little wider and the tongue is brought up against one side of the slot by set-screws. In the case in hand, a few thousandths inch clearance is provided in the slot and the set-screw G in Fig. 104 is used for bringing the work against the further edge which stands in correct relation to the holes to be drilled. The apron is held down against the bottom surface of the jig by four heavy set-screws H.



Figs. 105 and 106. Jigs in which the Work is Located by means of Beveled Surfaces.

It will be noticed that the jig is open right through the sides in order to facilitate the finishing of the pads at the ends of the work, and a swinging leaf like the one previously described, reaches across one side for holding the lining and loose bushings for the hole K which is drilled and rose-reamed in the usual way. The large hole V, Fig. 103, is bored out with a special boring tool M, as there are no standard drills obtainable for this large size of hole. This special boring tool is guided by a cast iron bushing which fits into the lining bushing; it is provided with two cutters, one for roughing and one for finishing. The small screw holes O around the large hole V are drilled from the bushing P. For drilling the rest of the holes, except the hole Q, stationary bushings are used. The screw holes ought to be drilled simultaneously in a multiple spindle drill. The jig is provided with feet and cored out in convenient places in order to make it as light as possible to handle. Lugs project wherever necessary to give ample bearings to the lining bushings and, in turn, to the loose guiding bushings.

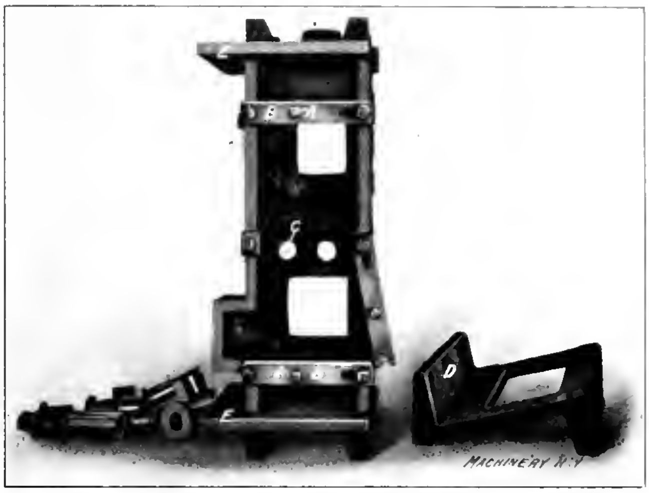


Fig. 107. Jig for Drilling Holes at other than 90-degree Angles.

Figs. 105 and 106 show two closed jigs made up of two main parts which are planed and assembled by screws and dowels as indicated, the reason for making the jigs in this way being the ease of planing the bottom section. The work drilled in these jigs, some special slides, is located by the dove-tail and held up against one dove-tail side by set-screws A, as shown in both illustrations. In Fig. 105 the work is located endwise against a dowel pin and is held up against this stop by a set-screw through the block shown to the left. This block must be taken out when the slide is inserted, this being the reason why a lug cast directly in place, through which the set-screw could pass, is not used. The top plate D is held down on the main body by six fillister-head screws E, and two dowel pins F to prevent it from shifting. No clamping arrangements, except the set-screws A, are necessary. The holes being drilled from the top, the main body of the jig takes the thrust. These jigs are also used in multiple spindle drills.

One objectionable feature of the jig in Fig. 106 is that set-screws A are difficult of access. There are, therefore, holes piercing the heads of the set-screws in two directions in order to allow a pin to be used when tightening the screws. A better idea, however, would be to have the screw heads extend out through the wall, and if this were solid, to have cored or

drilled holes to permit the heads of the screws to pass through.

In Fig. 107 is another closed drill jig in which the work is located against the finished seats and held down by the set-screws *A* in the straps *B*. All the holes, except the holes marked *C*, are drilled in the usual manner, the jig standing on its own feet, but when drilling the holes *C*, which come on an angle, the special stand *D* is employed which brings the holes in the right position for drilling, as illustrated in Fig. 108. If only the holes *C* were to be drilled, the feet on the side opposite the guiding bushing for these holes could have been planed off, so that they would have been in a plane perpendicular to the axis of the holes. The principles determining the design of jigs of this type were outlined in the November issue. This last jig has a peculiar apperance on account of the end walls coming up square, as shown in the illustrations, but this design was adopted only to simplify matters for the patternmaker, it being easier to make up the pattern this way.

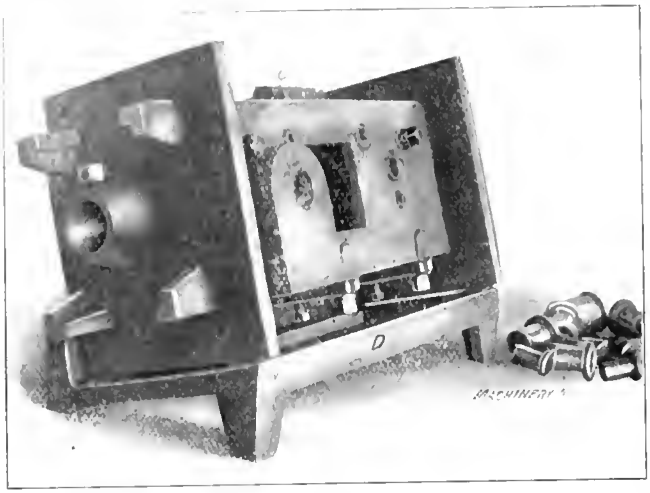


Fig. 108 Jig in Fig. 107 in Position for Drilling Holes at an Oblique Angle with the rest.

* * *

The great improvement in mechanical construction made possible by alloy steels, is startling to those even who are most familiar with their characteristics. For example, modern ordnance which hurls a 12-inch shell at an initial velocity of 2,500 feet per second, is only made possible with carbon steels by adopting the built-up structure by which one tube is shrunk upon another until the core is put into a state of compression nearly equal to the tensile stress that will be exerted upon it by the explosion of the powder charge. The elastic limit of ordinary steel is too low to resist the great pressure, and the layers of steel next to the powder chamber of a single-tube gun would be stretched more and more with each succeeding explosion until the piece burst. The built-up structure distributes the internal pressure more or less equally throughout the barrel and thus enables it to withstand an indefinite number of firings. But high-grade alloy steels may enable us to revert to the simple tube forms again for heavy guns. A gun tube used in the Davis double torpedo made of vanadium steel one inch thick and weighing only 350 pounds, successfully withstands a powder charge sufficient to propel a 10-inch shell with a velocity of 1,100 feet per second!

* * *

The recent sale of 2,000 practically unused breech-loading Springfield muskets for 69 cents apiece by a New York department store is a good example of the enormous waste of war and preparation for war. These weapons cost the United States Government $18 each, and for years were considered to be the best army gun in the world, but the rapid improvements in shoulder arms during the past fifteen years have made the model obsolete, as well as several others that followed it. Thousands of obsolete arms are sold at auction by the governments of the world every year for little more than their value as old metal, but still the armories go on year after year turning out new models at tremendous cost—for what?

GRINDER KINKS.

PAUL W. ABBOTT.*

The following article will deal with some of the kinks used in our tool-room by the tool grinders, some I have seen around the shop, and others which I have used myself. They are all good, practical kinks which are in use every day.

Fig. 1 is a hand grinding rest which is very handy for use on the universal grinder. It is adjustable up and down for height, and is used for hand grinding circular and straight form tools, sharpening metal slotting saws, formed cutters, etc. Fig. 3 shows the application of the hand rest to the grinding of saw teeth in a blank. The tooth rest used in connection with this operation is shown in Fig. 2. These saws are first ground on an arbor, the old teeth being ground off, leaving a perfect circle. The operator then puts on this device, setting the tooth rest so that the teeth will be about ¼ inch apart, and grinds around by hand, not quite bringing each tooth to a sharp point. On the last nine or ten teeth he evens up any inaccuracy in the spacing, the wheel being trued off to the exact shape of tooth space wanted.

Fig. 4 shows a device for accurately sharpening formed cutters up to 3 inches diameter, which is used when the cutter grinder has another job in it, or could be used to advantage where there was no surface or cutter grinder. The device consists of the cast iron slide *B*, at the end of which is a tapped hole *C*, with a small fillister head screw which holds the various sizes of bushings which fit the holes in the cutters. On the same end is the index pin *D*, which is adjustable back and forth. In operation, the hand rest shown in Fig. 1 is also used, and the pins *A* are lined up parallel with the forward travel of the wheel and so that the cutting face of the wheel is on a line with the center of the bushing. The cutter is then slipped on over the bushing and the index pin is set so that the required amount will be ground from the face of the tooth. The operator brings the wheel up to the proper position and then pushes the slide forward until the wheel has reached the bottom of the tooth space; he then withdraws the slide and indexes to the next tooth, and so on, tooth after tooth. It will be noticed that the index pin rests against the back of the tooth, which means that upon the previous milling of the teeth depends the accuracy of the grinding; but on the standard cutters furnished by numerous concerns this spacing will be found accurate enough.

Fig. 5 is a center for the head-stock for holding small forming tools of odd size, or threaded pieces which are to be ground on the periphery. The tools are simply clamped to the face of the center, and trued up by an indicator. Fig. 6 is a device for grinding snap gages for the tool grinder, where there is no surface grinder for this class of work. The shank of this device is made to fit the head-stock, and the gages are clamped to it by a small strap and two screws. This fixture revolves while in use, and the jaws of the gage are ground by feeding a thin wheel in and out by hand. Revolving the device insures perfectly straight gage faces. Fig. 7 shows a center for the universal grinder for holding a standard line of large end milling cutters with threaded holes, while sharpening. The head-stock is swung around at right angles to the ways, and with a long support for the tooth rest (Fig. 8), which is bolted to the platen, the cutters are ground very handily by throwing in the feed and grinding one tooth, and then, before the wheel comes back, indexing to the next tooth, and so on.

Fig. 9 shows a hardened roll which is ground all over, and Fig. 10 the fixture for the universal grinder for grinding the sides of this roll. This plate was made of cast iron, with both sides ground and with each hole ground to 0.0005 inch over standard size. Each hole has a ¼ inch set-screw, as shown at *A*. In operation, the plate is fastened to the face-plate by a draw-back rod, and the head-stock is swung around at right angles. As the plate revolves, 16 rolls are ground at once; first on one side, and then the plate is turned and the other side ground, the rolls being made to standard length by using a depth gage. The hardened roll shown in Fig. 11, which is used on swaging machines, is held by the centers shown in Figs. 12 and 13, when being ground. Fig. 12 is

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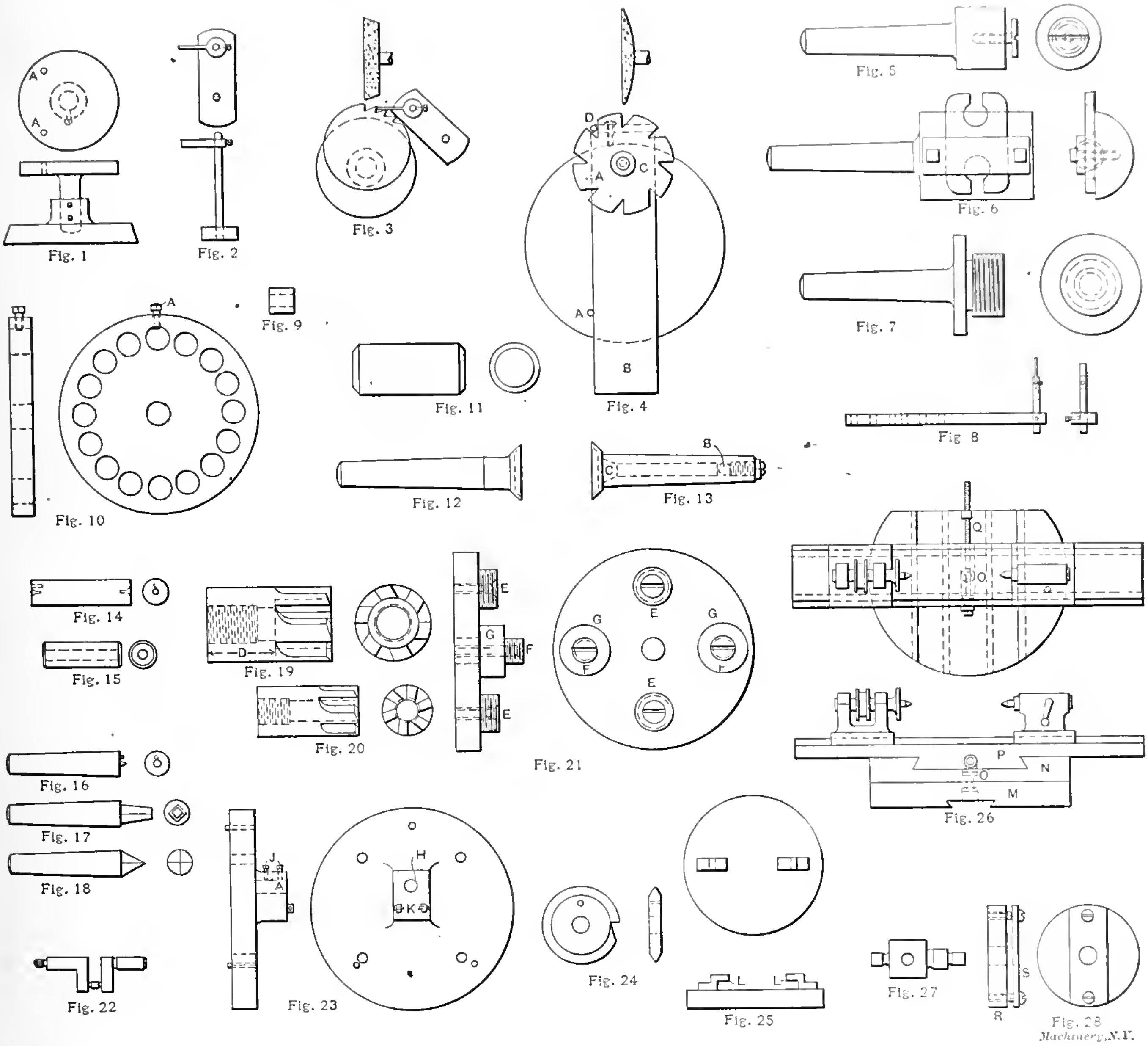
the head-stock center cupped out on the end to fit the beveled end of the roll. This center drives the roll by friction, the pressure being obtained by the spring tail-stock. Fig. 13 is the tail-center which is in two parts, the inner spindle running with the roll and being adjusted by the screw in the end so that the thrust is taken by the ball *B*, the tapered portions *C* just clearing each other. Other methods of grinding rolls are shown in Figs. 14 to 18. One example of grinding is shown in Fig. 14, and its center in Fig. 16. The roll is driven by a pin on the center, which engages with a corresponding hole in the work. A better method, which I have used, is to center the roll and then in one end drive a square 60-degree punch, using the square center shown in Fig. 18 for driving the work while grinding. Another good method for hollow rolls, such as shown in Fig. 15, is to use a 15-degree square center, such as shown in Fig. 17, the end of which just enters the hole.

Figs. 19 and 20 show two end mills. The smaller one is fastened inside of the larger when in use, and when in position rests against the bottom of the hole and projects outside a definite distance. The length *D* is standard in all these mills. Fig. 21 shows the fixture for grinding two pair of these mills at a time, so that the same amount will be taken off of both the short and long ones. Threaded bushings *E* fit the larger size mills, and *F*, the smaller. The collars *G* are of such a thickness that the cutting face of the smaller mill is brought into the same plane as the larger, and so when grinding, an equal amount is removed from the face of each mill. The plate is held to the face-plate by a draw-back rod. The head-stock is swung at right angles, and with the fixture revolving, the wheel traverses back and forth across the faces of the mills. The mills are then taken to a cutter grinder and backed off.

Fig. 22 shows a small crank-shaft, and Fig. 23 the fixture for grinding the pin. The bearings are first ground on centers in the usual way. The fixture is of cast iron and is held to the face-plate by screws and dowel pins. In the making of this fixture the hole *H* was ground out to the size of the bearing, and then the fixture was correctly located and doweled to the regular face-plate. The crank, while being ground, is held by the set-screws *J*, and the screws *K* which are set against the crank on either side.



Machinery,N.Y.

Various Tools and Fixtures for Miscellaneous Work on the Grinding Machine.

The grinding of formed cutters, similar to the one shown in Fig. 24, so that they will be interchangeable, is very interesting. The error limit is .00025 inch. The grinder used is a Norton universal tool and cutter grinder. After hardening, the cutters are first ground to a definite thickness. For this operation they are held against the face-plate by a draw-back chuck. The next operation is grinding the beveled sides, which is accomplished by holding the cutters against a small face-plate by a draw-back chuck. The correct angle of bevel is obtained with the protractor, and to get the correct diameter of the bevel sides, and to insure that the bevel sides stand exactly in the same relation to each other, the gage shown in Fig. 25 is used. This gage is hardened and ground all over, and the two gaging points *A* are set a predetermined distance apart and as near the same height from the platen as mechanical means can make them. It is ob-

vious that cutters which are all ground the same thickness, and which will pass through this gage with the beveled sides both touching the gage points with equal pressure, will interchange within pretty close limits. The operator grinds one bevel side at a time, trying the work every little while in this gage; when one side passes through the gage the cutter is turned around and the other bevel ground. For grinding the radius on the periphery and bringing the cutter to the correct diameter, the radius grinding fixture shown in Fig. 26 is used. The dovetailed base *M* is fitted to the platen of the grinder and upon this base is a sliding base *N* which is pivoted to *M* by a bolt *O*. Upon the base *N* there is an auxiliary platen *P* which can be adjusted back and forth by the screw *Q* for getting the proper radius. This auxiliary platen is made the same as the machine platen so that the regular head- and tail-stocks will go on it. A cutter is placed on a special arbor and the platen *P* adjusted to give the correct radius. The wheel is then brought up and the cutter is ground to the correct diameter, the curved face being obtained by swinging the base *N* back and forth by hand in an arc of a circle, with bolt *O* as a center.

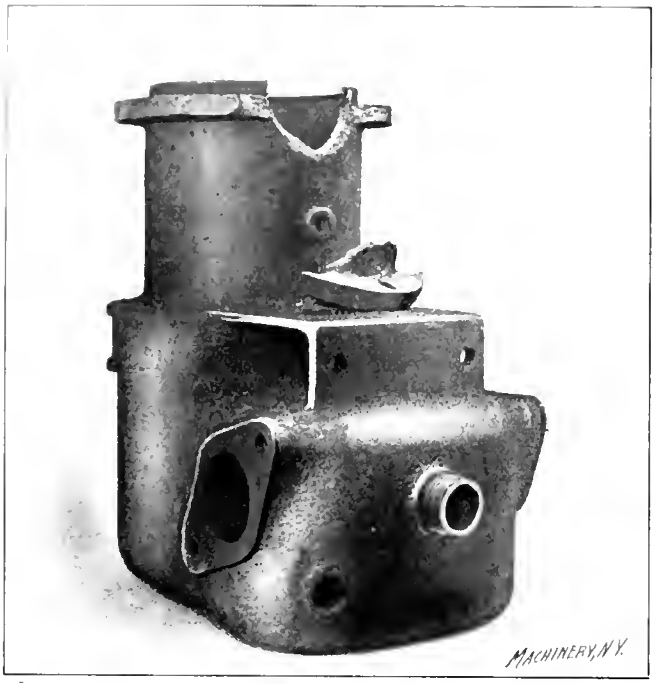


Fig. 1. Broken Cylinder to be repaired by Autogenous Welding.

Another ingenious scheme which I saw in the tool-room is shown in Fig. 28. The foreman brought along three or four pieces similar to the one shown in Fig. 27, and wanted the holes ground out. With an independent 4-jawed chuck this would have been easy, but there was no such chuck; and as there would never be any more of these pieces to be ground the fixture for doing the work had to be inexpensive. The face-plate could not be used as the pieces were smaller than the hole in the face-plate. The operator thought awhile, and then hunted around a few minutes and found a large washer *R*, tapped two holes in it, filed up the sheet steel strap *S*, and with a couple of machine screws was ready to begin. The washer was first put in the universal chuck and the outer side ground. One of the pieces was then clamped in place, and after putting on the internal grinding attachment it was ready to be ground.

* * *

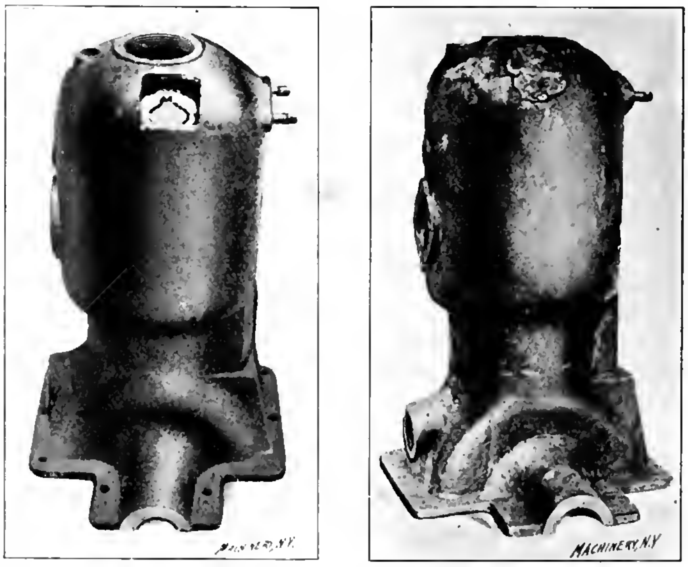
"From standing grain in the field to well-baked biscuits in twenty-two minutes was the record made in converting the raw material into the manufactured product at Waitsburg, Washington, recently." The foregoing, quoted from a newspaper, "is important if true." It indicates to what remarkable degree the mechanical processes of harvesting and preparing cereals for food have been developed. The statement appears incredible, however, because at least fifteen minutes would be required for baking, leaving only seven minutes for harvesting, threshing, grinding and preparing for the oven.

THE APPLICATION OF AUTOGENOUS WELDING TO AUTOMOBILE REPAIRS.[*]

HENRY CAVE.[†]

In the October, 1908, issue of MACHINERY, the apparatus used for autogenous welding was illustrated, and the principles involved discussed. In the present article a few applications of autogenous welding will be treated, particularly with reference to automobile repairs. As was stated in the article referred to, the metal to be welded is melted by the acetylene gas, burning with pure oxygen, and at the point of fusion the metals flow together and are practically "re-cast" locally, material being added when necessary from a rod of the same metal as the parts being welded. This applies to all metals, including cast iron and aluminum. These latter are mentioned specifically, because they are not commonly considered as possible to weld, and therefore serve better as an example showing the possibilities of autogenous welding.

Fig. 2. Enlarged View of Cylinder in Fig. 1, showing Part repaired without Impairing Finished Surface on Inside.



Figs. 3 and 4. Water-jacket of Cylinder, repaired from the Outside by filling in Cavity against Graphite Backing on the Inside.

One of the first principles to be understood in regard to autogenous welding is that the flame must actually come in contact with every particle of the metal welded. It is impossible to weld in places where this cannot be done. For

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[*] For additional information on this subject, see Oxy-Acetylene Process of Metal Cutting and Autogenous Welding, October, 1908, and other articles there referred to.

[†] Address: Autogenous Welding Equipment Co., Springfield, Mass.

instance, if a small boss is required on a casting, it is not possible to cut out a thin disk of metal of the size of the boss, with the idea of welding it onto the casting. In a case like this, the metal would be added drop by drop until the required size is reached, and if the boss must be machined to size, metal must be added for finishing. Metal up to one-eighth of an inch in thickness can be butt-welded. The heat passing down the opening is sufficient to insure a weld clear through the thickness of the metal. If the thickness is greater, the sides must be first beveled off, allowing the welding flame to penetrate to the bottom of the joint. The metal at the bottom will then first flow together, and the groove caused by the beveling must be filled up by adding metal of the same kind. The beveling or grooving is usually done by grinding, chipping or filing. When beveling a broken part, care should be taken to leave enough of the original break to line up the parts with. The best practice is to leave three short sections on each fragment for this purpose. It is evident, from what has been said, that it is not possible to make a lap-weld with this apparatus. Therefore, when it is required to weld such parts as are usually brazed, as for example the joints of the exhaust manifold for automobiles, which are made from steel tubing, it is necessary to fit the two tubes so they butt together, and they should not be flanged as for brazing. Flanges and other fittings are welded to the pipe only at the edge, either at the outside or inside, or both. It is necessary to weld around only at one place if the pipe is a good fit in the flange.

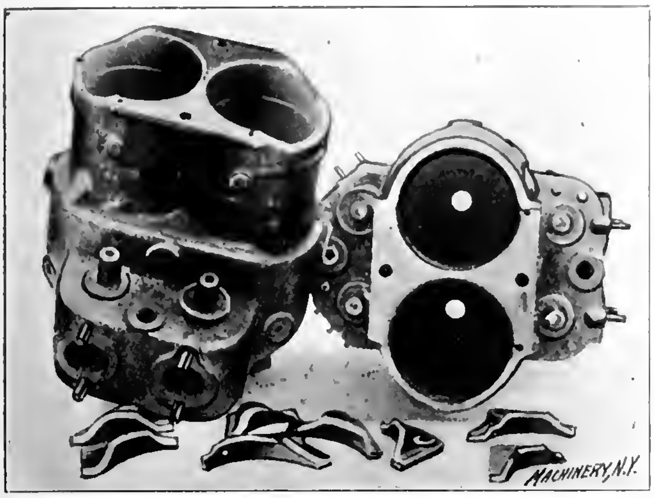

Fig. 5. A Badly-broken Casting, Illustrating the Possibilities of Autogenous Welding.

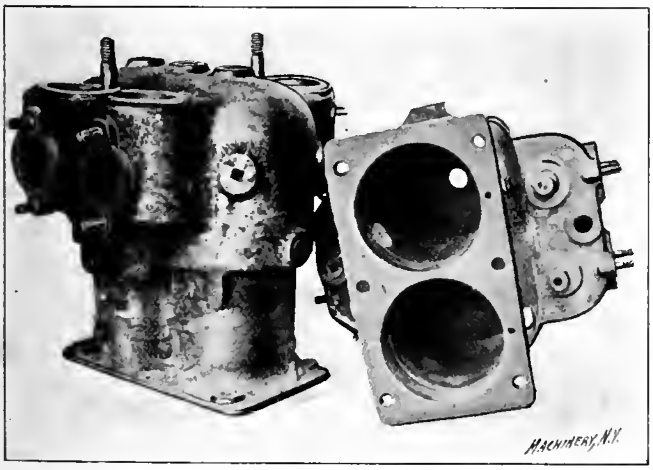

Fig. 6. Casting in Fig. 5 after having been repaired.

When a cut, crack or break passes through a machined surface as in the case of the cylinder, Figs. 1 and 2, and it is not necessary to eliminate all signs of the accident, the parts may be welded together entirely from the outside. The machined surface on the inside of the cylinder will not then be damaged, but the line of the crack can always be seen on the inside. If it is necessary to eliminate all signs of the break, then the crack must be welded on the machined side as well, and metal added which can be removed in remachining the parts.

It is sometimes impossible to gain access to both sides of a weld, as in the case of the two-cycle cylinder, Figs. 3 and 4 Then it will be necessary to make the weld entirely on the outside. In this particular case it is desirable that the inside be kept free from projections. To accomplish the repair in this case, a piece was therefore cut out of the jacket wall as shown in Fig. 3, and a block of graphite, which stands intense heat better than any other material, was fitted inside the cylinder. The weld was then made by filling in the hole, as shown in Fig. 4. When this was done, the graphite was removed, the inside surface being perfectly smooth. The outside of the cylinder in Fig. 4 can be trimmed off and finished, so that it will look the same as before the accident.

Figs. 5 and 6 illustrate a broken automobile cylinder successfully repaired. It will be seen from Fig. 5 that a great many parts are broken off and the repairing of this cylinder by welding gives a good illustration of the difficult class of repair work that can be carried out by the process. The illustrations show that autogenous welding can be extensively used, both in the manufacture of various kinds of machinery and in the repair shop. The saving of time which can be effected by quickly-made repairs, as compared with remaking castings, is plainly in evidence. The work illustrated in the accompanying engravings has been carried out at the demonstration plant of the Autogenous Welding Equipment Co., Springfield, Mass. It is likely that within comparatively few years the apparatus for carrying out autogenous welding will be recognized as part of the necessary equipment in any machine shop.

* * *

At the semi-annual meeting of the National Association of Cotton Manufacturers, at Saratoga Springs, N. Y., attention was called to the importance to manufacturers of reforestation. The president, Mr. Charles T. Plunkett, of Adams, Mass., in his address, touched on the subject, and afterwards several speakers in a discussion on the importance of forest preservation to manufacturers, voiced the opinion that the subject of forest preservation was of vital importance to everybody engaged in any kind of manufacture, and employing power. The energy stored up in our waterfalls will become comparatively useless if a fairly steady flow of water cannot be expected the year round. Reckless devastation of forests in the past and present makes it impossible to secure anything like an even flow in the streams of the country, and if the great amount of power that can be obtained from the waterfalls is not to be entirely lost in years to come, it is necessary that the hillsides should not be robbed of their natural capacity of acting as reservoirs for surplus water. Not only is this matter of importance from the point of view of power generation, but also on account of the destructive floods that of late have menaced many industrial properties in the country, along the banks of our larger rivers, most of which can be ascribed directly to the cause of permitting the regions along the upper course of the rivers to be stripped of their forests.

* * *

A special sub-committee of the British Society of Motor Manufacturers and Traders, has, as stated by the *Horseless Age*, evolved the following horse-power formula for gasoline engines:

$$\text{Horse-power} = KDN(D-1)(R+2),$$

in which formula,

K = a constant varying between 0.197 and 0.333,
D = the cylinder bore in inches,
R = the ratio of stroke to bore, and
N = the number of cylinders.

This formula, which is intended for use in connection with hill climbs and similar trials, takes into account that it is not possible to obtain as high mean pressures in large as in small engines, and also the ratio of bore to stroke. The source which we quote, unfortunately, does not give any information as to what conditions govern the selection of the value of the constant K.

WELDING.*

JAMES CRAN †

Up to comparatively recent years, the only process of welding wrought iron and steel was to heat the parts to be welded in a forge or furnace until they had reached a semi-melting condition, after which they were united by hammering. At the present time there are several distinct processes which give the same, or in some cases, better results than are possible by the ordinary process mentioned. Among these may be mentioned the Thermit process (see MACHINERY, March, 1903), the electric welding process (see MACHINERY, April, 1908), and the autogenous welding process (see MACHINERY, October, 1908).

The first mention of welding by electricity, was made by James P. Joule, of Manchester, England, in a paper published in 1856. It was, however, more than thirty years later before electricity became used for welding in the mechanical arts. One feature of importance in relation to the electric welding is that it makes possible not only the welding of iron and steel, but of metal widely dissimilar, as high carbon to low carbon steel, brass or copper to iron or steel, etc. It is, however, the writer's intention to deal in the following principally with welding as it is, or rather as it should be, done at the forge. It is the oldest, the most common, and, perhaps, the least understood of the welding processes. It has not received the attention that its importance merits, nor has it improved with other mechanical arts.

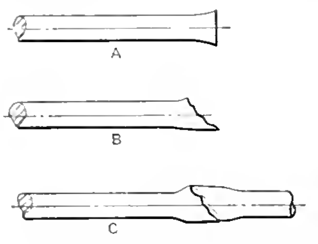

Fig. 1. Incorrect Upset and Scarfing for Plain Lap Welding.

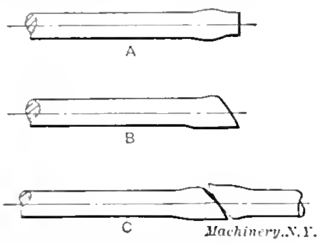

Fig 2. Correct Upset and Scarfing for Plain Lap Welding.

Brawn and muscle have generally been considered more essential to the blacksmith than brains, and thus the fact that preparing the pieces to be welded is of as much importance as the actual heating and hammering, is far too seldom taken into consideration. The preparation of work for welding depends greatly upon the shape of the forging and the class of work for which it is intended.

Plain Lap Weld.

The most common joint is the plain lap weld used on plain straight work, such as round, square, or flat stock, up to a certain weight and length. In nine cases out of every ten, the pieces are prepared and placed together for welding as shown in Fig. 1. The upsetting is done on the extreme ends of the pieces, as shown at *A*, and the greater part of the upset has to be drawn down to form a scarf, the face and sides of which are generally a series of steps or notches as indicated at *B*. The parts are placed in position for welding as shown at *C*. Some blacksmiths claim that notches on a scarf are an advantage and keep the pieces from slipping when being hammered together. This idea is responsible for a great deal of poor welding inasmuch as the notches make the best kind of a trap for slag or any foreign matter that is liable to adhere to them while heating. If this slag is closed in between the pieces, as it is almost sure to be when the points of the scarfs are welded first, as is generally done, all means of escape for slag or dirt is cut off and the welding will only be effected in spots. The defect will show up in machining if the weld does not come apart before.

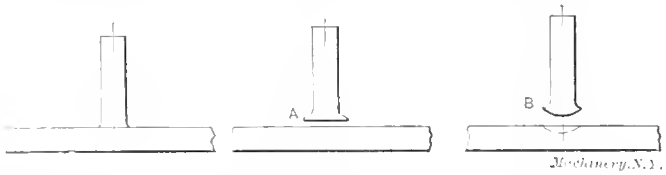

Fig. 3. Correct and Incorrect Methods of Scarfing for Jump Weld.

If pieces are prepared as shown in Fig. 2, defective welding will be reduced to the minimum. The upsetting should be done at least the thickness of the stock from the end, as at *A*, so that it will not be affected by the scarfing. This makes less upsetting necessary, and the scarfing is more easily done. The face and sides of the scarf should be fairly smooth, and crowned slightly in the center as at *B*, so that when they have been heated and brought together for welding, the center will be the first part to unite as shown at *C*. Any slag or dirt that may have adhered to the heated surfaces will be forced out as the welding proceeds from the center to the point of one scarf and then to the other.

Fig. 4

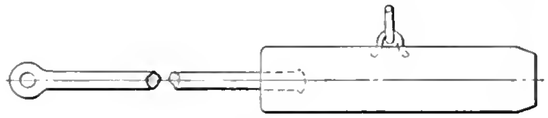

Fig. 5

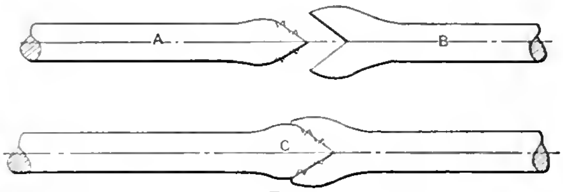

Fig. 6

Fig. 7

Fig 4. Wrought Iron Shaft prepared for Butt Welding. Fig. 5. Ram for Upsetting Long Bars. Fig. 6. Steel Shaft prepared for Welding. Fig. 7. Carrying Bar for Long, Heavy Forgings.

Jump Weld.

In welding forgings of the style shown in Fig. 3, usually only one piece, the shank, is prepared. It is upset on the extreme end, the edges scarfed and thinned, and the face left perfectly level, as shown at *A*. When prepared in this manner, the chances are that a little slag will adhere to the flat surface and be closed in between the two pieces. The edges of the scarf will be the only parts to unite with the other piece, and will have to support the whole strain that may come on the forging.

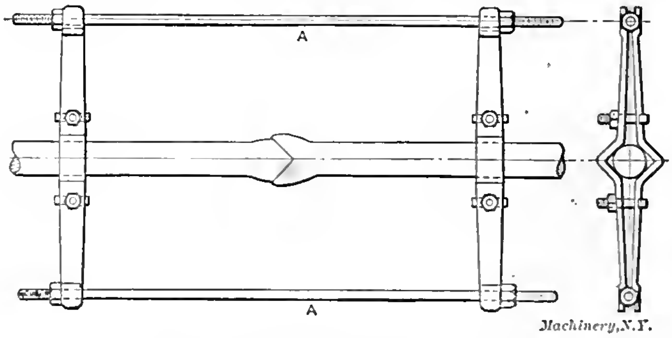

Fig. 8. Heavy Shafting prepared for Welding.

Work of this kind should be prepared as shown at *B*, the flat piece being hollowed out with a bob-punch as shown by the dotted line, and the shank upset and scarfed, as indicated, until it is just small enough so that the spherical portion will bear in the bottom of the impression, but not quite touch the sides. When heated to a welding temperature and placed in position, the first point of adhesion will be at the center, and two or three blows will upset the shank sufficiently to fill the impression. Any slag or dirt will be forced out as the welding proceeds, and a solid piece of work is insured when the weld is completed. This style of welding is known as jump welding.

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* For [illegible] information on kindred subjects, see 'Tools for [illegible] in Blacksmith Shops in the November issue of Machinery, and other articles there referred to.

† Address: [illegible] Third St., Plainfield, N. J.

Butt Weld.

Shafting and similar work, when made of wrought iron, can be butt-welded to advantage, the only preparation necessary being to upset the ends coming together, slightly crowning them in the center. The two ends are kept in alignment with a dowel pin as shown in Fig. 4. When heated to the proper temperature, the parts may be welded before they are removed from the forge by using a sledge hammer on one end, or, if the pieces are of large dimensions, a ram should be used. The welding commences at the center, and all slag or dirt is forced out as the pieces come together. By the time the weld is complete, the diameter around the heated parts will be found to have increased. This excess can be worked down to the same size as the rest of the piece either at the anvil or steam hammer while it is still at a welding temperature.

Welding Steel.

It is not advisable to butt-weld steel at the forge, as the pieces are liable to come apart when the upset portion is being worked down to the same size as the rest of the piece.

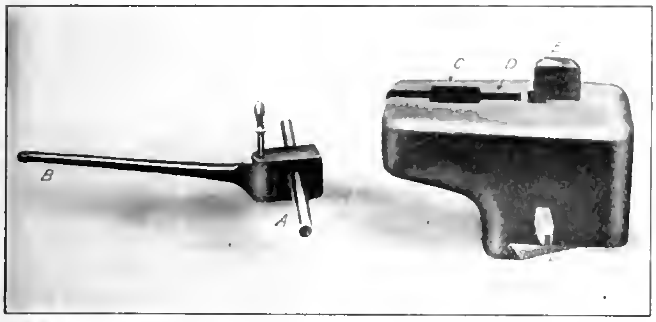


Fig. 9. Upsetting Attachment for Preparing Heavy Shafts for Welding.

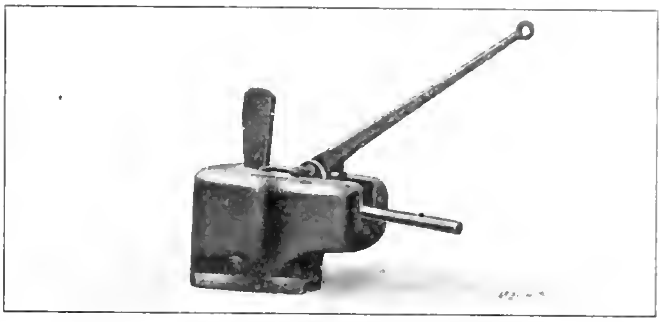


Fig. 10. Upsetting Attachment ready for Operation.

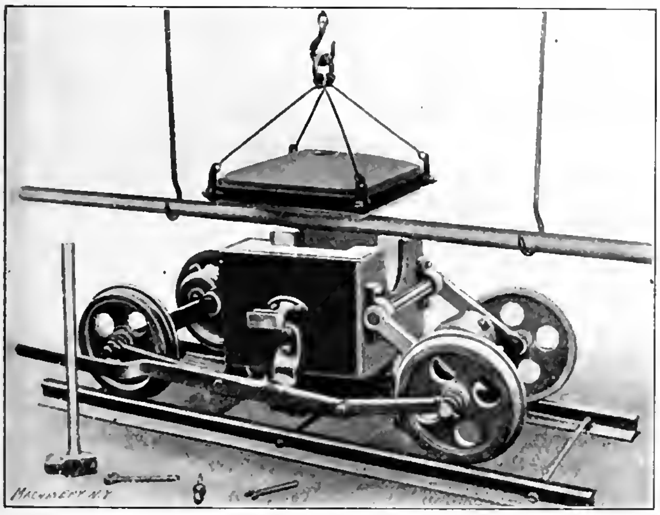


Fig. 11. Portable Forge ready for Use.

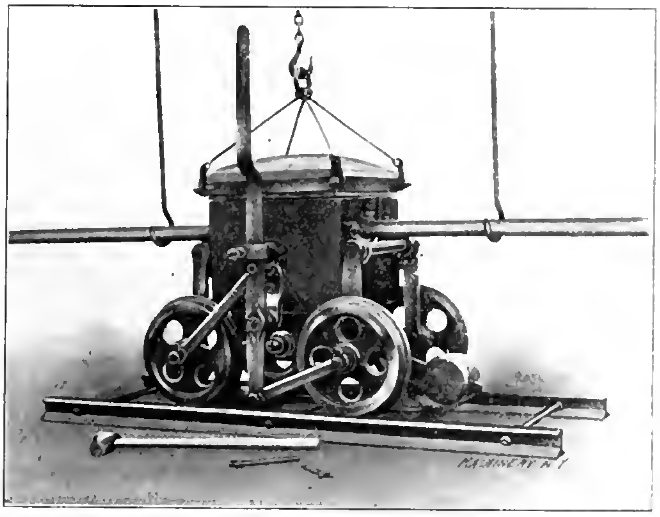


Fig. 12. Portable Forge in Raised Position.

All forgings either of ordinary machinery or carbon steel should be made from the solid, if possible. If this is impracticable, welding should be done either by the plain lap method or by split weld. The split weld is seldom used except upon very long or heavy work, such as shafting, lead-screws for long lathes, and similar work where the parts are either too long or too heavy to be heated separately and placed upon each other for welding with any degree of comfort or accuracy. Work of this kind is usually prepared for welding by being heated on the end and upset with a ram of the style shown in Fig. 5, which is suspended from above by a chain attached to the ring of the ram with a hook. The ram is arranged so that it can be adjusted to any height. It is swung horizontally by means of a rope attached to the shank or handle. Three or four men are needed to give it momentum and one man to guide it by the shank. An equal number of men are needed to keep the shaft in position when acted upon by the ram. When the pieces have been sufficiently upset, one is scarfed as shown at *A*, Fig. 6, and the other is split and scarfed in the shape of a snake's head as shown at *B*. A few sharp burrs are raised with a chisel on the sides of *A*. Part *B* is heated and closed in on the burrs which keep it in position, as shown at *C*. The parts are then placed on the forge, heated, and welded in the usual manner at the steam hammer.

Bars of the style shown in Fig. 7 are used to lift the shaft from the forge and convey it to the hammer. One man is required for each end of the bar; sometimes as many as a dozen or more bars are used, according to the length and weight of the work. When the diameter exceeds three inches, the separate pieces are usually held in position by means of clamps, as shown in Fig. 8. When the heat has been raised sufficiently high for welding the pieces, they may be forced together, before removing them from the forge, by using a sledge hammer or a ram on one end of the work. When the pieces have been fairly united, the tie rods *A* are removed, allowing the work to be turned in the fire so that all sides can be brought as near as possible to the same temperature. The shaft is then lifted from the forge to the steam hammer, where the welded portion is worked down to about the same diameter as the remainder, using the clamps which are still left in position for handling and turning it.

Making Long Lead-screws.

Lead-screws frequently are as long as sixty feet, and occasionally eighty feet or over. Defective welding on this class of work is very serious as it renders the screws practically useless. When work of this nature exceeds the length of the longest lathe in the shop, two or three bars, together equaling in length about the capacity of the available lathe, are welded together, turned, and the thread cut to within about three feet of the end of the bar. This is then returned to the blacksmith shop where a few more lengths are welded on, which are also turned and threaded. This is repeated until the full length has been reached.

To facilitate handling and to reduce the cost of such work, the writer designed the upsetting attachment for the steam hammer, shown in Fig. 9, which takes the place of the ram and can be used with considerably less help, the blacksmith, his helper, and the steam hammer operator being all that is required. To use the attachment, the anvil block is removed from the steam hammer, and the fixture is keyed in its place. The ends of the bars to be upset are heated, placed in V-blocks *A*, which are notched or toothed inside to insure their bearing being firm upon the work, the grip being just

behind the heated portion. The V-blocks are brought to bear upon the work by means of a lever and cam *B*. The V-blocks with the work held firmly between them are placed in a recess *C* in the end of the fixture, thereby preventing them from moving backwards. A steel plate made to slide in groove *D* comes in contact with the hot end of the work. The plate is forced forward in the groove by wedge *E*, driven home by the steam hammer. Should the wedge in any way become cramped, it can be removed by a small wedge *F* which crosses its point near the lower side of the attachment. If the amount of upsetting done at one operation is insufficient, the grip can be released upon the work in the V-blocks, the shaft pushed through as far as it will go, and the operation repeated. A fixture of this style can be arranged to form collars or in fact any kind of work where upsetting is necessary. In Fig. 10, the device is shown ready for operation.

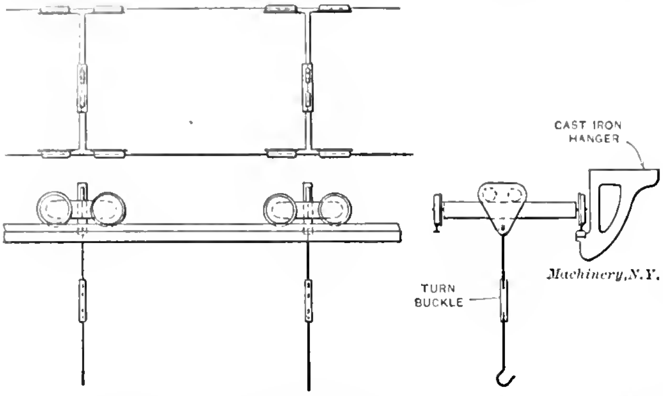


Fig. 13. Diagram of Trolley System in Blacksmith Shop for Handling Long Lead-screws.

Portable Forge for Welding.

Figs. 11 and 12 show a portable forge specially designed by the writer for heating long work to be welded. The general arrangements are such as to afford greater convenience in heating and handling this class of work than is possible with an ordinary forge. By its use a saving of at least 75 per cent in help is effected. In Fig. 11 the work is shown in position ready for heating and supported by hooks. The body of the forge is made deep enough to support the sides of the fire which necessarily have to be high enough to allow the work to be covered by it. The forge is lined with fire brick to prevent the sides getting overheated and warped. The top is covered with a large fire brick bound around the edges with iron straps, and supported by a chain from above. A hole in the center of the brick allows smoke and gases to escape; this hole can be closed or partly closed, when necessary, with a piece of sheet iron or boiler plate. The fire brick cover gives all the advantages and none of the disadvantages of a hollow fire for welding, as it can be placed in position or removed without in the least disturbing the fire. The forge is mounted on wheels attached to the body with axles which can be spread by means of a lever and link motion (see Figs. 11 and 12), allowing the body to drop far enough for work to be removed without lifting it to clear the sides of the fire. To make the forge easily raised and lowered, the body is counterweighted, the weights being made to slide on levers so that they can be adjusted to give a perfect balance. They are held in position with set-screws. The other ends of the levers are connected to the body with links, and work in fulcrums attached to the track on which the wheels rest. The fulcrums are just high enough to clear the bottom of the air chamber when the forge is raised to its full height, which allows it to be easily removed from the track when the levers are disconnected. Fig. 11 shows the forge lowered, and the brick cover suspended by the chain clear of the work. The latter can be conveyed to the steam hammer, as it rests in hooks connected with an overhead trolley. Fig. 12 shows a view of the forge when raised to its highest position by linkage.

Air is supplied from a blower through a flexible hose attached to a flanged pipe. The shut-off can be opened or closed from either side of the forge by means of the two small levers. When in use, the forge has to be placed so that when the work to be welded is in position for heating it will be on a level with the lower die of the steam hammer. It is necessary to use a trolley system of the style indicated in Fig. 13 to convey the work from the forge to the steam hammer and from the steam hammer to the forge. The side track should be long enough to allow handling the longest work and wide enough to reach from the forge to the steam hammer. The cross trolleys, of which there should be at least four, support the work in hooks fitted with turnbuckles so that they can be adjusted to the proper length. With four or more cross trolleys the longest work can be perfectly balanced and conveyed from forge to steam hammer without any danger of bending or distorting the hot portion. This type of forge can be used for purposes other than welding. By closing the opening on one side, it could be used as a furnace for heating any kind of forging within its capacity. Being portable, it can be placed near a steam or trip hammer or any other place where it would be most convenient for the work being done.

Fig. 14 shows the style of tuyere used in the forge already described. This type of tuyere can be used with any kind of a forge and will give better results and less trouble than the average tuyere in general use, especially in welding. It being in the shape of half a sphere, clinkers and slag will not choke it but will form a ring around the base and as a rule can be removed from the fire without breaking them up. Most of tuyeres in general use are usually flat or slightly hollow. Slag or clinkers accumulate in the center, and are a source of annoyance in doing any kind of forge work, especially welding. The tuyere here shown has a single hole to admit air which tends to concentrate the heat and keep the fire from spreading. No bolts or screws are needed to keep it in position; a little fireclay packed between it and the bottom of the forge is all that is necessary to make it air-tight at the base and keep it in place.

In all kinds of welding it is important that there be a fair depth of fire between the tuyere and the work so that the oxygen in the air will be consumed before it reaches the pieces being heated; otherwise the work will scale and only unite with difficulty if it unites at all.

For any kind of welding, hollow fires should be used when the shape of the work will permit. In no case should the work be allowed to come in contact with the fuel any more than is necessary.

Fluxes for Welding.

Wrought iron can be welded in a clean, well-kept fire without necessarily using a flux of any kind except when the work is very thin. Fine, clean sand will answer the purpose. With steel of any kind it is different, as there is no kind of steel that will stand the same amount of heat as wrought iron will. A flux of some kind must be used to get the separate pieces in a condition to adhere to each other. There is a large variety of welding compounds on the market; some of them are suited for one class of welding, some of them for other classes. Welding plates or any of the gritty brands are suitable for any kind of welding when the pieces are heated separately. For pieces put together previous to welding, as in split welds, or when taking a second heat, usually termed a "wash," a compound or flux that will flow freely should be used.

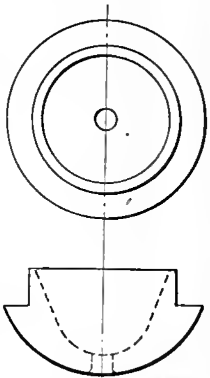


Fig. 14. Tuyere for Portable Forge in Figs. 11 and 12.

When borax is used for a flux it will give the best results if burned, which can be done by heating it in a crucible until it has been reduced to a liquid state. It should then be poured on a flat surface to form a sheet. When cold it can easily be broken up and pulverized. This can be used as it is, or it can be mixed with an equal quantity of fine, clean sand and about 25 per cent of iron (not steel) filings or small chips.

Too much care or attention cannot be given to welding. Poor welding may mean a railway wreck, a steamship disaster, or a number of other things likely to endanger life and property.

A GERMAN DESIGN OF FRICTION SPINDLE PRESS.

So-called friction spindle presses are used to a very large extent on the European continent, and especially in Germany, for forging and stamping purposes. A type of this class of press in an improved form, brought out by the firm of Brüder Boye, Berlin, Germany, is illustrated in Fig. 1. American readers will at once recognize that presses of this type are seldom, if ever, seen in this country.

There is one pulley with a friction wheel on each side of the press, mounted on horizontal shafts in such a manner that either of the friction wheels may be shifted to engage the rim of the heavy central friction driving wheel, attached to a vertical screw. By means of this screw the ram of the press is raised or lowered. The advantages claimed for this type of machine are that it provides for an "elastic" blow, the drive not being positive, and that therefore this design does not require as large dimensions of standards, bearings, shafts, etc., as are required in presses with positive drive, in order to prevent breakage. Besides their use for drop forging, bolt-heading, etc., these presses are also used instead of hydraulic presses and steam hammers for general forging work. For these purposes they possess the advantage of smaller operating cost and cheaper foundations.

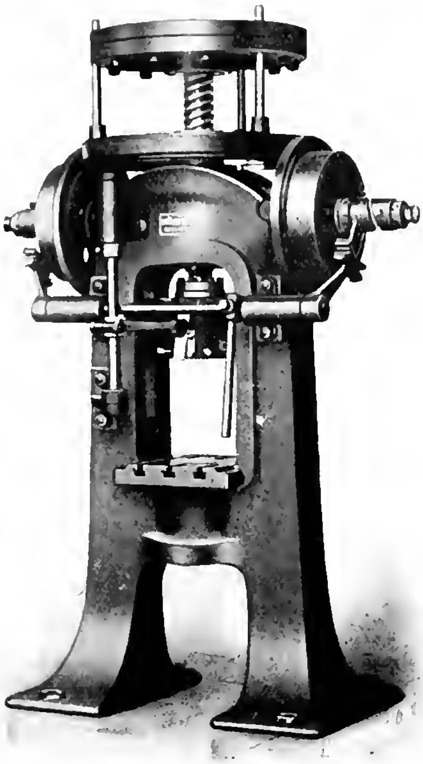


Fig. 1. Friction-driven Press built by Brüder Boye, Berlin, Germany.

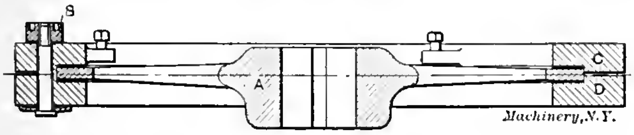


Fig. 2. Safety Fly-wheel used on Brüder Boye's Friction-driven Presses.

The type of press shown in Fig. 1 has been improved in several details over previous designs, the main features of improvement being a special safety fly-wheel, a new driving device and a special arrangement for the friction brake. The design of the fly-wheel, which is placed at the top of the machine at the upper end of the screw, is shown in Fig. 2, and known as Schull's system. In former constructions, it has been common to make the fly-wheels in a solid piece, rim, spokes and hub all cast together. The fly-wheel shown here is made in an entirely different way. It consists of a disk *A*, which forms the hub and the spokes of the fly-wheel, and of two fly-wheel rings *C* and *D*. Between the disk and the rings *C* and *D* are arranged segments or fiber disks. The fly-wheel rings *C* and *D* are tightened to the disk *A* by means of a number of nuts *B*, screwing onto bolts passing through the two rings. These nuts can be tightened only by means of a special spanner wrench having a form as shown in Fig. 3, for the smaller presses, and a form shown in Fig. 4 for the larger presses, the feature of this wrench being that it is provided with a friction attachment, making it impossible to tighten the nuts more than a certain amount, and thus providing for a chance of slip between disk *A* and rings *C* and *D*, if the resistance becomes great enough to overcome the friction between these parts. On account of the peculiar construction of the fly-wheel, this possibility of slip between the fly-wheel rim and the hub, which prevents the fly-wheel from giving out stored-up energy above a certain amount, eliminates breakage of the parts of the press. The capacity of the friction spindle press can also be increased largely on account of this fly-wheel construction, and it is interesting to note to what an extent this construction of fly-wheel permits the full capacity of the press to be taken advantage of. In Fig. 5 are shown four cylinders of tool steel. The first and third views show pieces compressed on an ordinary press of this type, the machine being used to the limit permissible, without risking breakage; whereas, the cylinders in the second and fourth views are compressed on the same press when equipped with the safety fly-wheel.

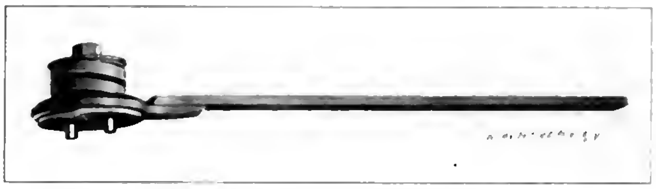


Fig. 3. Friction Wrench for Tightening Nuts in Fly-wheel

Fig. 4. Friction Wrench with Worm and Worm-wheel Drive, used for Large Sizes of Presses.

The driving device shown in Fig. 6 has also several points of interest. This differs considerably from that found in the old type presses. The fly-wheel on the older type serves at the same time as friction driving wheel, and as accumulator of energy. For this reason it was necessary to use large friction disks for turning the fly-wheel, and furthermore the whole driving device of the presses had to be arranged largely above the press. The mounting of the driving disks and the renewal of the leather covering was therefore rather difficult, so that this work was only done in cases where it became impossible to work further with the press. In the machine shown, however, the fly-wheel is used only as an accumulator of energy and the friction driving wheel *E* is separated from it, as shown in Fig. 6. The driving wheel is connected with the fly-wheel by means of pins *F* which pass with a free fit through holes in the fly-wheel. When the driving wheel *E* is rotated, the fly-wheel and the spindle which is connected with it are turned, and the ram is lifted or lowered as the case may be, and while the old presses are provided with

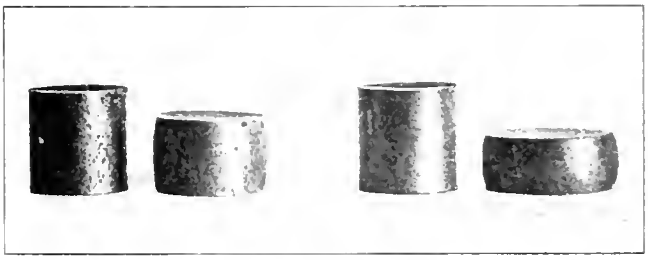


Fig. 5. Comparison of Capacity of Presses having Ordinery and Safety Fly-wheels.

large driving disks placed on movable shafts, it is possible in this design to arrange for smaller driving pulleys and fixed shafts on both sides of the press, as shown in Fig. 6. The control of the machine can be made simpler and more positive than in the old press. As indicated, the movement of the controller handle *P* is transmitted to a shaft provided with two arms *R*, having gear segments at their ends. (See detail view in upper right-hand corner, Fig. 6.) These segments mesh with other segments on arms attached to cams *K* and *O*, which in turn work against cam surfaces on the ends of bushings placed on the ends of the pulley shafts. By means of small springs the pulleys *L* and *H* are always held out of contact with the driving wheel *E*, but when the handle *P* is gripped by the operator and its shaft turned so that the segments *K* and *O*, with their cams, are brought against the cam surfaces on the bushings on the end of the pulley shafts, either one of the pulleys *H* and *L* are easily moved against the driving wheel *E*. When the controller handle is permitted to return to its original position, the pulleys *H* and *L* immediately move away from the driving gear. This driving device gives an easy and absolutely safe control of the machine. The cam bushings on the ends of the pulley shafts are held in place by set-screws, so that it is very easy to turn them at any time to any required angle, and to set them at the correct distance from the cam surface on the segment in order to obtain a good and precise working of the whole driving device.

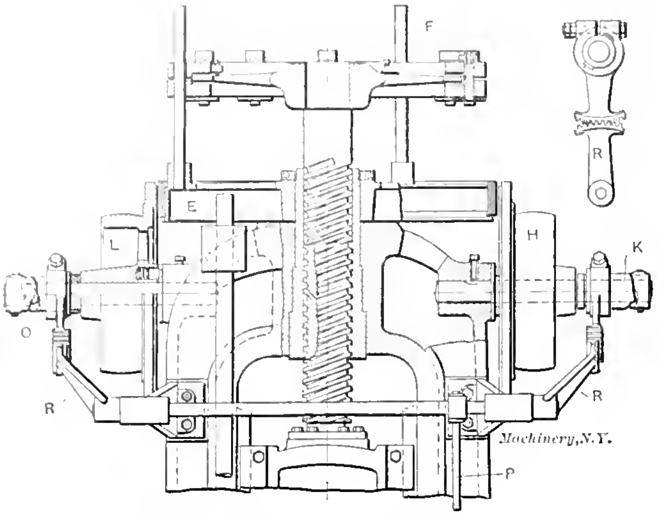


Fig 6. Section of Fly-wheel and Driving Arrangement

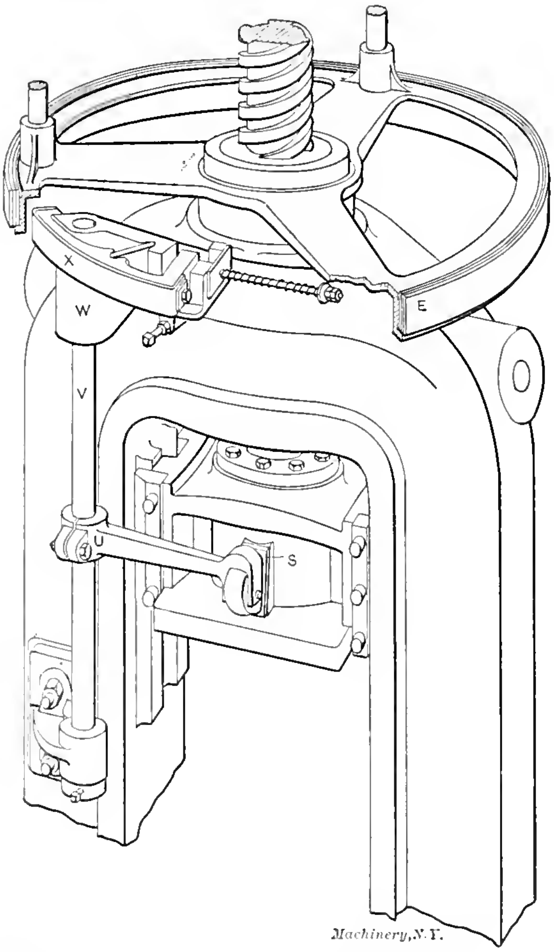


Fig. 7. Design and Action of Brake.

Another interesting feature of these presses is the arrangement of the brake for the movement of the driving pulley, as shown in Fig. 7. The oblique surface *S* on the ram of the press controls, through a roller, a lever *U* on the shaft *V*, which in turn carries the brake *W*. The part *X* of this brake is covered with leather, and acts upon the inner rim of the driving wheel *E*. The lever *U* can be set at any required place on the shaft *V* by means of the clamping arrangement shown. By this arrangement the ram can be stopped at a predetermined point, according to the setting of the lever *U*. The working of the brake is so precise that it is possible to control the movement of the ram within 1/16 inch, and it is therefore possible to use the smallest strokes with precision. The advantage of the brake is not only the precise control of of the ram, but also the added security to the operator.

* * *

TEMPER COLORS, AND TEMPERATURES AND COLORS FOR HARDENING.

The following tables of temper colors, and temperatures and colors for hardening are published in a booklet issued by the Halcomb Steel Co., Syracuse, N. Y., and Chicago, Ill. The temperatures tabulated are a result of personal investigations made by Mr. Garson Myers, manager Chicago branch; a gas furnace equipped with a pyrometer was used. After the records were made they were tested by two experienced tool steel hardeners, one using an electric heating furnace with a pyrometer and the other a magnetic heating furnace also connected with a pyrometer. Neither knew of the other's work, but there was an astonishing uniformity in the results of their independent investigations, corresponding very closely to the figures obtained by Mr. Myers. The company feels that it can without reserve or hesitation recommend that the temperatures and colors are absolutely reliable, having been twice verified by independent workers.

HEAT TEMPERATURES AND COLORS FOR HARDENING.

Degrees C.	Degrees F.	Colors.
400	752	Red heat, visible in the dark.
474	885	Red heat, visible in the twilight.
525	975	Red heat, visible in the daylight.
581	1077	Red heat, visible in the sunlight.
700	1292	Dark red.
800	1472	Dull cherry red.
900	1652	Cherry red.
1000	1832	Bright cherry red.
1100	2012	Orange red.
1200	2192	Orange yellow.
1300	2372	Yellow white.
1400	2552	White welding heat.
1500	2732	Brilliant white.
1600	2912	Dazzling white (bluish white).

The heat and temper colors to which tools should be drawn were contributed by a hardener and temperer of long experience, working on all grades of tool steels, and they also are considered to be perfectly reliable.

HEATS AND TEMPER COLORS OF STEEL.

Degrees C.	Degrees F.	Colors.
215.6	420	Very faint yellow.
221.1	430	Very pale yellow.
226.7	440	Light yellow.
232.2	450	Pale straw yellow.
237.8	460	Straw yellow.
243.3	470	Deep straw yellow.
248.9	480	Dark yellow.
254.4	490	Yellow brown.
260.0	500	Brown yellow.
265.6	510	Spotted red brown.
271.1	520	Brown purple.
276.7	530	Light purple.
282.2	540	Full purple.
287.8	550	Dark purple.
293.3	560	Full blue.
298.9	570	Dark blue.
315.6	600	Very dark blue.

ITEMS OF MECHANICAL INTEREST.

MANGANESE STEEL RAILS.

Within a few months after the elevated division of the Boston Elevated Railway Co. was open for traffic in June, 1901, it was found that the rails on the curves would wear out at a very rapid rate, and the question of maintenance and the cost of rail renewals became a very serious problem. It has been found, however, that manganese steel rails are far superior to ordinary bessemer rails, even when the difference in price is considered, and the accompanying illustrations, Figs. 1 and 2, will give a comparison of the tremendous difference between the wearing qualities of the two classes of rails. In Fig. 1 is shown an ordinary bessemer rail used for 44 days, the lower profile line showing the extent of the wear in this time, while in Fig. 2 is shown a manganese steel rail, which has been in use for 6 years, 3 months and 7 days, and is still in service. No better evidence than this could be shown of the superiority of the manganese steel rail.

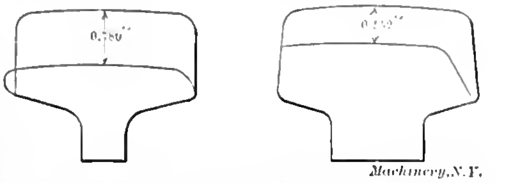
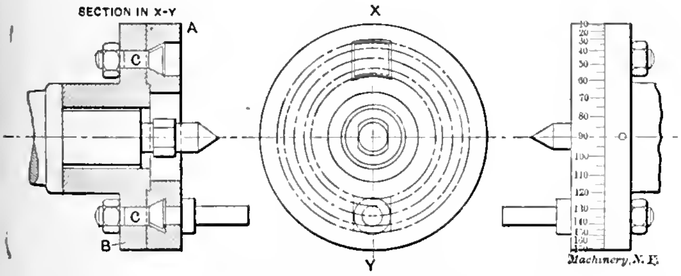


Fig. 1. Ordinary Bessemer Rail after 44 Days' Service on Curve near Park St. Station, Boston Elevated Railway.

Fig. 2. Manganese Steel Rail after 6 Years' 3 Months' and 7 Days' Service. Rail still in use.

FACE-PLATE CONSTRUCTION FOR THREADING LATHES.

The accompanying illustration, taken from the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, issue of August 25, 1908, shows an interesting development of face-plate arrangement for threading lathes, brought out by the firm of Ferdinand Pless, Fechenheim, a. M., Germany. The face-plate is intended for facilitating the cutting of multiple threads in the lathe. As seen from the illustration, it consists of two parts, *A* and *B*, the part *A* being free to be rotated in relation to the part *B* when the bolts *C* are loosened. The driving pin for the lathe dog is attached to the plate *A*, and in cutting multiple threads, when one thread is finished, the bolts *C* are simply loosened, and the plate *A* turned around in relation to the spindle of the machine an amount corresponding to the type of thread being cut; thus, for instance, if a double thread is cut, the plate *A* is turned around one-half revolution, or 180 degrees; for triple thread, 120 degrees; for a quadruple thread, 90 degrees, etc. The periphery of plate *A* is graduated in degrees, and a zero line provided on plate *B*, so that the required setting is very easily obtained. On lathes which are constantly used for thread cutting the advantage of an arrangement of this type is very evident, as it saves employing any of the more or less cumbersome methods in vogue for moving the work in relation to the tool when cutting multiple threads.



Face-plate to facilitate the cutting of Multiple Threads in the Lathe.

NEW TYPE OF MILLING CUTTER.

An interesting milling cutter especially intended and made for fluting locomotive main and side rods, and for milling large keyways in axles, has been devised by Mr. T. R. Hellgren, of the Aurora shops of the Chicago, Burlington & Quincy Railroad. A general view of the cutter is shown in the half-tone Fig. 1; and the line engraving Fig. 2, shows the dimensions for a 9-inch diameter cutter with 2½-inch face. It will be seen that the characteristic feature of the cutter is that every alternate full tooth is cut on a right-hand and left-hand spiral, respectively, and one-half tooth is cut in between every two full teeth, this tooth being on the same spiral as the full tooth in front of it. While this cutter will be rather expensive to manufacture, it is evident that it possesses a cutting action far superior to that of cutters having the teeth either straight across the face of the cutter, or all inclined to the same spiral angle. The inventor has applied for a patent on his idea, for which he claims that the greatest advantage is that in the first place the work is not struck by any two points on the same tooth at the same time, thereby overcoming the objection to cutters with straight teeth, and secondly that no severe side strains are produced on the arbor as is the case with cutters having spiral teeth in one direction only.

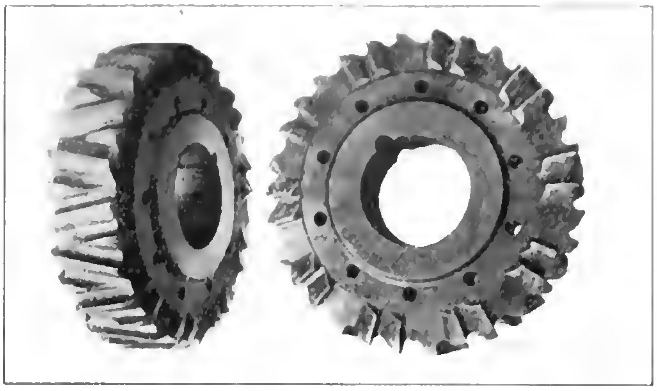


Fig. 1. General Appearance of Hellgren's New Type of Milling Cutter.

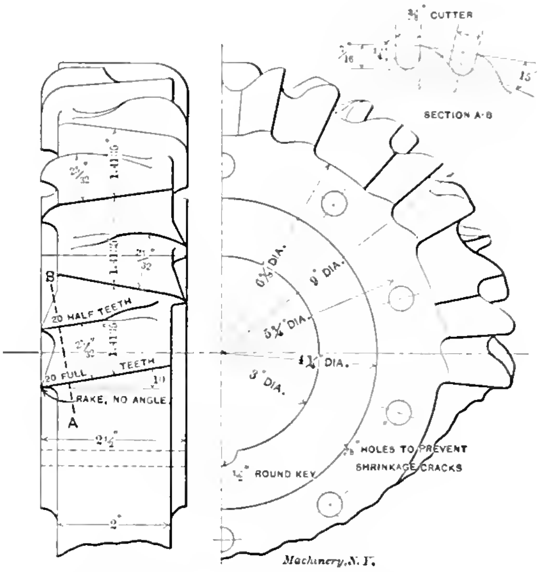


Fig. 2. Detail Drawing of New Type of Milling Cutter.

* * *

An ingenious and interesting use of the telautograph—an instrument for reproducing writing at a distance, invented by Prof. Elisha Gray—was made by a number of New York daily newspapers to bulletin election returns. In this instrument the operator's pencil is connected to levers and the motion of writing is reproduced by similar levers at the receiving station, the receiving pencil making an exact copy of the writing, sketches, etc., made at the transmitting station. The reproducing instruments in the bulletin machines were placed in the focus of the lantern so that the writing was thrown onto screens, magnified many times and legible several hundred feet away. The scheme was eminently satisfactory, there being no loss of time between the receipt of the news and the preparation of copy, as is the case with the ordinary projector using the usual style of copy. Moreover, there was the interest of following the movements of the pencil on the screen, noting its hesitation when spelling such words as "Onondaga," and the other human characteristics with which it was uncannily endowed.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

TOOL-MAKING AND MANUFACTURING.

It is a matter of common knowledge with our readers that interchangeable manufacturing is *cheap* manufacturing, when compared with the old-time method of making the parts of machines without the use of jigs, fixtures and gages. That the identical parts of modern products, such as rifles, revolvers, watches, typewriters, and hundreds of other articles of common use are interchangeable, is really an incidental feature of the jig and fixture system—a very valuable feature, it is true; but not the fundamental reason for its general use, as some well-informed mechanics seem to think. Two machines, or a dozen, could be made from the same drawings without any of the identical parts being exactly the same, or anywhere near it, as a tool-maker would regard the measurements; and all these machines would give perfect satisfaction. If only a limited number of a given type of machine or tool is to be produced, it is a serious problem to discover whether it would be best to build jigs and fixtures for so-called interchangeable manufacture, but really cheap manufacture, or to avoid the heavy tool-making expense and build the product "every one like itself." The manufacturing cost by the latter method would be greater than by the use of jigs, fixtures, press tools, and other features of modern manufacturing, but the over-head expense of that equipment might swamp the enterprise should the output be comparatively small.

A valuable tool was patented a few months ago by a tool-maker, which may be used widely, but is not likely to be sold in large numbers. By this we mean that it is not a tool that every mechanic would want, but one that almost every up-to-date shop would supply in its tool-room when its merits became known. The inventor and his promoters are at a stand-still as regards manufacturing, because of the lack of the comparatively large capital required for the elaborate equipment which they believe should be provided. Being tool-makers, they are unable to entertain the idea of producing the tool by any other than the familiar, exact system.

If every manufacturing business in successful operation to-day had been obliged to start with a first-class equipment, doubtless many of them never would have reached their present state of development. It is quite feasible to turn out many products by a system that is not strictly interchangeable, but which answers practical purposes very well, save that the manufacturing cost cannot be made as low as by the interchangeable system when the tool equipment has once been provided. In the tool above referred to, the matter of interchangeability of the parts and of exact accuracy is not important, save in one detail; and this can be readily provided for by well-known processes familiar to mechanics.

The training of a tool-maker tends to make him ignore the common methods of manufacture, wherein extreme precision and interchangeability are virtually sacrificed to practical conditions that must be met if the business is to be started without heavy initial outlay. After a business has been successfully launched, the refinements of modern manufacture can be developed with profit; but it is better to start without them than not to start at all.

* * *

METHODS OF REWARDING LABOR.

At the annual convention of the National Machine Tool Builders' Association in New York, a paper was presented by Mr. Harrington Emerson on various methods of paying employes, with a statement of the advantages and disadvantages of each to the employer and the employe. Mr. Emerson has developed a system under which labor is individualized, each man being rated according to his personal efficiency. A standard day's work is established by rigid investigation, and the employe's personal efficiency is determined accordingly. The skilled and rapid worker does more, and is paid more, than his less skillful and slower shopmates.

The discussion following the paper was animated, the general sentiment seeming to be that no one could determine a standard for a day's labor, and that the determination of a standard was the crux of the problem. Conditions and practices are constantly changing and improving, and a full day's work now may be a small product a year from now. The tremendous influence of the discovery of high-speed steel was quoted to show what changes in machine work are made by inventions and discoveries, and it was mentioned that some kinds of lathe turning now require only from one-half to one-quarter the time required with ordinary carbon steel tools.

Students of economics realize the practical need for an equitable wage system, but they cannot help deprecating attempts to reward labor according to its production. In the last analysis it seems to us that the schemes devised for stimulating labor production are merely thinly disguised plans for getting more out of the men for a *living wage*. Labor may profit temporarily by the introduction of premium, bonus or piece-work plans, but eventually all wages are determined by the law of supply and demand, and will be at best a living wage only, under our present economic system. The man who works with his hands and brain, without ownership in the enterprise, must expect that the larger profit on his product will be absorbed by others, who, through their ownership of land and public or private utilities, occupy strategic positions. The workman is benefited by increased production, but not directly, except temporarily.

The competitive system pits one man against another, and increases production; but it also pits one concern against another, and tends to reduce the selling prices of the product. It is doubtful, in the end, if either the employe or the employer profits materially by greatly increased production per capita, except as the general standard of living is raised. The net result of the last century of progress, during which machine tools, railroads, steamships, telegraphs, telephones and hundreds of other great wealth producers have originated, is that mankind eats better, sleeps better, lives better than before; but the great majority is not released from the necessity of constant labor. Working people simply get more for what they do—and require more.

We hope that the appeal to selfishness made by all the present plans for rewarding labor, will some day give way to methods addressed to the nobler characteristics of mankind—pride in production and quality, sense of civic duty, a keener understanding of one's duty to his fellowmen and of the need for cooperation, and the application of the golden rule in all its bearings. But before this millennium will arrive, both employer and employe must handle the question from a totally different standpoint from what they do at present.

FORFEITURE OF PATENT RIGHTS.

E. C. SMITH.*

The writer has read with interest the editorial in the November issue regarding patented inventions which are wilfully kept dormant or suffered to remain so, but the sentiment regarding forfeiture is not concurred with. In the first place, an invention is not one of the "bounties of nature," nor can it be properly considered or treated as such. In that category are the natural elements and their various combinations in the mineral formations, animal and vegetable life, and in physical formations of the earth. They are the sensible and tangible products of nature's creative action, and we believe them provided for and essential to the welfare and conservation of the race. In this aspect it is inexpedient that they should be subject, either in part or as a whole, to exclusive privilege for a few, or their use and enjoyment limited by a few.

Inventions are thought creations and their corporeal embodiments are the visible and tangible products of creative mental acts. They are mental progeny just as children are physical progeny, and are therefore akin to the individual. The inventor's right to his invention is therefore deemed inherent and inviolable.

That patents were originally devised to accord the patentee exclusive use of the patented art or article, for the purpose of assuring him a reasonable reward for his enterprise is unquestionably true, but it must be remembered that the first patents were granted largely, if not almost exclusively, for importation of industries rather than for the discovery or creation of new arts or devices. With the development and growth of individual inventive resource there has also developed the sentiment that the products of such individual effort essentially belong to the individual. Inasmuch as invention is incorporeal property and unsusceptible of precise definition like real and personal property, special means were devised for its protection and the protection of the inventor's rights. To conserve these rights the patent system has been established. Under this system the public enters into a contract with the inventor whereby his rights may be defended. To secure his means of defense—the letters-patent—the inventor must disclose his invention completely. This disclosure, as I understand it, is not so much for the purpose of enabling others to practice that particular invention as to enlighten them as to the mode of practice, opening up new fields of endeavor and directing inventive thought in new lines.

It must be admitted that a patented invention even though kept dormant for seventeen years, is more valuable to the public than if unpatented and undisclosed. If the result secured by the invention is peculiarly desirable then the desire to secure the same or similar results by other means will whet the inventive wit the keener.

Laying aside academic considerations, there are practical and cogent reasons for not causing forfeiture of patents on account of non-practice of inventions. It sometimes happens that the invention disclosed in a patent containing broad, basic and therefore valuable claims, is in a form less desirable for use and less economical of production than that of a subordinate patent. It is not unusual for the proprietor of one patent, the invention of which is practiced, to have several other patents covering less desirable forms of construction which are not practiced.

Many inventors diligently pursue the commercial exploitation of their inventions without success for the greater part of the life of their patents. Surely it were unfair to deprive the generic inventor of his basic claims unless he manufactures continuously for seventeen years a device that is undesirable and expensive, simply because it is the patented embodiment of those broad claims. Equally unjust would it be to compel a proprietor of several patents to manufacture several alternative forms of apparatus for seventeen years, with all the attendant cost for plant, material and labor, simply to maintain those patents. Superlatively unjust were it to deprive a man of his patent rights because of failure to practice his inventions, when that failure is due to adverse circumstances.

Any question as to "best use" would start a train of technicalities in an action for forfeiture or in defending against an action for infringement more involved than any of our present day patent litigation is cumbered with, and the merits of a case would turn on matters of opinion rather than fact. The only way in which the justice or injustice of such forfeiture or defence against infringement could be ascertained would be by a hearing before some tribunal which would only slightly mitigate and not entirely correct abuse. How many grasping corporations and enviously malign individuals would harry poor inventors with actions for forfeiture? How much incentive would one have to invent were there hung above his head the Damoclean sword of forfeiture proceedings?

The path of the inventor is sufficiently precarious as it is, without adding further obstructions and detriments, and seventeen years is a short period to wait, even for the inventor who derives satisfaction from withholding his patented device from public use. The rights of the public are better cared for with respect to patents than ever before. To secure a patent an inventor must exercise diligence in applying for a patent and in prosecuting his application. But when his patent has been obtained, the inventor is secure in his exclusive rights, of which he can be divested only by due process and because of defective title, which must be conclusively proved.

The world owes much to the inventor, and if some wanton vagary leads him to exercise his prerogative under letters-patent, to the extent of refusing the public the use of some one invention, it, in turn, should remember the multitude of inventions, the use of which it has had, and not overlook the sundry inventions it has wantonly filched or ruthlessly wrested from the inventor.

[The arguments presented by our correspondent in favor of the rights of inventors to protection in non-worked patent rights, are undoubtedly correct from a legal point of view, and that we concur with this opinion was plainly stated in the editorial referred to. From an ethical point of view, however, it appears that the inventor who prevents others from using an invention which he will not or cannot use himself, resembles very much the dog in the manger. In the case of an invention it is not merely a question of it being a creation of a certain individual, and that he, therefore, has an absolute and exclusive right to the profit afforded by the patent, because, during the seventeen years a patent is in force, a number of other inventors may independently work out and invent practically the same appliance or method as has formerly been invented; and while in the case of patents obtained and *used*, the first inventor naturally must be protected on account of priority, it is difficult to see his moral right to prevent others from using independently worked out ideas which he does *not* care to *use* himself. Besides, the question hardly involves inventors as individuals, because it is hard to conceive of an inventor who would acquire a patent and refuse to work it if it had any commercial value. It is much more a question of the ethics of the not unusual practice of corporations of buying up patents from individual inventors and keeping the patent dormant because it may interfere with some inferior product of theirs which they prefer to continue to place on the market. We do not think that the requirement of working a patent within a certain number of years after being granted would involve a hardship for inventors as individuals. On the contrary, it is likely that such a clause would prove beneficial to the real inventor's interests. That the idea is not new and that the principle stated is recognized as correct is evidenced by the fact that the patent laws of most European countries contain a clause requiring the patent to be worked within a certain number of years after being granted. If the inventor or others to whom he may assign the rights to his patent do not care or do not find it profitable to make any use of the patent, it is either impractical, and in such a case there could be little reasonable objection to infringement; or it is held out of use for commercial reasons which are not commendable, and thus actually work an injury to the very inventor who is supposed to be protected. It must be understood that the question raised in the editorial referred to was one not of whether the present law was correctly interpreted, but of whether the law corresponded to true moral principle.—EDITOR.]

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ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

At the convention of the American Street and Interurban Engineering Association, at Atlantic City, last October, it was proposed that street car wheels should be made without flanges, and the flanges instead placed on the rails. Many plausible arguments were brought forward to show the superiority of such a system over the present one.

According to *Page's Weekly*, the company formed last summer at Hamburg for utilizing the forces of the tides near the mouth of the Elbe, to which reference was made in the June issue of MACHINERY, has raised a capital of $750,000, and various buildings connected with the undertaking are now in course of completion at Cuxhaven. It is intended to use the tides for the production of electric power for factories.

It is stated by the *Scientific American* that a company has been formed for boring another tunnel connecting Switzerland and Italy under the Alps. This tunnel will begin at Martingly in Switzerland, and come out at Courmayeur, Italy. It is planned to be 28 miles long, and is expected, it is said, to be completed in three years. So far, however, it exists only on paper, and like many of the engineering projects in the way of tunneling of late years, may remain in that state.

Among the concerns mentioned in our November issue as having joined the National Machine Tool Builders' Association was that of the Powell Tool Co., Worcester, Mass. As published it appeared as the Powell Planer Co., and as such was erroneous. The Powell Planer Co. was originally the name of the Woodward & Powell Planer Co. and the name is held to be the property of the said company. The Woodward & Powell Planer Co. has been a member of the National Machine Tool Builders' Association for the past six years.

It is stated in the monthly *Consular and Trade Reports* for September, issued by the Department of Commerce and Labor, that in extensive competitive tests carried out in France, a decrease in consumption of gasoline, amounting to 53 per cent per ton-mile, as compared with the results of similar tests performed in 1907, has been achieved. Sixty per cent of all the cars which entered the race made the entire tour, which occupied twenty-seven days, during which 2,175 miles were covered. The total average consumption of gasoline per ton-mile was 0.074 quart as compared with 0.157 quart in similar tests undertaken in 1907.

Remarkable steam economy was shown by a stationary, self-contained engine and boiler set of the portable engine type, built by the firm of R. Wolf, of Magdeburg, Germany, and recently tested by Professor M. Gutermuth, of Darmstadt. The tests are reported in the *Zeitschrift des Vereines deutscher Ingenieure* of October 3, 1908. When the engine tested developed 103 H.P., it showed a steam consumption of only 8.86 pounds per horse-power-hour, and a coal consumption (using coal of 13,900 B.T.U. per pound) of 1.06 pound per horse-power-hour. This engine works on superheated steam, and is compounded, having both cylinders seated in the smoke box, and therefore jacketed by the hot flue gases. The superheat at the entry into the high-pressure cylinder averaged 236 degrees F., and after having passed through a reheater, the steam entered into the low-pressure cylinder with a superheat of 200 degrees F. The mechanical efficiency of the engine alone varied from 93 to 95 per cent.

Consul Thomas H. Norton, of Chemnitz, Germany, states that electric steel melting furnaces are becoming more and more used at German iron works and that one important steel works, engaged in the production of tool steel products, intends to replace its whole battery of crucible furnaces by one large electric melting furnace, the cause for the change being the reduction of cost possible. The whole equipment consisted of thirty-two furnaces, each containing six crucibles, with a capacity of 77 pounds. These are to be replaced by an electric furnace capable of holding a charge of 2,200 pounds. The advantages of the electric process are stated briefly as follows: cheaper raw material can be employed in place of the more expensive Swedish iron formerly required; in melting quantities of one ton at a time, it is possible to produce more homogeneous masses of a well-defined grade; and, finally, the molten steel leaves the furnace at a much higher temperature than when prepared in crucibles, and is therefore in a more liquid condition, and is easily transferred to the ordinary ladles.

An interesting offer has been made by Sir Christopher Furness, of the Middleton Ship Building Yard, England. This works met last year with a loss of about $85,000, largely due to labor troubles, and as Sir Christopher realizes the injury both to the works and to the employes of conditions bringing about such losses, he has offered the yards for sale to the trade unions at a price to be decided upon by independent assessors. If this offer is not accepted, he offers an alternative proposition, agreeing to issue to the men preferred shares in the company, to be paid for by a deduction, from week to week, of five per cent of the wages. These shares would receive a fixed rate of interest of four per cent, whether the common shares received any dividend or not, and when the common shares receive five per cent as a yield on the capital investment, the balance of the profit is to be distributed between the common and the preferred stock. This experiment will bear watching, as it is a step toward that cooperation in the industries, which may be inevitable, in some form or other, in order to obtain industrial peace within industries organized on a large scale.

At the time of the discovery of the Taylor-White process of treating tungsten steel so as to greatly increase its cutting qualities, it was asserted in one of the English engineering journals, that the discovery was nothing new. Certain steel makers in England had anticipated the discovery, but, strangely enough, had not realized the commercial importance of the steel, and had taken no steps to put it on the market, contenting themselves with its use in their own work. The same discovery appears to have been made in the United States. A certain manufacturer of files and rasps had developed a high-speed steel for cutting files some time before the discovery of the Taylor-White process. It was not, of course, as efficient as present high-speed steels, but was far in advance of the carbon steels or air-hardening steels then in general use. In none of these cases does it appear that the importance of the discovery was recognized until Mr. Taylor and Mr. White demonstrated the tremendous increase in machine shop production that could be realized by using this steel for lathe and planer tools. A true discoverer is one who recognizes the value of his find and who makes it known to others so that there can be a common benefit derived from it.

The pyrometer for hardening and tempering steel is coming into general use. It does away with guess-work and enables the hardener to exactly reproduce a desired hardness and temper with a given brand of steel, as many times as is desired and whenever wanted, but the pyrometer is still an unknown instrument with many hardeners who are nevertheless doing good work without it. Being deprived of a pyrometer does not mean that the hardener is necessarily obliged to work by "judgment" and guess-work entirely. A simple test can be made of a brand of steel which will soon develop the proper temperature, as determined by the eye, which gives the best results. This test, mentioned in a booklet issued by the Halcomb Steel Co., Syracuse, N. Y., consists simply in taking small samples from a bar of steel and applying two or three different hardening heats. After hardening, break the samples and note the fracture. The heat

producing the finest grain, obviously, is the proper heat at which to harden that grade of steel. This, of course, applies to carbon tool steel. In this connection it may be mentioned that the Union Twist Drill Co., Athol, Mass., applies the fracture test to every bar of tool steel used. Thin disks are sawed from the ends of each heavy bar, and are hardened at the standard temperature which repeated tests have determined to be the best hardening temperature for the brand of steel employed. If the samples do not show the required fineness of texture in the fractures, the steel is rejected. It is no uncommon occurrence to find bars of steel which show different grades of fracture at opposite ends.

In the April, 1908, issue the use of an ordinary magnetic compass for ascertaining proper hardening heats for carbon steel tools was described by Mr. George T. Coles, with an illustration of use. This simple method has attracted much favorable attention, and is being practiced by many tool hardeners who have found it convenient and reliable. An extension of the idea has been patented in England, which has a certain advantage over the compass method. The drawback to the compass method is that the determination of the heat is in a sense, negative in character, the operator not receiving a definite warning the instant when the proper heat has been reached. All he knows is that when the tool has reached the hardening temperature it no longer attracts the compass, but he has no proof that it is not many degrees higher, except the heat appearance. This defect is overcome in the device referred to. An ordinary horseshoe magnet is provided with iron wire extensions to the poles, the poles being drilled axially before hardening and magnetization. A small horseshoe magnet will attract and hold small objects applied to the ends of the wire extensions, even though they are three or four inches in length. The pieces to be hardened are thus held magnetically at the extremity of the iron wire extensions in a blow-pipe flame over a jar of brine until they have acquired the proper hardening heat, when they drop off into the brine, having lost their magnetic attraction for the wires. The use of the wires, of course, is simply an expedient to avoid heating the magnet and causing destruction of its magnetic property, as would surely result if it was inserted in the flame directly. The process is automatic, but, unfortunately, it can be applied only to comparatively small parts, unless large, expensive and cumbersome apparatus is provided.

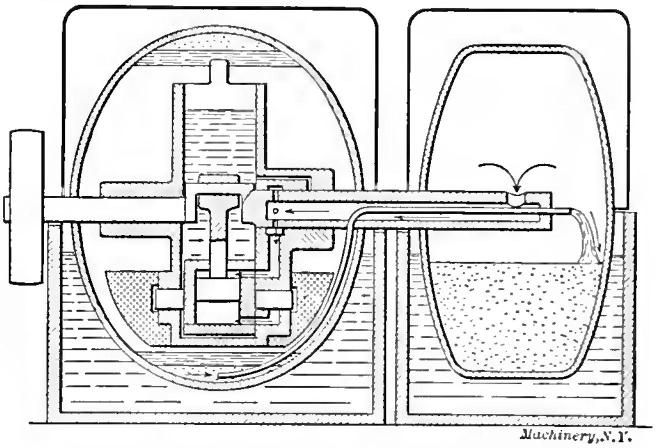
An interesting machine for testing rail wear is described and illustrated in the *Railway and Engineering Review* of October 24, 1908. Such a machine has been a subject of discussion for many years, and many ideas have been proposed, but few, if any, have ever taken practical shape. An exception to this general statement may be noted in the machine devised by the engineering department of the Pennsylvania Steel Co., and exhibited at the recent convention of the American Street and Railway Engineering Association. The apparatus is intended to test the relative wear of rails of different grades of steel. The test is conducted by bolting the rails to a circular cast iron base 20 feet in diameter, the rails forming a continuous circle. On these rails two car wheels, mounted at the ends of a heavy beam rotating on a pivot, are continuously running. A compression spring is mounted on the top of the revolving beam, which can be adjusted so as to exert pressure from zero to about 60,000 pounds on each car wheel. The vertical pressure exerted by each car wheel due to the dead load is about 7,500 pounds, so that by means of this apparatus a vertical pressure of about 67,500 pounds can be exerted on the head of the rails. In addition to the vertical pressure, lateral pressure is also exerted by means of compression springs mounted on the axle of each wheel, the maximum lateral pressure being from 15,500 pounds at 10 R.P.M., to 47,800 pounds at 85 R.P.M. The maximum speed at which the machine is designed to run is 85 R.P.M., which would correspond to a train speed of practically 61 miles per hour. As the conditions under which this machine will test the rails are very similar to those to which rails are subjected in the work, the machine will undoubtedly be of advantage in settling the question of rail wear.

A NEW ICE-MAKING MACHINE FOR DOMESTIC USE.

Scientific American, October 17, 1908.

Nearly all ice-making machines depend for their operation upon the property of certain substances to absorb a large amount of heat when changing from the liquid to the gaseous state. As a rule, anhydrous ammonia is the substance used, and this is forced through a closed cycle consisting of a compression chamber and an expansion chamber. In the latter chamber the ammonia expands into a gas, absorbing heat as it vaporizes. Then it is drawn into the compression chamber by a pump and compressed into a liquid, only to flow back into the expansion chamber and expand into a gas. Thus one chamber of the machine is made cold by the vaporizing ammonia, while the other develops heat because of the compressing of the gas. The heat from the compression chamber is dissipated by a radiator system, while the influence of the expansion chamber can be extended at will by a system of pipes through which brine is circulated.

The difficulty with refrigerating machines as commonly constructed is that long stuffing boxes are necessary to prevent leakage of the ammonia, and the friction developed in these stuffing boxes not only absorbs energy, but generates additional heat. The smaller the machine, the more serious are these losses, because of the pressure that must be maintained, which does not permit the friction to diminish in proportion to the capacity of the machine. For this reason, refrigerating machines for domestic use have not been as economical as those of large plants.



Small Rotary Ice Machine, which requires Little Attention.

Recently a machine has been invented by Prof. Audiffren, of Paris, based on the same principle as the ordinary ice machine, but so designed as to do away with all stuffing boxes, pressure gages, agitators, valves, or anything that would require the attention of an operator. As shown in the accompanying sectional view, it consists of two chambers or drums, which are connected by a hollow shaft. A solid extension of this shaft passes through the larger chamber, and at its outer end carries a pulley, which provides means for operating the machine. The shaft is sealed into the chambers, so that as the pulley revolves, the chambers revolve as well. Mounted to swing freely on the shaft within the larger drum is a small pump, which is kept vertical by means of a lead weight attached to its lower end. The piston of this pump is connected to a crank offset in the shaft, so that when the pulley is rotated, the shaft revolving with it will operate the piston. In the smaller machines the drums are charged with anhydrous sulphurous acid instead of ammonia. The pump serves to draw the gas from the smaller or expansion drum through the tubular shaft, compress it into a liquid, and discharge it into the larger or compression drum, whence it flows back through a pipe leading through the tubular shaft into the expansion drum. Here the liquid evaporates, and is returned to the compression chamber by the action of the pump. In order to provide sufficient lubrication, the pump is kept swimming in oil, the pump being fitted with a reservoir capable of carrying half a gallon of oil. The oil cannot escape, and such of it as leaks out of the pump is trapped and returned to the reservoir. Owing to the rapid rotation of the drum, the liquid acid is centrifugally

thrown against the inner periphery of the chamber, and any oil that leaks into the chamber is centrifugally separated from the heavier sulphurous acid, forming an annular layer within the acid layer. The illustration shows the acid and oil at the bottom and top of the compression chamber. At the top of the oil reservoir is a scoop, which extends upward sufficiently to dip into the oil, but without reaching the layer of sulphurous acid. This scoop collects the oil, causing it to fall back into the reservoir.

The expansion drum rotates in a small tank partly filled with water, and this forms a layer of ice over the drum when the machine is in action.

ELECTRIC HARDENING FURNACES.

C. R. Straube in the *Elekrotechnische Zeitschrift*, August 6, 1908.

In externally-fired furnaces, the heat losses are always considerable, and only a small part of the energy used in heating is utilized for raising the temperature of the metal to be hardened. There is also a disadvantage in employing gas or oil-fired furnaces in that the high temperatures rapidly destroy the crucibles. Electric hardening furnaces, therefore, possess marked advantages for this work over the various types of externally-fired furnaces. The electric furnace described in the following has been brought out by the Allgemeine Elektrictäts-Gesellschaft of Berlin, Germany. A bath of melted metallic salts is contained within a fire-brick crucible, inside of which, at two opposite sides, are fixed electrodes of iron very low in carbon, the melting point of which is higher than that of ordinary steel. This crucible is surrounded by a thick layer of asbestos, which is, in turn, imbedded in a layer of some heat-insulating material, the whole being held together by a steel case. The walls of the furnace are made so thick in relation to the dimensions of the crucible that the steel case of the apparatus may be touched with the hand without injury after having been in operation for 10 hours, at a temperature of 2,370 degrees F.

The soft iron supply conductors to the electrodes are connected to the secondary copper bars of a regulating transformer which transforms the normal voltage to the low voltage (5 to 70 volts) employed in the operation of the furnace. A typical arrangement of the equipment of a large works has the furnaces provided with a hood in a central position, and a quenching tank immediately beside the furnace on one side. By this latter arrangement a change in temperature caused by carrying pieces from the furnace to the water tank is reduced to a minimum. The tank is supplied with heating and cooling coils with steam or cold water, so that the temperature of the quenching bath can be easily regulated.

A pure metallic salt or a mixture of several salts is placed in the crucible and melted by the passage of an electric current. Potassium chloride which fuses at about 1,425 degrees F. is selected for carbon steel; for high-speed steels, barium chloride, which fuses at 1,740 degrees F., is employed. Mixtures of these two salts will give all intermediate temperatures. For low temperatures, say between 400 and 750 degrees F., postassium and sodium nitrates may be used, and for very high temperatures, magnesium fluoride and fluorspar. The salt is melted by a movable electrode and a small piece of arc-light carbon placed in the circuit between one of the fixed electrodes and the movable one. Sparking between the carbon and the movable electrode causes salt immediately adjacent to melt and very soon a circuit is set up through a part of the salt. As the movable electrode is gradually drawn away, it leaves behind a streak of melted salt, which is extended by degrees to the opposite electrode. When this point is reached, the fusion of the remainder of the salt proceeds at a rapid rate. The temperature produced depends on the voltage employed, and may be varied by changing the intensity of the current, which is accomplished by means of a regulating transformer.

Even at a temperature of 2,400 degrees F., attainable in laboratory tests but not usually employed in commercial hardening, the damage to the crucibles of the electric furnace is very small. Working ten hours a day with this temperature, a crucible will last six months, and for ordinary hardening temperatures, fifteen months.

EFFICIENCY TESTS OF MILLING MACHINES AND MILLING CUTTERS.

Abstract of Paper by Mr. A. L. DeLeeuw, read before the American Society of Mechanical Engineers, December, 1908, Meeting.

The design of standard machine tools was for many years, and has been until quite recently, a matter of practical experience, judgment and intuition, and might as well have been called guesswork. Special tools of unusual magnitude were built on somewhat more scientific principles, and this, perhaps, simply because the required dimensions were quite out of the scope of the designer's experience. It was not quite so easy to show judgment about a 6-inch as a 1½-inch lead-screw; and it would not have done at all to make the screw 12-inch just to make sure; though the instances are not at all rare when some machine part, screw or shaft, on some smaller machine was made double the required size, simply to be on the safe side.

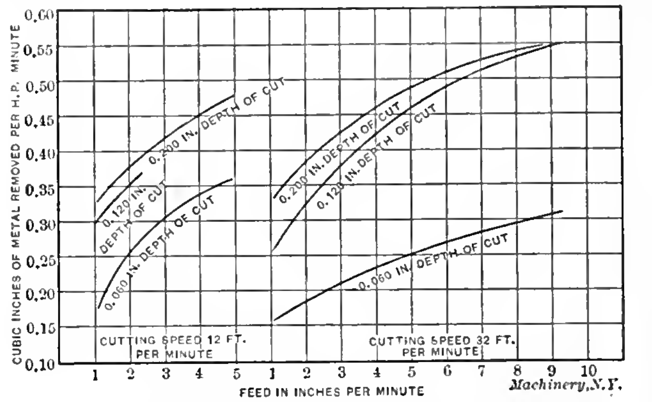


Fig. 1. Work of 1 H.P.-minute, measured in Cubic Inches of Metal removed, for Different Feeds and Cutting Speeds.

This condition was not due to ignorance on the part of designers or inability to apply engineering data, but to the fact that such data did not exist or were not public property when they did exist. Further, there was no inducement for the machine tool builder to spend time and money collecting data, as the tools, as built, filled all requirements to a reasonable extent.

This condition ceased to be satisfactory with the coming of the electric motor into the field of the machine tool builders. At first the wildest and most varied guesses were made as to the size of motor required to drive a certain tool. One builder would supply his machine with a 2½ H.P. motor, while another would equip the same size and style of machine with a 15 H.P. motor. This chaos was made worse by the fact that most purchasers of motor-driven tools would specify the size of motor to drive the machine. One user would condemn the machine tool builder because the 10 H.P. motor was entirely too small, and the next one because a 5 H.P. motor was much too large for the same machine.

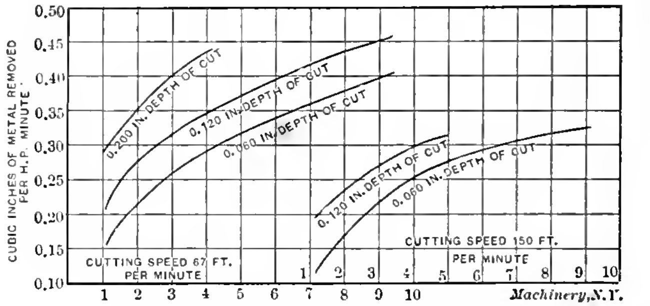


Fig. 2. Work of 1 H P.-minute, measured in Cubic Inches of Metal removed, for Different Feeds and Cutting Speeds.

This brought before the machine tool builder the fact that a machine was not always used to its full capacity and was sometimes badly overloaded. In sheer self-defense the machine builder was compelled to determine for himself the proper size of motor to be put on his machine, and he began to make tests and collect data; but although numerous tests have been made as to performance of machine tools, they have been confined almost exclusively to lathes. All other

machines seem to have been considered as following the lathe in cutting characteristics.

The author of the paper here abstracted therefore found it necessary to undertake a number of tests directly applied to milling machines, in order to collect data preliminary to the designing of a line of horizontal and vertical milling machines for the Cincinnati Milling Machine Company.

Specifications of Milling Machine Tests.

The main points to be settled were:

a. How much metal shall a machine of given size be capable of removing?
b. How much power is required for this work on existing machines?
c. Is it possible to improve on the efficiency of present machines and still produce a commercially successful machine?
d. How much power is required for the feed?
e. What is the efficiency of the feed mechanism?

The first question was a point to be decided by the sales manager rather than by the engineer, as it was greatly a matter of competition. As is quite usual in the design of a new line of machines, the desired capacity was placed somewhat higher than that of other makes of similar machines. To determine how much power was required to remove a given amount of metal, tests were made on various makes of machines. The metal to be cut was in all cases, both in these tests and in those to be described later, steel of the following specifications: carbon contents, 0.16 per cent; tensile strength per square inch, 52,378 pounds; limit of elasticity, 30,313 pounds.

The test blocks used were 18 inches long, 5½ inches wide and 5½ inches thick. The ends were milled to provide means for holding the block on the table of the milling machine. In all tests a spiral cutter with nicked teeth was used, 3½ inches in diameter, 6 inches face, and for a 1½-inch arbor. The cutter was driven by a key, and made of high speed steel. All tests were made by driving the machine by an electric motor, belted to the machine. The object was to have all conditions as near as possible to those under which the majority of milling machines have to run, the only difference being that the belt was nearly horizontal instead of vertical. In testing the efficiency of machines in this way, the belt must be considered part of the machine. The power consumed was ascertained by reading of ammeter and voltmeter, the amount of metal removed, by measuring width and depth of cut, and the amount of feed per minute, was computed from the gearing.

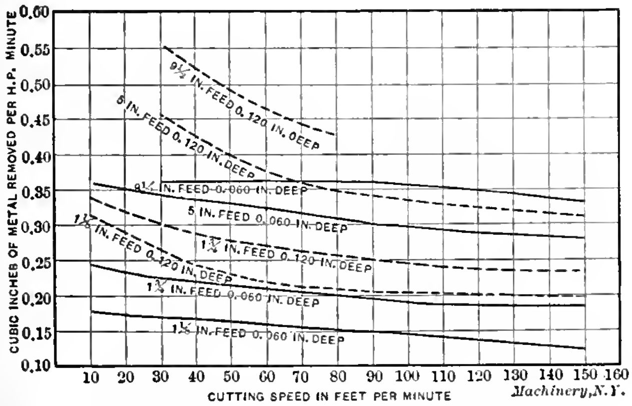


Fig. 3. Work of 1 H.P.-minute, measured in Cubic Inches of Metal removed, for Different Feeds and Cutting Speeds.

These preliminary tests showed considerable differences in the efficiency of different makes of machines; that is, one machine would cut considerably more material than another for a given amount of horse-power developed by the motor. They also showed that the efficiency of these machines was relatively low as compared to the lathe. This latter might have been expected considering the nature of the cutting tool. As the main problem in a machine shop is not to save power, but to get the greatest possible output, this lack of efficiency cannot be held up against the milling machine as a type, for its other peculiarities make it highly efficient as a producer of work. The fact that one make is so much more efficient than another is of great importance, however. It shows that the less efficient machines:

a. Use a needlessly large amount of power.
b. Have less capacity than they might have for removing metal.
c. Use a large amount of power constantly for the purpose of breaking down the machine.

It follows that it should be the aim of the designer to produce a machine of the highest possible efficiency as a power transmitter, because

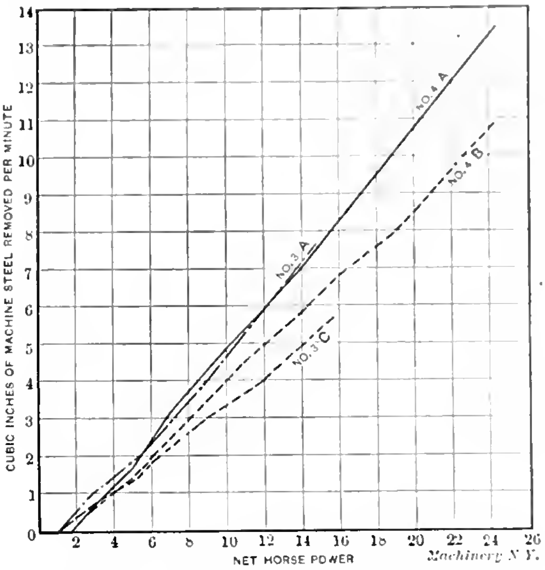


Fig. 4. Diagram showing Relation between Horse-power required and Metal removed.

a. This increases the capacity of the machine.
b. It insures long life and freedom from repairs.
c. It is economical in the use of power.

This high efficiency requirement stands by itself. It must be supplemented, however, by other good features, such as convenience, etc. The main features aimed at, and considered essential to high efficiency, were the following:

a. Absence of combined torsional and bending stresses in shafts.
b. Absence of torsional stresses in shafts subjected to heavy loads.
c. Moderate gear speeds.
d. Moderate shaft speeds.
e. Minimum number of gears in action.
f. No gears rotating, which are not required for the transmission.
g. Tumbler bearing anchored solidly, and not merely hung from a lever.
h. Pulley shaft relieved of belt pull.

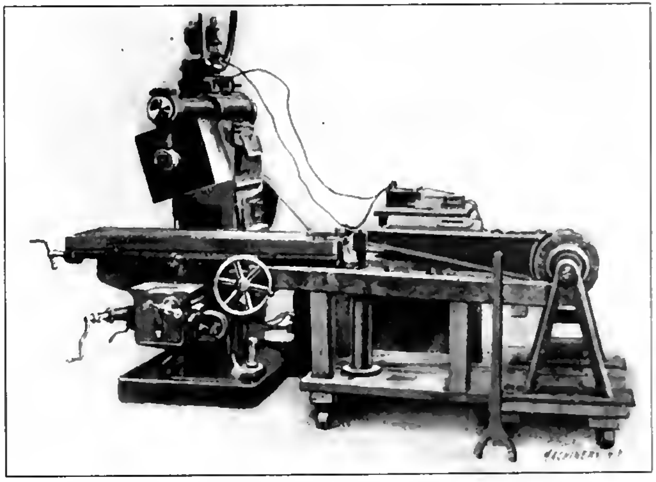


Fig. 5. Apparatus for Testing Efficiency of Feed Mechanism.

Final Tests.

More complete tests were made when the machine designed along the lines mentioned was completed. These tests were of three kinds:

a. Tests determining the amount of metal removed per horse-power.
b. Tests determining the efficiency of the feed mechanism.

b. Tests determining the efficiency of the feed mechanism

c. Tests determining the efficiency of the driving mechanism.

Power Required to Remove Metal.

The same motor and belt were used for all cutting tests. A series of tests was made with a depth of cut of 1/16 inch; then with a depth of 1/8 inch; then 3/16 inch, 1/4 inch, and 3/8 inch. This complete test was repeated four times. The cutter was sharpened in the ordinary way before starting a complete series of tests, and not resharpened during the test. The same cutter, resharpened, was then used for the next machine. For each depth of cut, a number of different feeds were used.

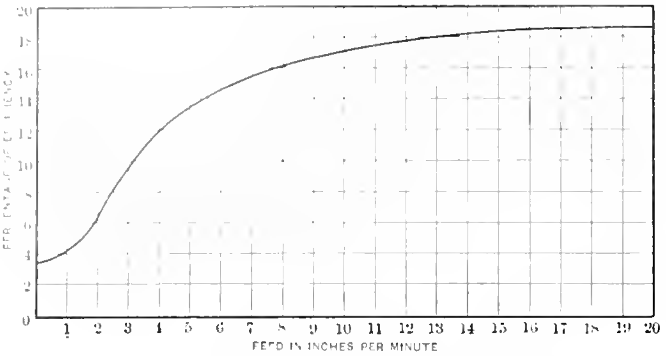


Fig. 6. Curve showing Efficiency of Feed Mechanism.

The amount of power required to remove a given amount of metal varied with the speed, depth of cut and feed per minute, and seemed to have a tendency to the minimum when the section of the chip removed per tooth approached most nearly a perfect square. Figs. 1, 2, 3, and 4 show curves giving relation between power required and metal removed under different conditions of speed, feed and depth of cut. The fact that the power required changes with these conditions of feed, speed and depth of cut made it impossible to plot a single curve giving relation between power and metal removed. The curves were extended to the zero point, but the high point of all curves is the actual highest average obtained, so that in a certain sense the curves also show the comparison of the greatest possible capacity of these machines. This should be taken as significant, however, only when remembering the conditions under which the machines were tested, and then only as a measure for the maximum driving power.

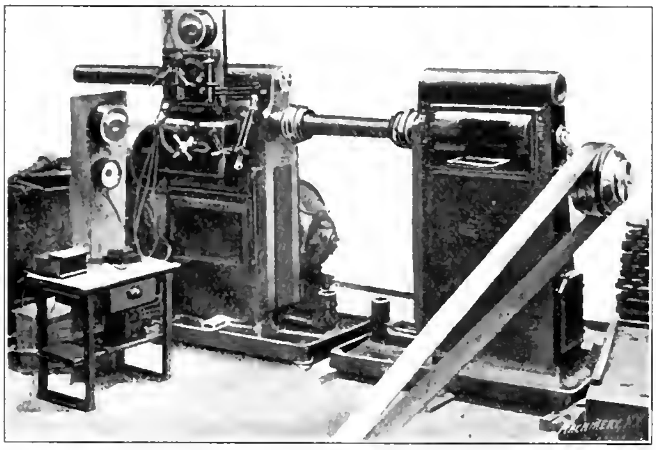


Fig. 7. Apparatus for Testing Efficiency of Driving Mechanism.

Efficiency of Feed Mechanism.

Fig. 5 shows the manner in which the machine was rigged up for testing the efficiency of the feed mechanism, and Fig. 6 shows the curve of average values plotted from the tests; each ordinate is the average of the ordinates corresponding to a certain amount of feed. The results of these tests justify again the precaution taken to obtain an efficient feed mechanism in the new line of milling machines. It may be mentioned here that these precautions consisted in avoiding idle running gears, high gear velocities, combined torsional and bending stresses in shafts, and ill supported and floating bearings, and above all, the use of quick pitch screws.

Tests upon Efficiency of Driving Mechanism.

The third series of tests relates to the efficiency of milling machines as power transmitting devices: that is, the ratio of "input" and "output" of power. Some preliminary tests were made by observing the power at the spindle by means of an absorption brake of the Weston type. This gave fairly good results at the higher speeds, the torque being small; but at the lower speeds and with greater torque the action of the brake became jerky and it was practically impossible to obtain reliable readings. The tests were carried on with the apparatus shown in Fig. 7. This consisted of two machines of the same type, make and size placed opposite each other and connected by a stout shaft. The feed works were removed, as were also knee, saddle and table, so that nothing was left but the bare frames and driving works. The machines were placed with the spindles approximately in line. A flange was screwed to the nose of each spindle; each flange was provided with a tongue engaging the groove in a similar flange opposing it, and keyed to the stout connecting shaft. There was plenty of clearance between tongue and groove and also endwise so that the connection could behave as a universal joint shaft in case the spindles were not exactly in line. It must be remarked here that the motion in this universal joint shaft was exceedingly small. Flat pieces of steel bolted to the first mentioned flange prevented the connection from coming apart.

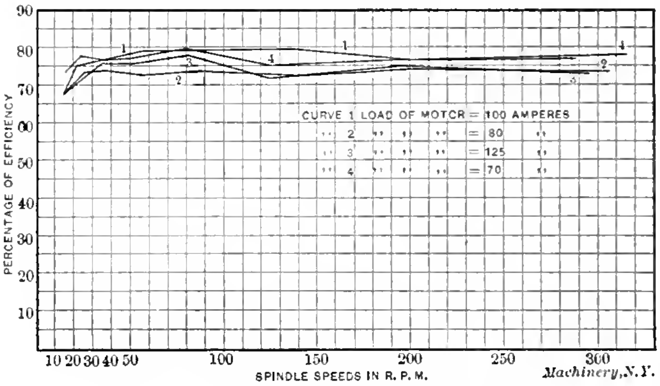


Fig. 8. Diagram of Efficiency of Drive of Milling Machines.

One of the machines was driven by a motor while the other drove a generator. The current thus generated was dissipated in a water rheostat, by means of which the amount of current could be closely regulated. There was a set of electric instruments for motor and generator each, so that all readings could be taken simultaneously. Both machines were driven by belts. A tachometer was used to determine if one of the belts slipped excessively. If the generator voltmeter showed considerable drop and the tachometer showed about the proper speed at the first driving shaft of the first machine (motor machine), then the belt to the generator must have slipped. If, however, the tachometer showed a drop, then the belt from the motor to the first machine must have slipped. The speed controlling levers of both machines were always in corresponding positions—that is, both were set for the same speed, so that at whatever speed the spindle was running, both driving pulleys were always running at the same speed, and that is the speed at which they are supposed to run under working conditions. The results of the tests are shown in Fig. 8. It will be seen that the efficiency of the machine varies from 67 to 79.7 per cent.

Efficiency of Cutters of Different Types.

The milling machine is not essentially less efficient as a power transmitter than any other machine tool, but the amount of metal removed per horse-power per minute is low; much lower in fact than for the lathe or planer. Were it not for other properties, the milling machine could not compete with either of these two machines. Still it cannot be denied that the milling machine would be esteemed higher if its power consumption could be brought down to the level of

the lathe. It is obvious that this cannot be done by increasing the efficiency of the mechanism, as the margin is not large enough to allow of any material improvement. Any substantial increase of efficiency must therefore be found in improvements of the cutting tool. With this consideration in mind, some tests were made as to the power required to remove a given amount of metal with different styles of cutters.

Cuts made with a spiral cutter with nicked teeth showed a best efficiency of 0.48 cubic inch of metal per net horsepower per minute, and this efficiency was obtained only in a few isolated cuts and with a very sharp cutter. Cuts made with a 14-inch face cutter with inserted teeth and on a No. 4 Cincinnati high power miller showed a production of 0.64 cubic inch per net horse-power per minute, an increase of 33 1/3 per cent over the spiral cutter. This result confirms the general belief that a face cutter cuts freer than a spiral cutter. The teeth of this face cutter were radial, as it is customary to make them. Tests made with the cutter shown in Fig. 9 showed an efficiency of 0.96 cubic inch of metal per net horse-power per minute, and a few isolated cuts even higher. This is an improvement of 100 per cent over the spiral cutter and 50 per cent over the face cutter with radial teeth. The cutter shown in Fig. 10 showed the same efficiency. Both cutters have the blade set tangent to a circle concentric with the cutter, thus giving them a rake angle of 15 degrees. The clearance was 7 degrees. The points of the cutting blades were rounded to prevent injury by burning or chipping, and this reduced the effective rake near the horizontal tangent to this curve. It was for this reason that the blades were set leaning backward as in Fig. 10. But for this curvature at the point of the blades, the simpler construction of Fig. 9 would be perfectly satisfactory. The leaning back of the blades is rather a refinement than a necessary improvement.

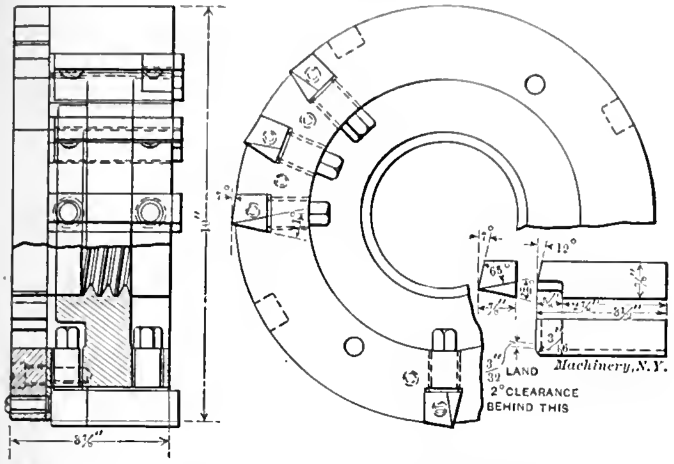


Fig. 9. Ten-inch, 16-blade Cutter used in Experiments on Milling Cutters.

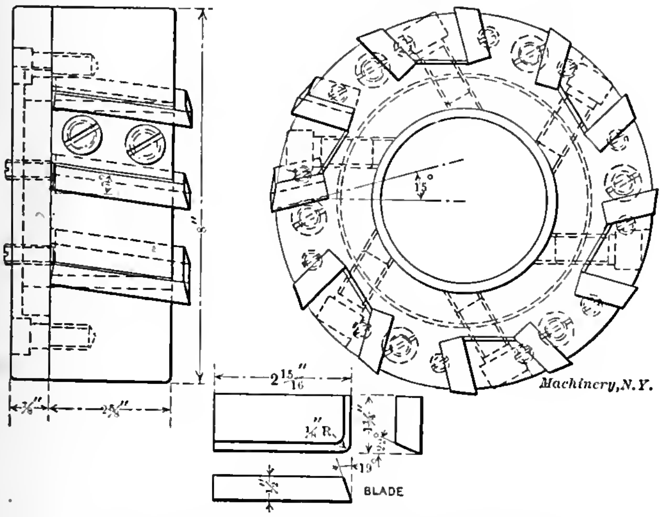


Fig. 10. Inserted-tooth Cutter showing High Efficiency.

It should be borne in mind that the tests made with these cutters were made on a vertical machine which had the same driving parts as a horizontal machine of the same size, and besides an additional two shafts and four gears, so that it is safe to say that its mechanical efficiency must be less than that of the No. 4 horizontal machine used with the spiral cutter with nicked teeth. The action of the feed on a machine using this cutter may be somewhat different from that on a machine using spiral cutters. Whether there is such a difference and what it amounts to, has not been ascertained by tests, and might be a promising field to explore. The fact that, generally speaking, the face cutter with rake removes double the amount of metal with the same amount of power as compared to the spiral mill, is significant, and places the vertical machine in the front rank for slabbing work wherever it is possible to use this type. Equally significant is the fact that a cutter with rake removes 50 per cent more metal than a cutter without rake. It may be mentioned here that many of these cutters, especially for so-called rotary planers, are being made and have been made for a great many years with the teeth leaning backward as in Fig. 10 but without rake; the makers and users apparently believing that this leaning constitutes rake.

[In the May, 1906, issue of MACHINERY, Mr. DeLeeuw commented on the subject of making milling cutters without front rake. It is interesting to note how correctly the results of actual experiments bear out the opinions then expressed.—EDITOR.]

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CONSTANTS FOR CALCULATING HELICAL GEARS.

C. W. PITMAN.*

The calculation of helical gears always is a time-consuming operation, and any short-cuts or labor-saving methods, proposed from time to time, are eagerly accepted by designers. The working out of a table of constant factors which can be applied directly to the various requirements of the design, opens up one of the easiest and shortest roads to the solution of helical gear problems known to the writer, and such a table has therefore been computed and is presented in the accompanying Supplement. The use of this table will reduce very materially the time necessary for the computation of the angles, dimensions, etc., of helical gears, as well as greatly simplify the calculations.

The body of the tables in the Supplement gives constants C_t for center distances of shafts for each speed ratio given, the shafts being at right angles, while the factors U, F, and L are equally applicable to gears on shafts at any angle. The constants for unit diameter of gear per tooth, U, and for unit center distance per tooth of fast gear, C_t, are calculated for gears cut with spur gear cutters of 1 diametral pitch; for any other pitch divide the constant by the diametral pitch of cutter used. The factors C_t given in the body of the tables, are, it should be noted, per tooth of fastest running gear, or gear having the smallest number of teeth. All factors are given for each degree (from 12 to 78 degrees) of angle of tooth helix. For angles including a fractional part of a degree, while strict accuracy would require the use of interpolation formulas, test calculations have shown that the proportional value between factors, as used in the examples given later in this article, is sufficiently accurate to meet all practical requirements.

The simplicity of the operation of calculating a pair of spiral gears will be apparent from an example: Required the number of teeth, diameters, and center distance, for a pair of gears, helix angle of pinion 60 degrees, of gear 30 degrees, speed ratio 2 to 5, and teeth of 6 diametral pitch. The following notation will be used in the formulas:

N_a = number of teeth in pinion (gear having the smallest number of teeth),
P_d = diametral pitch,
C_t = center distance per tooth (1 diametral pitch) of pinion, as given in tables in Supplement,
U = unit diameter per tooth (1 diametral pitch), given in the Data Sheet Supplement,
L = lead of tooth helix per inch pitch diameter, given in Supplement,

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D = pitch diameter,

F = cutter factor, as given in Supplement.

From Table II in the Supplement, we find the factor C_t for this angle and speed ratio to be 2.4435, and by the formula $N_a = \frac{C_t}{P}$ center distance, and disregarding for the moment the number of teeth, we have $\frac{2.4435}{6} = 0.40725$.

If we wish a center distance of approximately 5 inches, we will use a value of $N_a = 12$; this gives us $0.40725 \times 12 = 4.887$ inches center distance; 12 teeth in pinion; and $12 \times \frac{5}{2} = 30$ teeth in gear.

For the further calculations, using the formulas given below, and the factors for the angles stated, we have:

$\frac{U \times N_a}{P_d} = \frac{2 \times 12}{6} = 4$ inches pitch diameter of pinion,

$L \times D = 1.814 \times 4 = 7.256$ inches lead of tooth spiral of pinion,

$F \times N_a = 8 \times 12 = 96$, thus requiring No. 2 cutter for pinion.

Using the same formulas for the gear gives us:

$\frac{1.1547 \times 30}{6} = 5.774$ inches pitch diameter of gear,

$5.441 \times 5.774 = 31.416$ inches lead of spiral of gear,

$1.54 \times 30 = 46$, requiring No. 3 cutter for the gear.

From the above it will be at once apparent that the tables giving as they do constants for finding all data necessary for the sizing and cutting of the gears, permit a great saving of time over any other method, whether graphic or by calculation. In fact, by their use the task is rendered practically as easy and as simple as the figuring of a pair of spur gears, and the novice can do this work as well as the expert.

The above solution meets the conditions involved in probably nine out of ten spiral gear problems, that is, where the center distance of shafts is adjustable, and the helix angle can be taken at will. Occasionally, however, it becomes necessary to calculate the gears to suit a fixed center distance, in which case the helix angle must be made to suit the other conditions. This has always been a tedious and time-consuming operation, but the use of the table cuts out the drudgery, and reduces the time required to a minimum.

For instance, suppose in a machine having the above gears, it were required to replace them with others having a speed ratio of 1 to 2, without changing the position of the shafts. Transposing the formula for center distance and solving, we have

$$C_t = \frac{P_d \times \text{center distance}}{N_a}$$

and using for trial the same number of teeth in the pinion as before,

$$C_t = \frac{6 \times 4.887}{12} = 2.4435.$$

Inspection of the tables in the supplement shows that this corresponds to an angle lying between 68 and 69 degrees; this might do, but a smaller angle is preferable; trying 14 teeth, we have

$$C_t = \frac{6 \times 4.887}{14} = 2.0945.$$

This gives an angle of 55 degrees 15 minutes for the pinion, and is much better; for the gear we have 28 teeth, and a helix angle of 34 degrees 45 minutes, and using the proportional value between factors U for these angles, gives by the formula for pitch diameters,

$\frac{14 \times 1.7546}{6} = 4.094$ inches, pitch diameter of pinion,

$\frac{28 \times 1.2171}{6} = 5.679$ inches, pitch diameter of gear.

While the range of speed ratios given is sufficient to meet nearly all requirements, gears can be as readily calculated, and the center distances then found, for any other ratio. Thus, for a pair of gears of 4 pitch, 19 and 20 teeth, helix angles 45 degrees, we have, by the formula for gear diameters:

$\frac{19 \times 1.4142}{4} = 6.717$ inches, pitch diameter of pinion,

$\frac{20 \times 1.4142}{4} = 7.071$ inches, pitch diameter of gear, and

$\frac{6.717 + 7.071}{2} = 6.894$ inches, center distance.

For shafts at other than a right angle the factors C_t do not apply, and for fixed centers the proper helix angles can be found only by repeated trials. Where the center distance can be made to suit diameters, however, as is usually the case, the process is very simple. Thus, for shaft angle 65 degrees, speed ratio 1 to 4, gears 8 pitch, we have:

Pinion, 8 teeth, 30 degree helix angle;

Gear, 32 teeth, 35 degree helix angle.

$\frac{U \times N_a}{P_d} = \frac{1.1547 \times 8}{8} = 1.1547$ inch, diameter of pinion;

$\frac{1.2208 \times 32}{8} = 4.8832$ inches, diameter of gear.

Center distance $= \frac{1.1547 + 4.8832}{2} = 3.0189$ inches.

The lead of spiral and the cutter to use for milling the teeth will be found as in the first example.

For helical gears on parallel shafts the table will also be found a great convenience, as it reduces the necessary calculations to a minimum. The constants given in the body of the table do not apply for these gears, since the helix angle of both gears of a pair is the same, and their diameters are therefore proportional to their velocities. For example: suppose a speed ratio of 1 to 5, helix angle 15 degrees, 8 diametral pitch. Using 14 and 70 teeth for pinion and gear respectively, we find by formula

$\frac{U \times N_a}{P_d} = D$,

$\frac{1.0353 \times 14}{8} = 1.812$ inches, diameter of pinion,

$\frac{1.0353 \times 70}{8} = 9.059$ inches, diameter of gear, and

$\frac{1.812 + 9.059}{2} = 5.436$ inches center distance.

If it were desired to replace these with gears of 6 pitch, speed ratio and center distance the same, the diameters would obviously be the same, and the helix angle must be found; transposing our formula, we have

$$\frac{D \times P_d}{N_a} = U.$$

For N_a we must assume a value, but as the helix angle for these gears is generally kept as small as possible, the number of teeth in the smaller gear of the pair will always be taken at the nearest whole number less than $D \times P_d$; therefore

$$\frac{1.812 \times 6}{10} = 1.0872 = U.$$

Consulting the table we see that this value of U will give an angle of 23 degrees 6 minutes. The leads and cutter to use are found as follows:

For the pinion, 10 teeth,

$7.367 \times 1.812 = 13.338$ inches lead of tooth spiral,

$1.28 \times 10 = 13$; use No. 8 cutter.

For the gear, 50 teeth,

$7.367 \times 9.059 = 66.737$ inches lead of tooth spiral,

$1.28 \times 50 = 64$; use No. 2 cutter.

METAL-CUTTING TOOLS WITHOUT CLEARANCE.*

The principles of a turning tool intended to cut without clearance, consisting of a cutter and a holder so constructed as to allow the cutter a slight oscillatory freedom in the holder, are discussed in the following: The center line on which the cutter oscillates is substantially coincident with the cutting edge. The oscillation of the cutter about the center line does not affect the position of the edge, but allows the face of the cutter to swing around to conform to the face of the metal from which the chip is being severed. The objects of this construction are to make possible the use of more acute cutting edges to reduce the cutting stresses; to wholly or partly equalize the unbalanced side pressure on the cutting edge; and to obtain a rubbing contact to prevent lateral vibration.

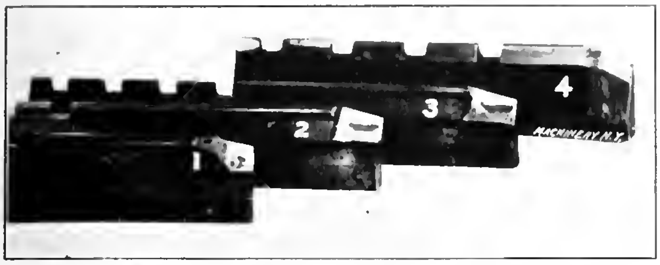

Fig. 1. Illustration showing the Abrasive Contact of Chip on the Top Slope. Nos. 1, 2 and 3 were used in Tool-holder illustrated in Fig. 3. No. 4 shows one of the Earlier Forms.

In order to make clear the reasons for the construction of the tool shown, it will be necessary to briefly analyze some of the conditions under which metal is worked in a lathe, dealing particularly with cutting angles, clearance of cutting edges, and the importance of minimizing the tendency of the work and tool to separate under cutting stresses. The subject has been approached from the standpoint of a designer and manufacturer of lathes, and particularly lathes of the "flat turret" lathe type.

The generally accepted cutting angle of greatest endurance under high speed is about 75 degrees, and the angle of least resistance, according to some of Dr. Nicholson's tests, is about 60 degrees. The cutting angles of the tool illustrated and discussed may be varied from the present orthodox angles down to 30 degrees or less, according to the nature of the work. The results obtained by Dr. Nicholson, which showed an increase in cutting stress for tools more acute than 60 degrees, may have been due to the cuts having been taken without suitable cutting lubricant. Furthermore, the comparative lack of durability of the more acute edge below 70 degrees, may have been due either to heat or lateral vibration, or both. The heat would have been greatly reduced by a liquid cooling medium, especially one having some suitable lubricating qualities, and the lateral vibration may be eliminated by means to be explained. The thin edge of an acute tool is obviously the least suited to carry off heat or to withstand the vibration incident to cutting.

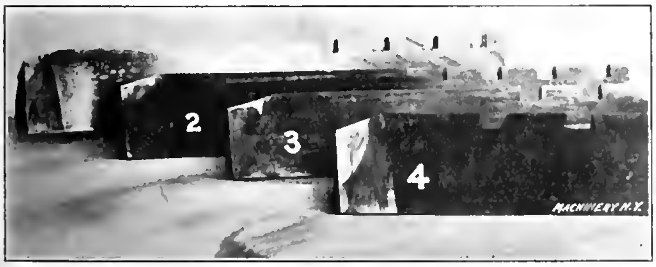

Fig. 2. Reverse Side of Cutters shown in Fig. 1. Illustration shows Rubbing Contact of the Tool against the Shoulder of the work. Each Tool bears Same Number in Both Engravings.

Class of Work Considered.

The tool illustrated should be considered from the standpoint of one who sees nothing but lathe work under 20 inches in diameter, and of the kind usually found in any machinery building plant, not that the means may not be of value in larger work, but simply that this is out of the author's range of experience, and such work was not considered in designing the tools described. A more exact description of the range of work for which this tool is intended may be stated as follows: Lathe and turret lathe work under 20 and over 4 or 5 inches in diameter, and less than 8 or 10 inches in length, also work up to 2 and 3 feet in length of diameters under 3 to 3½ inches and generally over ¾ or 1 inch in diameter. This includes three classes of work: (*a*) chuck work, having diameter generally exceeding length, held wholly by a chuck or face-plate; (*b*) bar work, which is held in chuck and steadied by back rests; (*c*) work having dimensions similar to bar work, but which must be turned on centers, with or without following and fixed steady-rests. The material dealt with is regular open hearth machinery steel of about 20 points carbon.

In work supported on centers and in chucking work, the connection between the work and tool includes a number of joints, both for sliding the tool in relation to the work, and for the rotation of the work. Each of these joints has more or less slackness, and each of the slides and other members are more or less frail in structure. With a mounting of this kind, the cutting edge of the tool does not pass through the metal without swerving and flinching.

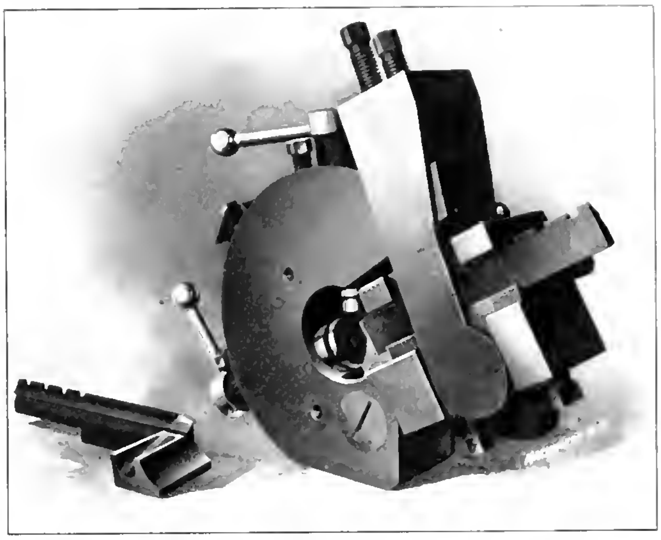

Fig. 3. The No-clearance Turning Tool for the Flat Turret Lathe.

Means for Improving Efficiency.

A machine's efficiency is proportional to its strength to resist its working stresses. There are two ways to increase this efficiency: (*a*) by strengthening the machine, and (*b*) by reducing the stresses for a given result. In the author's previous work the strengthening of the machine has been accomplished by the elimination of unnecessary features, and placing the necessary joints for obtaining the various motions in the least objectionable positions. The next step was to devise a means for minimizing the stresses at the cutting edge, and the object in view is to explain how this result has been obtained. This reduction of stresses may not be important in roughing work in which a flinching of the work or machine may be disregarded so long as the machine continues to crush off the metal, but for the kind of work mentioned above it must be considered of first importance.

Analysis of Conditions.

In the class of work under consideration each piece has several diameters, with shoulders which should be accurately spaced and formed. Nearly all the shoulders required in this class of lathe work are the so-called square shoulders. In engine lathe practice these shoulders are "squared up" by a side tool after the other turning has been done by a round nose or diamond point tool, but in the turret lathe, for bar work, these shoulders are produced by the same tool that takes the stock-removing cut. The tool used in turners for bar work cuts on the same principle as the engine lathe side tool; that is, its rake or top slope is almost wholly side

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* Abstract of paper by Mr. James Hartness read before the American Society of Mechanical Engineers, December meeting, 1908.

[The lathe tool, the principles of which are here discussed, has been developed by Mr. Hartness of the Jones & Lamson Machine Co., Springfield, Vt., for special application to the flat turret lathe manufactured by this company. It is strictly a special turning tool, and will not be furnished as a part of the regular equipment of this machine.—EDITOR.]

slope, and its cutting edge stands at an angle of 90 degrees to the axis of the work.

In the engine lathe a tool of this character has generally been unsatisfactory for rapid turning, yet in the turret lathe this very tool seems to be universally used for all bar work. The difference in performance seems to be due to the difference in mounting. It works well where there is no chance of vibration, but trouble begins when it is used in a machine like the engine lathe or turret chucking lathe in which the work is supported by one part of the machine and the tool by another, and the true path of the cutting tool through the metal is dependent on the entire structure of the machine, there being nothing to prevent vibration. The no-clearance tool to be described is a side tool without clearance. Its under face bears flatly against the work, thereby preventing lateral vibration.

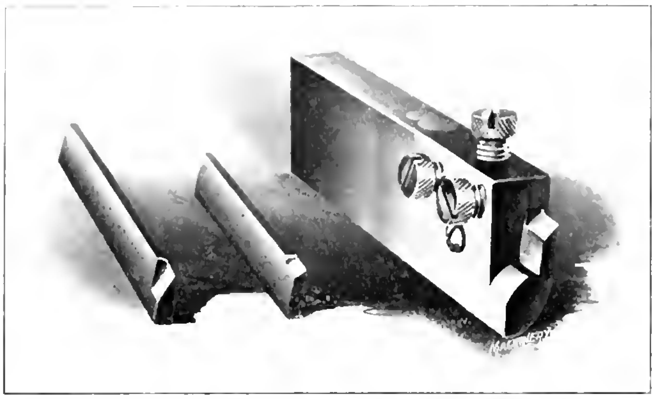

Fig. 4. No-clearance Tool for Standard Engine Lathe Tool-post, showing Three Cutters of Different Angles.

For the purpose of analysis the cutting stress may be divided into three elements; the direct cutting stress, the separating stress, and the tendency to vibrate.

Direct Cutting Stress.

By direct cutting stress is meant that part of the stress that is directly downward in a lathe. With all other conditions unchanged, we should expect to find an acute edge tool offering the least resistance, and that the difference in direct cutting stresses for tools of varying cutting angles would show a marked reduction in favor of the more acute tools. Dr. Nicholson's experiments, already mentioned, showed an increase in cutting stresses and a marked loss in endurance, below 60 degrees, but these tests were on dry cutting without the benefit of a lubricant or cooling solution. Thin edge tools are undoubtedly benefited more by lubricant or cutting medium, than blunt edge tools. Just what cutting angle would be the best under conditions of most efficient cooling medium may not yet be fully known.

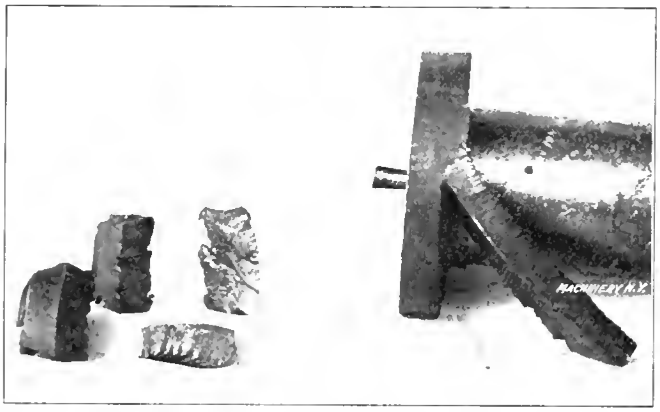

Fig. 5. Sample of Broken Chips and Work with an Unbroken Chip. This View is nearly Full Size. The Exact Dimensions of Sample are 1 3-4 Inch Diameter turned down to about 1 Inch; feed about 7 per Inch; Cutting Angle of Tool about 38 Degrees; Extreme Edge 1-32 Inch Flat. These Chips were broken by a Chip Breaker.

It is obvious that the least direct cutting stress for a given depth and feed should be obtained by a straight edge tool, and one that would take a chip in which there is the least molecular change. Crushing and partially or wholly shearing the chip into chunks which are three or four times the thickness of the feed undoubtedly increase the working stresses and heat.

A flat top slope should have a straight cutting edge. The more the edge is rounded the greater the conflict of the metal crowding onto the edge. The flow of metal on the top slope of the round nose does not move in one direction wholly, but tends to travel towards the center of the curve. The conflict of currents of metal which approach the center from various parts of the curved cutting edge, increases the direct cutting stress. The crushing process of the usual method of turning is due both to the bluntness of the cutting angle and the shape of the edge.

Separating Stress.

By separating stress is meant that stress which, in turning a shaft, forces the tool outward radially. Increasing this stress causes the work and tool to move apart, and results in variation in diameter, also in irregular and generally inaccurate product, particularly when the rough stock runs eccentric or irregular. Although this separating stress may be decreased by giving the tool more back slope, this is only possible in tools taking light depth cuts. A lathe tool, however, which takes a cut like a side tool, shows little or no tendency to separate radially. With the side tool set at an angle of 90 degrees to the travel of the feed, the feeding stress does not tend to force the work and tool apart; in fact, this tool may be set so as to produce a slightly beveled shoulder either side of the 90-degree angle so as either to draw the work and tool together when making an overhanging shoulder or to force the work and tool apart when producing an external bevel.

Vibration Stress.

The quivering stress which is due to the nature of the chip is affected by the cutting angle of the tool. The chunks which make up the parts of a chip are less firmly united in a chip taken by a tool of 70 degrees cutting angle than by a tool of 50 degrees, and, of course, the more firmly united chunks give a more continuous chip with the least vibration

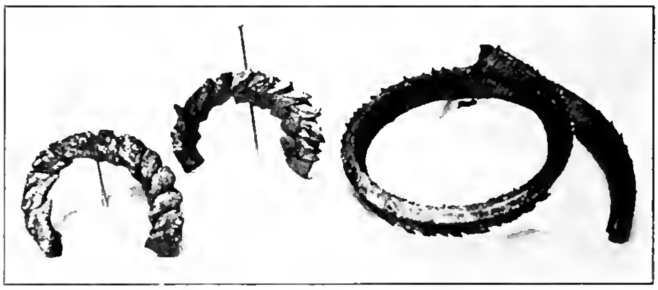

Fig. 6. Chips taken by Diamond Point Tool, 75-degree Top Slope and Slightly Rounded Nose.

Fig. 7. Chip taken by 40-degree No-clearance Tool at same Feed and Depth. Illustrations about Full Size.

In turret lathe practice, especially in bar work, the tool and work are held together by a back rest which follows on the surface produced by the cutter, and in some kinds of turret chucking work the tools for interior work are mounted on boring-bars which take bearing either in the work or in the chuck which holds the work. When tools get this steadying support directly on or in the work, they are freed from the chattering due to the machine mounting, but not free from that due to their own frailty or to the intermittent flow of the chip as it is taken off in chunks.

Relative Destructive Effect of Heat and Lateral Vibration.

Attention should be called to the effect of heat in the destruction of the cutting edge, and no amount of care in the mounting of the work and tools will prevent destruction of the cutting edge of the tool by heat. Heat is undoubtedly most destructive when roughing at high speeds, but the vibration plays a very important, if not the greatest part in edge destruction when finishing at the usual speeds. As the speed is reduced, the vibration gains in relative importance, which should be taken into account in considering the no-clearance tool. With the slower speeds, tools should be used that give the best results at slow speeds.

The failure of the keen edge under normal cutting conditions, and its surprising endurance under some abnormal conditions, seemed to indicate great possibilities open to any scheme that would maintain the best conditions. For instance, the edge of a diamond point may be broken off by an

ordinarily heavy chip, at one time, and at another time a similar tool becomes deeply imbedded into the metal without breakage. Under some conditions a cutting tool will actually sharpen itself in the process of cutting, yet neither of these results is regularly maintained. They suggested, however, the possibility of supplying a means by which they could be maintained in regular work.

Clearance.

Since the birth of the slide rest lathe in which the tool was first guided by mechanism, turning tools have been given clearance and it has been assumed that they would not cut without clearance. Of course, it is well known that the orthodox lathe tool goes out of commission after losing its clearance, but that does not demonstrate that a tool cannot cut without clearance. It only proves that the ordinary tools require clearance as they are now formed and mounted. A tool which has been ground for clearance and set in such a position that its under face is at an angle to the shoulder produced, presents but a small area to the shoulder of work when the clearance of the extreme edge has given way. The area is so small, compared with the stress of the abrading metal passing it, that it rapidly scores and wears into a rough surface standing at a negative clearance angle.

The tool which has been set by chance in an engine lathe, so that a comparatively large area of the under face rides on the wall of metal, does not wear away, because its surface is not subjected to as great abraiding pressure per unit of area. Its area is sufficient to withstand abrasion. It was therefore assumed that increasing the contact of the under face of the tool against the face of the work would make it possible to cut without clearance. The advantage of a no-clearance tool is that its face rides on a good area and supports the under edge against the pressure of the chip, thus relieving the edge from the one-sided pressure which must be borne by a tool having clearance.

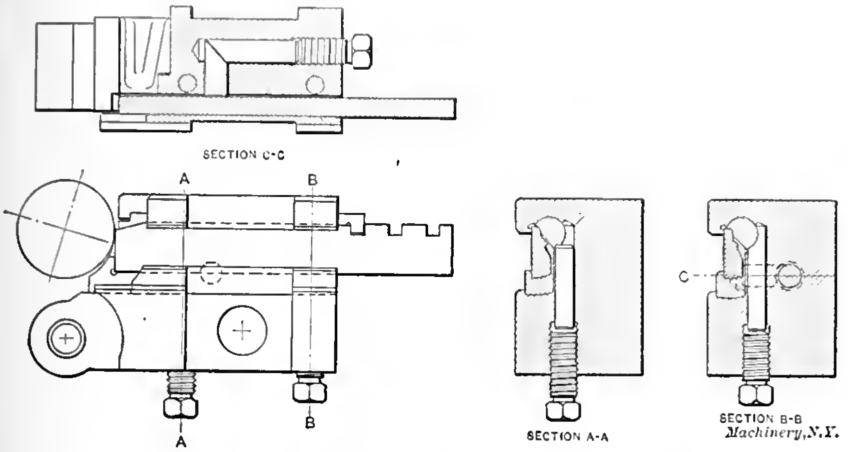

Fig. 8. Holder for No-clearance Tool in the Flat Turret Lathe.

No-clearance Tool.

In order to enable the tool to ride flatly against the wall of metal from which the chip is being removed, it must be mounted so as to allow a comparatively free swiveling action on a center line that is substantially coincident with the cutting edge of the tool. When the tool is so mounted, the pressure of the chip on the top slope tends to throw the so-called clearance face against the shoulder, for the mounting allows the tool to swing around to any angle that may be necessary to fit any work form, from a straight surface in planer work and the nearly straight surface in work of large diameter down to the angle of a helix obtained by the coarse feed on work of relatively small diameter. A tool so mounted either swings automatically to adapt itself to angularity of feed, or may be swung by hand as soon as the cut is started. Its natural tendency holds it snugly against the metal, but the force may be varied from one that equalizes the stress on each side of the cutting edge down to a very slight stress which only holds the tool in no-clearance position. An important feature is that the tool is free to swing around to offset the unequal wear on the "clearance" face.

The swivel mounting of the tool allows the cutter to swing around to take care of not only the feed, but the changing surface of the tool due to wearing action. In the early experiments, cutters were used which were clamped rigidly in a holder, which, in turn, was pivotally mounted on a fixed holder. The cutting edge of the tool was so located as to stand exactly on the center line of the swiveling holder.

In the later experiments the scheme has been simplified by loosely mounting the cutter itself, providing it with a round bottom struck from a center line which is near the cutting corner of the tool. The cutting edge is usually standing at an angle to its center line of swivel, giving the tool a front slope. The scheme of inclining the cutting edge to the line of swivel was adopted for the purpose of using a bar-shaped tool in which its shape could be maintained by grinding, for with this shape grinding back, the end provides for the wearing down of the top edge. This gives the tool a front slope when the swiveling center is kept horizontal. In some cases it may be well to tilt the holder to an angle that brings the cutting edge horizontal. This departure from the ideal center position of the line of swivel is not sufficient to cause any trouble. In fact, the pivotal line need not be exactly parallel to the cutting edge, neither is it necessary to have it very near the center line of swivel. It is probable that, under some conditions, the cutting edge may advantageously be located either above or below or on either side of the cutting edge. The exact location of the cutting edge relative to the center of oscillation partly determines the pressure with which the tool rides against the wall of metal from which the chip is taken.

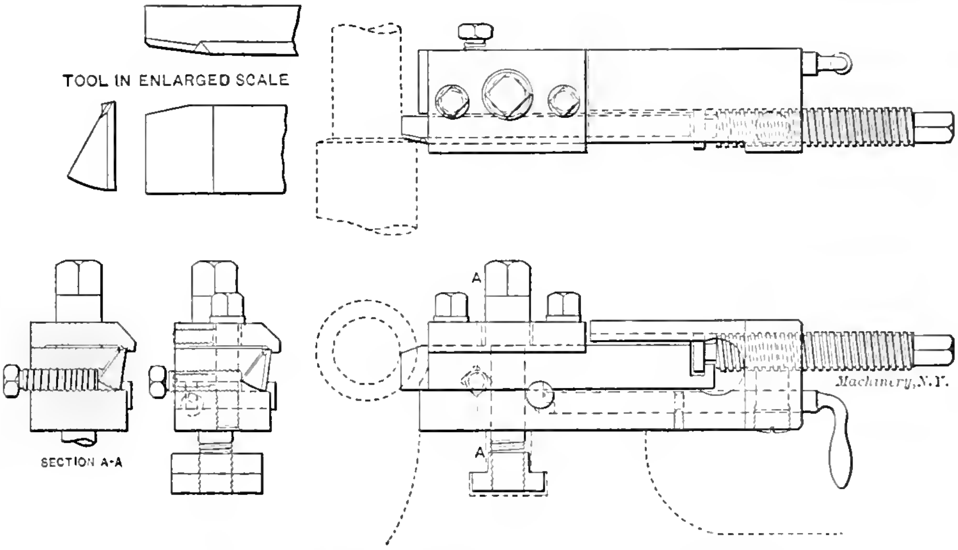

Fig. 9. Holder for No-clearance Tool when used in the Engine Lathe.

The extreme top edge of the tool, in some instances, has been slightly flatted on the more acute angles, the flat measuring from about one-sixty-fourth to one-thirty-second inch, and standing either 90 degrees from the so-called clearance face or sloping in either direction. Very good results were obtained by giving it a negative side slope of a maximum of from 10 to 15 degrees from the horizontal. This top flat seems to make a good resting place for the false edge, and it may be that its successful operation is dependent on the false edge.

One interesting phase of these experiments has been the

comparative willingness on the part of the tool to relieve the carriage of the duty of feeding. This first became apparent when the carriage continued to advance after the feed had been "thrown out." This self-feeding feature, of course, cannot apply to the action of planers, boring mills, or work of large diameter. It is only mentioned here to indicate the absence of resistance to the feeding motion under some conditions. The ultimate outcome of the use of acute angle tools may lead to allowing each tool taking a heavy cut on small diameters to determine its own feed. In the turret lathe this would be a distinct advantage.

Chip Lifter and Chip Control.

The chip produced by the acute angle tools possesses great lateral strength. The continuous chip is preferred by any operator who has had experience with hot chips which are thrown off by the tools of blunter angles, but while this particular feature enables him to closely observe the action of the tool without risk, the continuous chip in itself becomes troublesome, if allowed to run too long without breaking. In some of the first experiments with this tool, chips having a depth of about three-eighths of an inch, and produced by a feed of six revolutions of the work to the inch, were found exceedingly troublesome, especially when allowed to run out to lengths of five to fifteen feet.

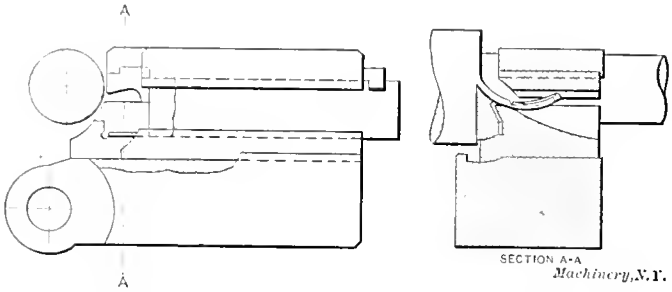

Fig. 10. Chip Breaker used in the Flat Turret Lathe.

The lateral stiffness of the chip of the more acute tool made it possible to increase the tearing open or splitting effect. In order to increase the tearing action of the chip it is necessary to allow the chip, after it has passed from the edge of the tool, to pass over a lifter in the form of a wedge, either formed integral with the tool or placed in the path of the chip near the tool, having an angle that not only assists in tearing the metal ahead of the tool, but will also relieve the slope of the tool near the edge from an important part of the work. Although this chip lifting effect may be produced by a top slope having a curved surface, it has seemed best for the convenience of grinding the tool on an ordinary wheel to keep the top slope of the cutter a flat surface, and introduce this chip lifter as a separate member, either as a part of the toolholder or in conjunction with the chip breaker described below.

Although it is a satisfaction to be able to stand near the cutting tool, and to know that the chips will not shoot out in hot chunks at all angles from the tool point, there remains the fact that a continuous chip is troublesome. Even with the blunt tools, the curling chips which are sometimes used to illustrate ideal working conditions of a machine, require constant attention of the operator, and either a very large receptacle which doubles the floor space required for the machine, or the almost constant attendance of an extra man for removing the chips from the room. The use of the more acute angles increases the chip trouble, and may in some instances make it advisable to retain the blunt cutting angles, or at least, tools which produce tolerable chips.

For turning bar work in the turret lathe it has seemed best to adopt a chip breaker which produces a fracture by placing an obstruction in the path of the chip at such an angle that the chip, shortly after it has left the tool, is bent beyond its breaking point either by lifting or depressing, or both. It is preferred to use a chip breaker which depends on depressing the chip after it passes over the chip-lifting incline. A breaker of this kind breaks the chip in lengths varying from one-half to three inches.

Conclusions.

The conclusions of the investigations may be summarized as follows: The no-clearance cutter relieves the edge from the one-sided pressure; it prolongs the life of the cutter by allowing abrasion on its face without producing negative clearance; it prevents lateral quivering; it converts the lip angle into cutting angle which for a tool of given form constitutes a gain of from 5 to 10 degrees in cutting angle; it has extended the working range of the side tool which gives the minimum separating stress; it has made possible the use of acute angle tools which reduce the cutting stress, thereby increasing the output of machines which have been limited by lack of pulling power; the reduction of the cutting and separating stresses has increased the accuracy on nearly all lathe work; this reduction also increases the output which has been limited mostly by the frailness or the slenderness of the work.

* * *

CUTTING WORMS AND HOBBING WORM-WHEEL SEGMENTS.

The two illustrations shown herewith explain the practice of the Garvin Machine Co. in making worms and worm-gear segments, such as are used for automobile steering gears. The cutting of the worm, as shown in Fig. 1, is done entirely by standard methods, the attachment shown in place in the machine being the regular spiral gear and worm milling attachment made by the builders. The use of an attachment of this kind permits the milling of spirals of very short lead, such as required for worms. It would not be possible to mill them with a cutter on the regular cutter arbor, as the table of the universal machine could not be swiveled to a great enough angle to permit this.

The hobbing of the worm segment requires special apparatus, the construction of which is plainly indicated in Fig. 2. The segment is mounted on an arbor with a worm-wheel of the same pitch and number of teeth as would be contained in the segment to be cut. On the cutter spindle is mounted a taper hob and a spur gear, the latter meshing with a corresponding gear of the same size, keyed to a worm supported in supplementary bearings fastened to the overhanging arm at the outer end, and to the machine columns at the inner end. This worm meshes with the worm-wheel on the arbor, on which is the work. This work arbor, with the worm-wheel and the work, is free to revolve when driven by the worm just described, being loosely mounted on the centers.

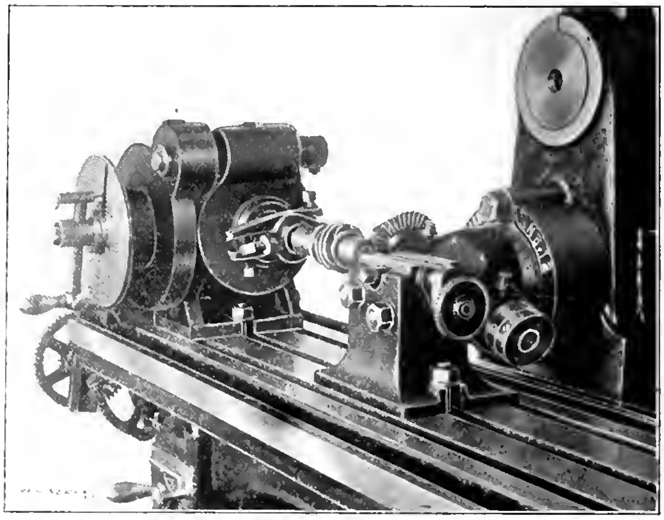

Fig. 1. Milling Worms with the Universal Attachment.

The principle of the hobbing operation is identical with that described in connection with Fig. 128, of the article entitled "Gear Cutting Machinery" in the June, 1908, issue of MACHINERY. The cutting operation starts with the saddle moved in toward the column until the work is beyond the hob at the small end, the knee being raised to the proper height so that the large or finished diameter of the hob will cut teeth of the desired depth. At this adjustment the driving worm and worm-wheel should be properly in mesh with each other. The saddle is fed outward, so that, with the ma-

chine in operation, the work is fed to successively larger diameters of the hob, which thus cuts deeper and deeper until finally the work passes out through the large end, as shown in the illustration. This finishes it to the proper depth. The work and the hob do not get out of step with each other, as the cross motion rolls the master worm-wheel on the master worm in just the proportion that the work should roll on the hob. Since the driving members do not get out of step with each other, the driven members do not.

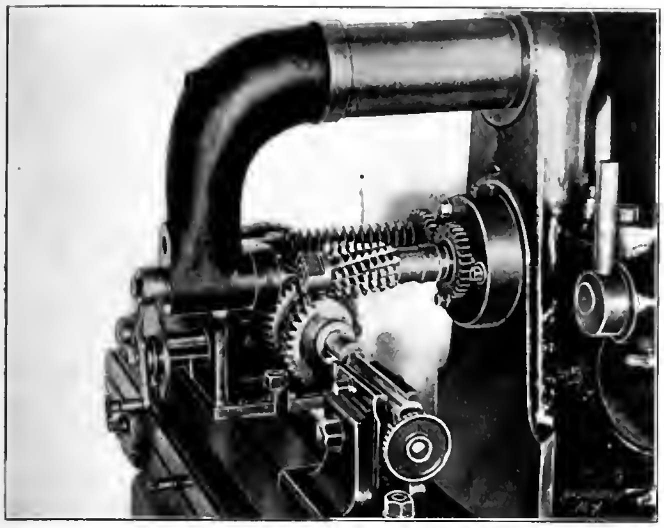
Fig. 2. A Positive Hobbing Attachment, employing a Taper Hob.

Of course the reason for making the worm-wheel in this way, aside from the question of time involved, is that the ordinary method of gashing and hobbing on a freely running arbor could not be employed in this segment worm-wheel. The apparatus would be fully as useful, however, with regular worm-wheels, doing the work in one operation instead of two.

* * *

MACHINE SHOP PRACTICE.*

MACHINING INTERNAL COMBUSTION ENGINE DOUBLE-CYLINDER CASTING.

When castings, such as the one shown on the Shop Operation Sheet accompanying this issue, are to be machined, fixtures to facilitate setting the work are essential to economical production. If only one or two castings were needed, the extra time required for setting them for the different machining operations, without fixtures, would not be great enough to justify the expense of such equipment. We shall assume, however, that in this case a sufficient number of castings are to be machined to warrant such expenditure, and in the following a description of the fixture for holding these castings will be given, and the way the various parts to be machined are set in proper relation with the tools in the turret, explained.

It will be understood, of course, that the layout and construction of a fixture for holding work of the kind illustrated, will depend entirely upon the shape of the casting and location of the surfaces to be machined. The dot-and-dash lines in Fig. 2 represent a plan view of the casting shown on the Shop Operation Sheet. As will be seen, there are, in this particular case, four valve ports and the openings *V* and *X* to be machined on one end of the cylinder, and the two cylinders to be bored from the opposite end. If the fixture which is to hold the casting is to be efficient, it must be so constructed that the four valve ports and the openings *V* and *X* can be brought in line with the axis of the lathe spindle without resetting the casting, and also so that the cylinders may be bored with a minimum amount of trouble and the distance between their centers kept uniform. The fixture, which is shown in Fig. 2, consists of a base-plate *A*, and a cylindrical plate *B* having a boss which fits into a recess in *A*, upon which the plate revolves to change the position of the work. Obviously, if the casting is centered upon plate *B*, the four port openings may be made to coincide with the axis of the spindle by revolving *B*, if the base-plate *A* is properly located upon the face-plate of the turret lathe, and means provided for setting plate *B* so that the centers of the port openings coincide with the axis of the spindle.

In laying out the base-plate *A*, the recess for the boss on plate *B*, and a hole for plug *C* which fits the hole in the spindle, are located upon a center line *a—b*, the distance between them being equal to radius *r*. After the boss on *B* has been fitted into the recess in *A*, the four dowel pin holes *k*, *l*, *n*, *p*, in plate *B*, should be located. The exact position of the centers of the four valve port holes are first laid out, and center lines drawn through them. Upon these lines and at points equi-distant from the center *J*, the four dowel-pin holes are drilled, and a hole to coincide with them is drilled in the base-plate *A* on center line *a—b*, at a point *k*. These holes are reamed with a taper reamer and a dowel pin fitted to them. It will be apparent that if the casting is centered on plate *B* so that the centers of the valve openings will come on the center lines *a—b* and *c—d*, each valve opening can be centered by revolving *B* and inserting a dowel pin in one of the four locating holes at a point *k*. For example if the valve seat *S* is to be machined, plate *B* would be revolved until dowel hole *l* coincided with the hole in base-plate *A* at *k*. The seat *S* would then be directly over locating pin *C* which fits into the hole in the lathe spindle.

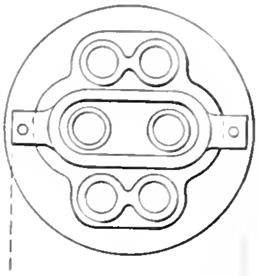

Fig. 1. Special Form of Clamp for the Fixture.

In order that the openings *V* and *X* be machined without resetting the casting, a second hole for the plug *C* is drilled and tapped in the base-plate *A* at a point corresponding with the center of *V*. When the four valve seats have been machined, straps similar to *Q* (see Shop Operation Sheet) are placed across the seats and *Q* removed, so that the holes *V* and *X* can be machined. The base-plate *A* is then removed from the face-plate, and the locating pin *C* shifted to the hole under opening *V*. When the base-plate *A* is again clamped to the face-plate, obviously, opening *V* will be centered. To center *X* it is only necessary to remove the dowel pin at *k* and turn plate *B* one-half a revolution. The removal of clamp *Q* and the substitution of others for this last machining operation, can be obviated by the use of the clamp illustrated in Fig. 1, which will not interfere with the movements of the tools and which will grip the work more firmly.

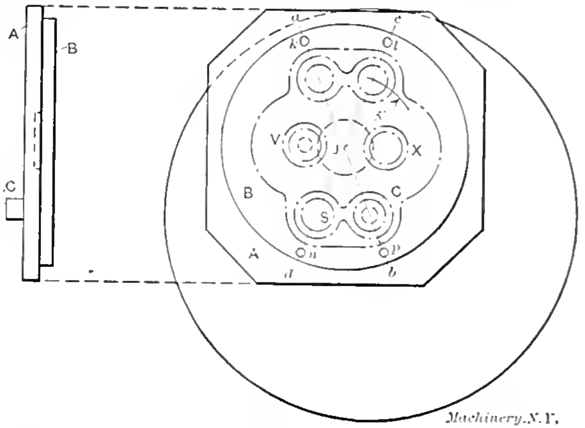

Fig. 2. Diagram of Fixture for Holding Double-cylinder Casting.

The next operation consists in boring the two cylinders. As the holes *V* and *X* are to be concentric with their respective cylinders, means must be provided for setting these holes true when the casting is inverted. As the work has remained in the same position with relation to plate *B*, this may be accomplished by locating two plugs, which fit the valve openings, at points on the center line *a—b* corresponding with the centers of the openings. When the position of the casting on plate *B* is then reversed, one cylinder will be in a position to bore and the other may be centered by revolving *B* one-half a revolution, using the dowel at a point *k* as before.

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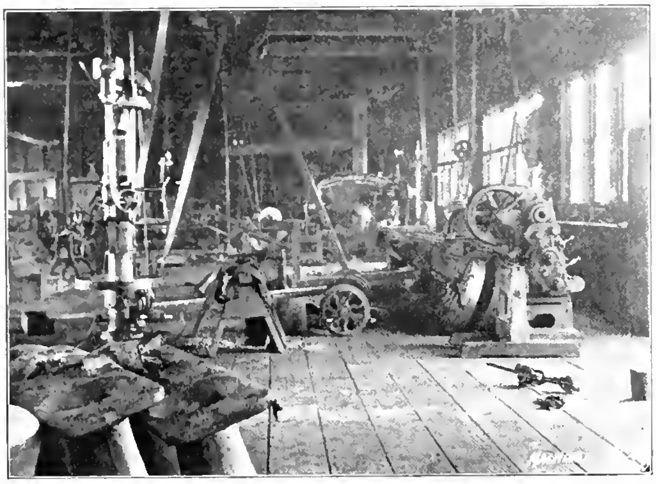
* With Shop Operation Sheet Supplement.

SHOP PHOTOGRAPHY.[*]

H COLE ESTEP [†]

It is the purpose of this article to give a few practical, pertinent hints on the taking of shop and engine-room photographs. If pictures are taken of ingenious hurry-up repairs, of the original appliances installed in the plant, or of new methods of setting up or handling work in the shop, supplemented by descriptive matter and drawings where necessary, it will be surprising to find how soon a complete, original, and valuable set of notes and data, which will be of constant service, can be collected. Furthermore, these data can be made useful to one's fellow craftsmen by publication in technical journals. Scale drawings and descriptive data are often essential, but usually, to get a clear understanding of an apparatus as it actually appears when in use, a photograph is indispensable.

The art of taking good photographs is not difficult, nor is expensive apparatus required. The writer has taken hundreds of pictures, which have been published in a score of technical magazines, all of which were made with a $20 folding hand camera. The prime requisites for a shop camera are flexibility and compactness. Pictures must be taken in all conditions of light and weather, indoors and out, for which an adaptable camera is necessary; odd angles, mazes of piping and cramped quarters require a compact construction. The lens for this work should have good definition (sharpness) and depth, should be reasonably, but need not be excessively, fast. The shutter should have a wide range of control and should work without jar. The bellows should be of such length as to permit the taking of small objects full size. The back of the camera, carrying the plate or film holder, should be reversible, so that it is not necessary to unscrew the camera from the tripod and turn it over, should a change from a horizontal to a vertical view be advisable. Ground glass is necessary for focusing, and, as will be seen later, a good, accurate view finder is often useful. Contrary to the experience of some, I have found the 4 x 5-inch size to be the most suitable; enlargements can be made, if necessary. This size combines features of economy of operation with a light and compact apparatus. I therefore use a 4 x 5-inch folding plate camera, the box, when closed, measuring 6 x 6 x 3 inches. This apparatus has a bellows, which can be extended to 13 inches, a good double rectilinear lens, giving sharp pictures with a wide open diaphragm, an automatic shutter working from 1/100 to 1 second, a reversible back, and ground glass focusing screen. The camera complete with case and one plate-holder cost $20. I discarded a roll film kodak, because it would not permit focusing subjects en ground glass; this focusing must always be done when possible, if uniformly accurate results are desired.


Photograph taken on a Film, thus Obviating the Halations Common to Interiors made on Plates.

At an expense of $1.50 I produced a "film-pack adapter," enabling me to use daylight-loading film-packs, thus combining all the advantages of the plate and roll film cameras, with none of the drawbacks of either. I have used film-packs for two seasons, and find them admirably suited to shop picture making. Using films, I have often taken pictures directly against the strong light from adjacent windows, without the slightest blur, or any of the evil effects of halation, inevitable with plates. An example of this is shown in the accompanying half-tone, where a good picture is presented in spite of the poor light of the shop.

After selecting the proper apparatus, the next thing, in order to secure good results, is the proper lighting of the subject. The over-zealous amateur often reasons, to his subsequent undoing, that since light makes the picture, one cannot have too much of it, forgetting that it is the contrast of light and shadow and the shading of light into shadow that really makes a good photograph. Unfortunately, the matter of lighting in work of this kind is usually absolutely beyond the control of the operator. About all he can do is to select the point of view best suited to the subject and take the light as it comes. Reflectors and screens are used by some, and although they are of service, my experience has been that they are usually more bother than good. Wherever possible, the light should be from the side, striking the floor at an angle of 45 degrees from the horizontal. But these are "laboratory" conditions with which we are not concerned. Machinery, lathes, etc., that are not too large, can be set in relief by a white background. In taking pictures in boiler rooms, I have often made pipes, practically invisible at first, stand out by an application of whitewash or whitelead.

Much of the evil in shop photographs, due to the unavoidably poor lighting, can be ameliorated by proper exposure. As in all kinds of picture taking, accurate exposure is the key to success in shop photographs. The question of exposure brings with it the one of diaphragm or stops. The lens of the camera is supplied with an iris diaphragm, by means of which the hole through which the light enters can be varied in diameter from about 1/16 inch to the full diameter of the lens. Except where extreme sharpness is required, I have found that a U. S. No. 16 stop (diameter ¼ inch) is the best lens opening for all around work. The question of proper exposure is one of experience entirely, by the aid of which one feels what is right without going through any definite reasoning process. However, as a guide, I have established what I call "a standard exposure under standard conditions, using a No. 16 stop." It is defined as follows: With clear weather outside, the standard exposure, using films, in the interior of the *average* shop or engine room is 35 to 40 seconds. In hazy weather, double this time; in dull, cloudy weather, quadruple it.

Often one cannot focus on the ground glass and must depend upon the scale of distances on his camera-bed for focusing, and upon his view-finder for properly placing the subject. A very little practice will enable one to judge distances accurately and focus with the scale. The view-finder should be tested by focusing some object on the ground glass and observing its position in the finder. It is rare that an object in the center of the plate will also appear in the center of the finder. The error must be determined and allowed for when using the finder alone. Use a light, stiff tripod and do not straddle one leg while focusing. A gossamer focusing cloth is best. At a small extra expense, a supplementary wide-angle lens can be obtained, which will be found very useful in tight corners.

Unless one is experienced, it is best to have the developing done by an expert. To obtain the best results in this class of work, the negatives should be printed on glossy silver-chloride paper, toned to a deep brown, almost verging on a blue, and giving a high polish in a burnisher or on a ferrotype plate.

* * *

The State Department announced some time ago, officially, that the World's Fair, which was to have been held at Tokio, Japan, in 1912, has been postponed by the Japanese until 1917, when it is proposed to have a grand celebration in commemoration of the fiftieth anniversary of the Mikado's ascension to the throne.

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[*] For additional information on this subject, see the following articles previously published in MACHINERY: Correcting Perspective in Shop Photography, February, 1908, and other articles there referred to.

[†] Address: 302 Pioneer Building, Seattle, Washington.

LARGE COLLET MADE ON AUTOMATIC SCREW MACHINE.

Fig. 1. Collet, 4 5-8 Inches in Diameter, finished from 40-point Carbon Steel in 70 Minutes on an Automatic Screw Machine.

In the November issue of MACHINERY some interesting work produced on a large sized Cleveland automatic screw machine, manufactured by the Cleveland Automatic Machine Co., Cleveland, O., was illustrated. This work consisted of a cast iron piston provided with a stem, practically finished all over, and a drill chuck with taper shank. The size of the parts made, and the rapidity with which the operations were performed, gave special interest to this article and illustrated in a clear manner how the automatic screw machine has during the last few years proved itself capable of performing a great many operations, which but a short time ago were considered as belonging to the province of the engine lathe. In the half-tone accompanying the present article is illustrated a piece of work the dimensions of which are larger than those of the parts shown in the previous issue. The work illustrated is a collet used in the Cleveland automatic screw machine, made from 40 points carbon steel; it is made from the bar in one hour and ten minutes. The full significance of this will be better appreciated by referring to the dimensions of the collet as shown in the line-engraving, Fig. 5. It will be seen that the largest diameter of the collet is 4⅝ inches and that the length is 7 1/16 inches. The size of the bar, as indicated in Fig. 2, is the same as the largest diameter of the collet when finished.

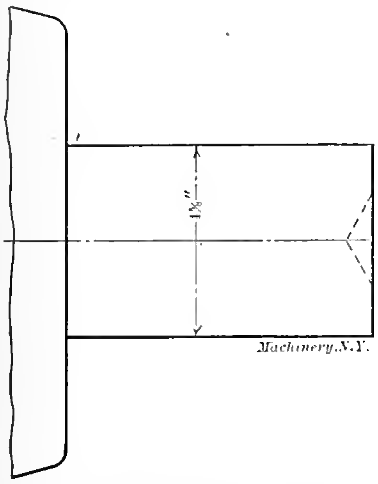


Fig. 2. Bar fed forward and Centered.

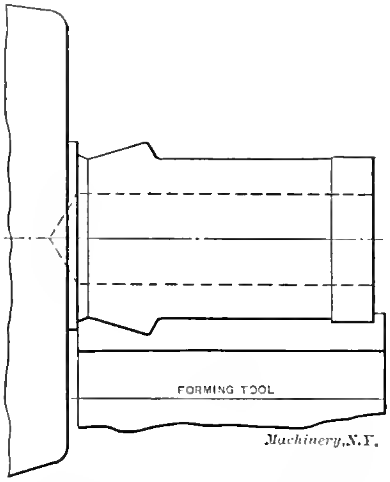


Fig. 3. Hole drilled and Outside formed.

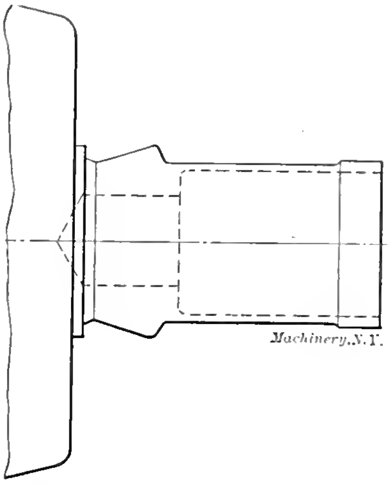


Fig. 4. Hole in Collet counterbored.

The operations performed on the bar are shown in the four line-engravings, Figs. 2 to 5. In Fig. 2 the bar is shown fed forward to the proper position and centered. In the second operation the small hole through the bar is drilled as shown in Fig. 3 and the outside of the collet is formed by a forming tool as indicated, the whole length of the cylindrical surface of the collet being formed at once. The diameter of the hole drilled is 2¼ inches. In the third operation this hole is counterbored to a diameter of 3⅝ inches and to a depth of 5 inches, as shown in Fig. 4. Finally, in the fourth and last operation, this counterbored hole is reamed to the exact size and the collet is cut off from the bar.

The weight of the stock from which this collet is made is 34½ pounds before machining, and the weight of the collet when finished and cut off is 8½ pounds. It will thus be seen that the stock removed in seventy minutes is 26 pounds and that the metal has been removed at the rate of nearly 0.4 pound per minute. Taking into consideration the expense of producing this piece of work, it will be noted that inasmuch as the operating expense of the automatic screw machine employed is only a mill a minute, the actual labor cost for this collet chuck blank is only seven cents. The same piece could be produced from machine steel of about 10 or 15 points carbon in about fifty minutes, or at an actual labor cost of about five cents, which is a remarkable performance if compared with the time required to perform this work either in a lathe or in a hand-operated turret machine. It is not only the size of the work in this case which is of interest to the mechanic, but also the accuracy with which it is performed. Thus the front end of the collet is provided with the correct taper required, when it leaves the screw machine, and the outside diameters are of correct dimensions. The forming operation employing but one single forming tool for a surface over seven inches long and of a shape requiring considerable more metal to be removed at some places than at others, is also very remarkable. In the past it has usually been considered impossible, or at least impracticable, to attempt to take forming cuts of such width; and the present example gives one an entirely different idea of the possibilities of forming operations with forming tools of broad face, than has been generally entertained by mechanics.

The size of the machine in which the work illustrated was performed is, of course, of large dimensions, it being known as a 6-inch automatic, and handling bars weighing from one thousand to twelve hundred pounds. There are, doubtless, many mechanics working in shops where small and medium-sized work is being done, who will be surprised to learn that such large automatic screw machines are being built, which are capable of producing work of the size here illustrated.

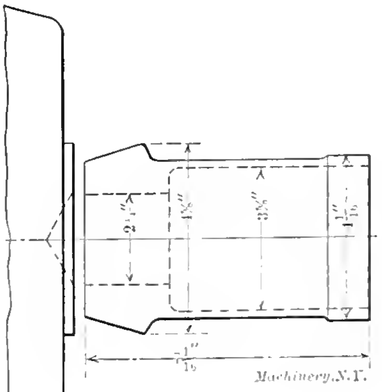


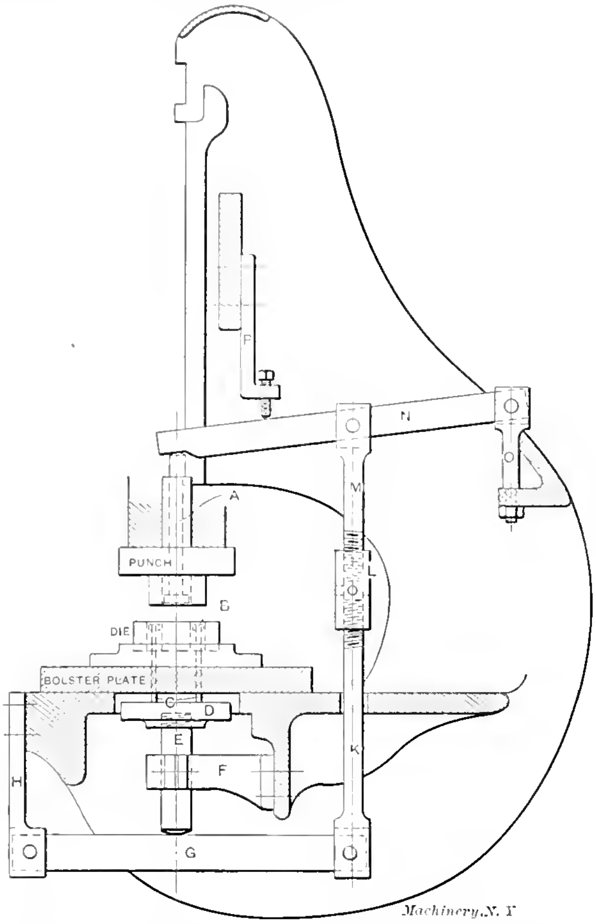
Fig. 5. Collet cut off, after Counterbore is Reamed

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

STRIPPER ATTACHMENT FOR PUNCH PRESS.

It happens frequently in a great many shops that the punch presses do not give half the results they are intended to give; for example, the inclinable presses are not used inclined, and the tools put on them are provided with the "spring and rubber" type of stripper, with all the annoyances belonging to this type, *viz.*, only one-half of the stripper working, the springs breaking, the dies split by the rubber, etc. In a shop within the writer's experience, where these conditions prevailed, it was finally decided to design a stripping arrangement that would work right, and the device shown in the line engraving was installed. The illustration shows a section through the inclinable part of the press and indicates the position of the ribs. The tool shown is of the washer type, *i. e.*, the punch is a ring, cutting both on the outside and inside. Inside of the punch is fitted a stripper plunger *A*. This plunger is longer than the punch, so that its end extends beyond the shank of this tool.



Machinery,N.Y.

View showing the Way in which the Stripper is attached to a Press.

The die has a circular stripper *B* to which are attached rods *C* descending under the bolster plate. The ends of these rods bear on a circular plate *D* supported by a shank *E*. This shank moves freely through the bracket *F* bolted to the press frame. The lower end of shank *E* rests on a lever *G* held in a support *H* fixed in the front of the table of the press. At the other end, this lever is attached by rods *K* and *M* to the lever *N* which bears on one end on the top of the stripper plunger *A* and is pivoted at the other in a support *O* fixed on a cross rib of the machine. The combined length of rods *K* and *M* is regulated by the turnbuckle *L*.

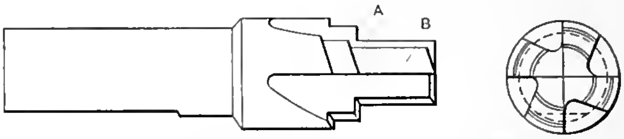
This attachment works as follows: Let us suppose the press ram is in the lower position, the tool cutting the blank. As the whole stripping device is supported from plunger *A*, all parts are in the lowest position. When the ram starts upward the weight of all the moving parts of the stripper is supported by the blank in the punch, this being generally enough to strip the punching. The plunger *A* is prevented from coming too low down by a collar, not shown. Going higher up, the press ram carries along, through the levers, the plate *D*, thereby stripping the lower blank. If the upper blank did not give way at first, it is stripped when the lever *N* encounters the stop *P*, the lower punching being then already stripped.

In making such an arrangement, one should not be afraid of putting too much strength into it. We had Bliss No. 21 presses, that is, presses with about 8 inches opening and a crank-shaft 3 inches in diameter, and we used 3 × ¾-inch machine steel for lever *N*, 4 × ¾-inch for lever *G*, the rods *K* and *M* being 1 inch. All the small pins were ¾ inch, and the guide *E* 1½ inch in diameter.

New York. E. FULBER.

RELIEVING SPECIAL REAMERS.

In making many forms of special drills and reamers, used in valve work or for other irregular forms, the relieving attachments usually furnished with the Pratt & Whitney or Hendey-Norton lathes, will not cut all angles of relief. This necessitates hand work where it is least desirable, as inaccuracy will cause chattering or rough and oversized holes. For the class of finishing reamers shown in Fig. 1, relief at *B* is easily cut with the standard relieving attachments, but relief at points designated by *A* is not so easily obtained, especially if it is desired to undercut the corner slightly.



Machinery,N.Y.

Fig. 1. Class of Reamers to which the Relieving Attachment is adapted.

Not long ago, in a shop where thousands of special reamer and drill forms are turned out each year, I saw an attachment made to use in conjunction with the regular relieving mechanism, that enabled the tool-maker to cut relief at any desired angle, with as much ease and certainty of accurate results as in relieving plain work in the regular way. This attachment is shown applied to a Hendey-Norton lathe, in Fig. 2. It consists, primarily, of an additional universal joint mounted on a sliding base or carriage of its own. This double joint taking the place of the regular single joint, allows the compound rest or tool carrriage to be operated at any angle within an arc of 90 degrees, or even more if needed. The usefulness of this attachment will be apparent, at once, to anyone having use for a relieving mechanism. It was designed by a local tool-maker, and all the parts made by him, except the universal ball joints which were made by the

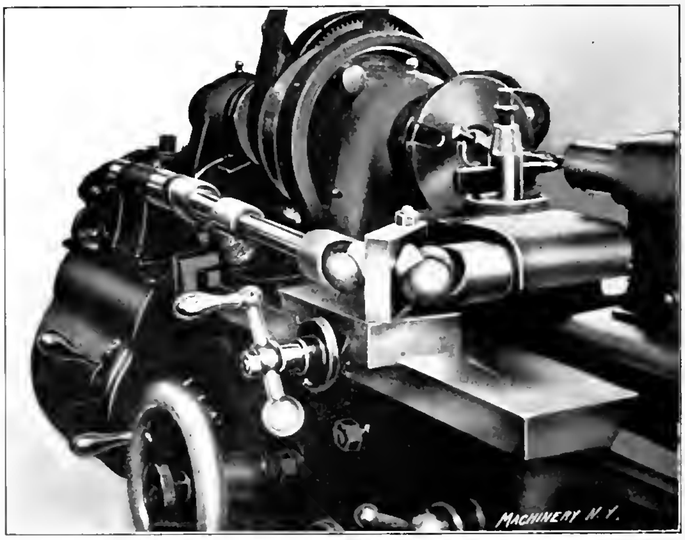

MACHINERY N.Y.

Fig. 2. The Relieving Attachment in Place on a Lathe.

Hendey Machine Co. The device has been in use about two years, and has given satisfaction on all classes of work.

Referring to Figs. 2 and 3, the base of the device *A* is made a nice sliding fit in the cross-slide ways, and is left free to move out or in with the tool-post mechanism. The upright part *B*, which carries the two universal ball joints, is clamped at any desired angle by means of the bolt *E* which engages a nut sliding in the slot *C*. As the motion of the cam shaft and universal joints is oscillating, the bearing in the upright part *B* is simply a bored hole with a well-fitted pin inserted in it to hold the two ball joints together. The rod *F* is the regular cam shaft connecting with the cam and gearing at the left of the lathe, while part *D* connects with the tool-post mechanism.

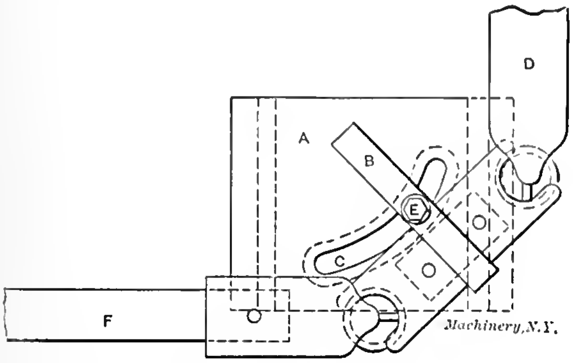


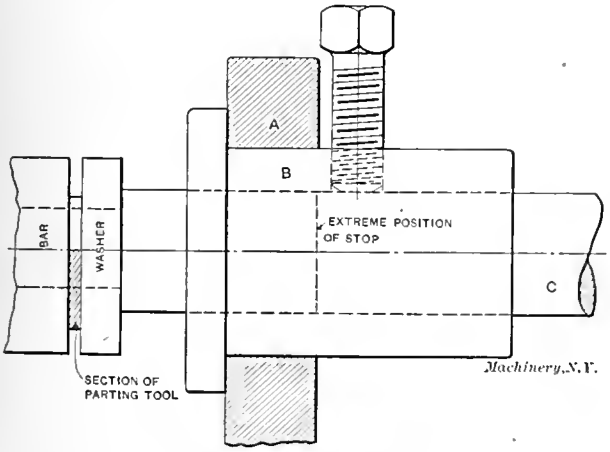
Fig. 3. Plan of the Attachment showing its Construction.

The beauty of the device lies in its simplicity and the ease with which it is placed on the lathe and set at the desired angle. It is also useful for relieving many forms of special and irregular, formed milling cutters, and it is the only device that I know of that enables one to relieve the cutting edges on the *inside* of the hollow mills or "outside reamers," that are so convenient for sizing various parts used in brass valve work, but which are not usually used on account of the difficulty of obtaining accurate inside relief. Everyone knows that relief is absolutely necessary for tools of all kinds, used for brass cutting, especially the brass usually used in a manufacturing plant. Ethan Viall.

Decatur, Ill.

STOP FOR JONES & LAMSON TURRET LATHE.

The accompanying engraving shows a stop for work up to, say, six inches long, to be used in the Jones & Lamson turret lathe, in place of the regular swinging stop. When the latter is used, it is necessary to run the turret slide of the machine back against a stop fixed at a predetermined point on the bed. This consumes a certain amount of time. When turning up bushings, washers, etc., which are cut off from the bar, a stop such as illustrated will be found advantageous on account of its convenience. The sectioned part *A* is that part of the regular cross-slide through which the bar ordinarily passes when cut off, and which is provided with a hole for the bar. In this hole the bushing *B* is inserted, which, in turn, holds the stop rod *C*. This stop rod can be pulled back inside of the bushing, as indicated by the dotted line in the engraving, leaving only a sufficient amount to the binding screw to bind against. When the work is comparatively short it can be passed up against this stop, and cut off to proper dimensions, without making use of the regular swinging stop provided. It is clear that the longest length of stock that can be gaged in this manner is determined by the location of the cutting-off tool in relation to the location marked as the extreme position of the stop in the engraving. Frank L. Immler.



New Form of Stock Stop for Jones & Lamson Turret Lathe.

Pilot Knob, Mo.

MACHINING PLANE SURFACES TRUE WITH BORED HOLES.

When small castings, etc., are to be bored in a lathe, so that the hole will be true with another surface, a very quick and accurate method of doing this is as follows: Bolt the piece to the face-plate in such a manner that the hole can be bored first; then take the face-plate off the lathe without disturbing the setting, and clamp it to a milling machine or planer table, and machine the surface, using the edge of plate to measure for center distance. Recently I had two castings (see Fig. 1) to bore and finish on the bottom. The center distance *A* had to be about right, and the holes in line with the bottom. I proceeded by clamping both castings on the face-plate, as shown in Fig. 2, and boring and threading the holes, after which I took the plate off the lathe, and clamped it to the milling machine table. By measuring the diameter of the face-plate and subtracting the center distance *A* from the radius I obtained the right distance to feed in after touching the edge of the plate with the end mill. This was a very quick and accurate way of doing the job. It will be understood that the outside diameter and back edge of the face-plate must be true when on the lathe spindle.

Providence, R. I. R. C. Scholz.

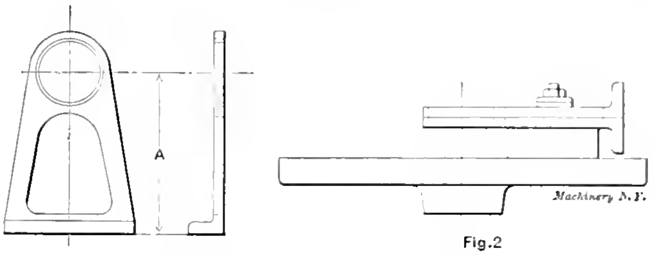


Fig.1

Fig.2

Figs. 1 and 2. Work to be Machined and Method of fastening to Face-plate so as to bore and mill at one Setting.

SOME USES FOR WROUGHT IRON PIPE.

Wrought iron pipe may be used to such good advantage in many emergencies that it is only necessary to show a few examples to prove how widely useful its application may be. In cutting round holes in brickwork, masonry, or concrete, it has become quite common practice to discard the old star chisel, and use instead the common form of the so-called "brick drill," which is nothing more or less than a piece of pipe with teeth filed across one end similar to saw teeth. Repeated case-hardening in prussiate of potash gives sufficient hardness to penetrate even the most stubborn concrete walls. To provide slight clearance for the body of the drill as it enters into a deep hole, the teeth should be mushroomed out slightly with a round taper plug. To avoid splitting the pipe by the repeated blows of the hammer, a malleable iron cap should be screwed tightly to the end, thus furnishing a good head for striking blows. Chips do not retard the cutting action of this form of drill, because they crowd down into the hollow core, and are removed when the drill is withdrawn from the hole.

An extension for a 5/16-inch twist drill can easily be made of a piece of ¼-inch pipe of suitable length, by tapping out the hole in one end with a standard 5/16-inch tap and running a die over the shank of the drill for a distance of about ¾ inch. When pipe and drill are thus screwed together, the drilling operation has the tendency of making it hold tighter in the extension, but if the drill should hap-

pen to break before the seam in the pipe splits open it is an easy matter to replace the broken shank with a new drill. We hear so much about positive-drive drill chucks, double-tang drills, oval sockets, etc., that I wonder why we do not drive all drills by means of a standard thread on the shank the same as a lathe chuck. If the only objection is the added cost of the thread, it seems as though we might have quite an interesting discussion on all the merits and demerits of the various positive-drill drives. On some of the larger sizes of drills the standard pipe may not be strong enough to stand the pressure of driving the drill after being tapped out, the end may then be covered with a reducing coupling and then tapped out, or better still, extra strong or double extra strong pipe may be used if it is on hand.

When cutting off heavy stock in the circular cutting-off saw or in the hack-saw, it is advisable to support both the overhanging ends. A cheap and serviceable stand having no loose parts and able to stand hard usage may be made as follows: A standard cast iron flange 8 inches in diameter, tapped for $\frac{3}{4}$-inch pipe, is used as the base. An upright piece of the right length is screwed into the base, and to the upper end is fastened the support upon which the bar rests. This support consists of a tee having two elbows screwed up close into the ends by means of close nipples. When all is tightly screwed together, the top of the tee should be the same height from the floor as the bed of the saw. Two or more of these stands at each saw do away entirely with blocking up, prevent heavy bars from crashing into the floor, and enable one man to cut with safety any bar he is able to lift.

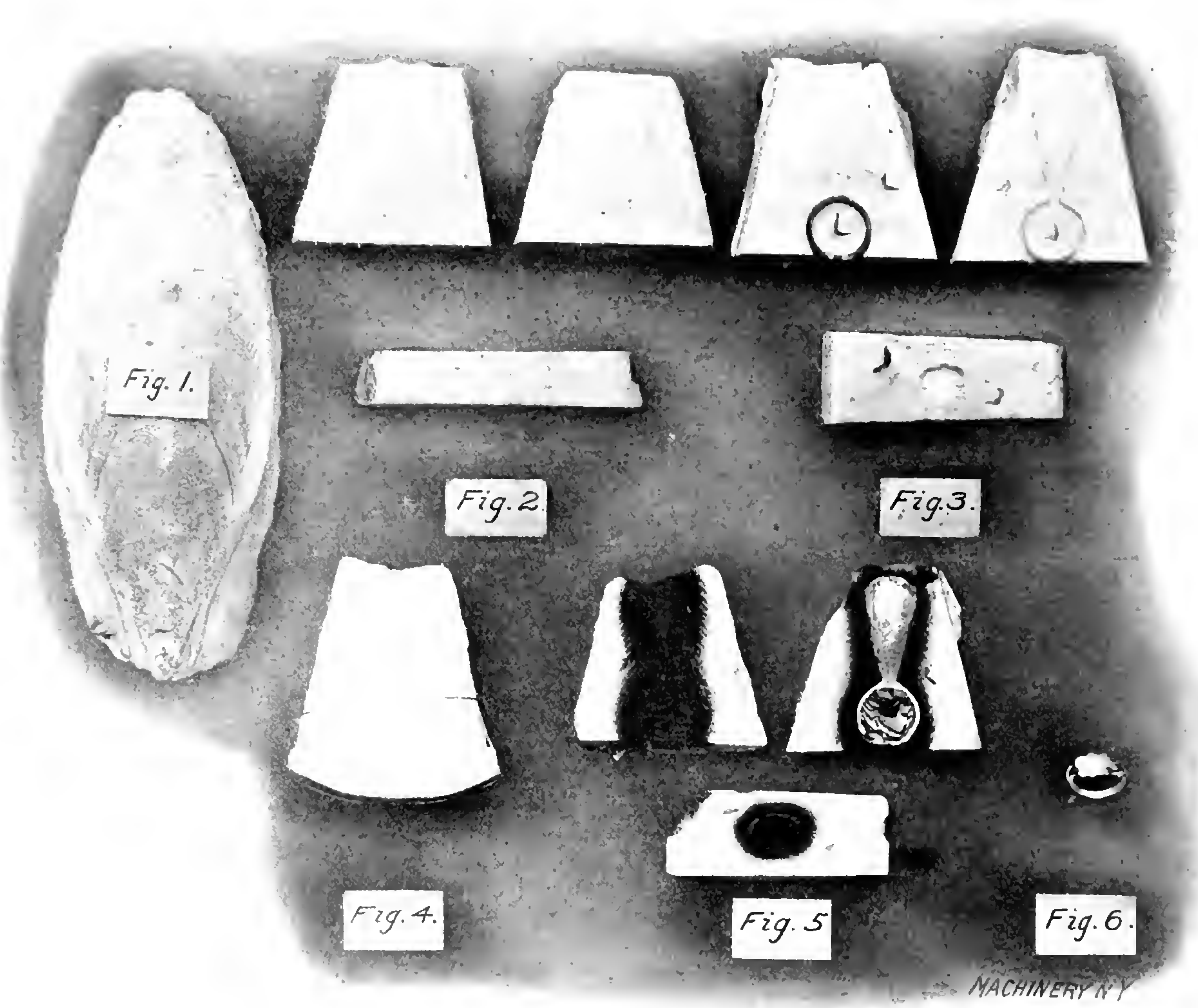
H. J. Bachmann.

New York City.

[The light weight relative to its strength, and comparative cheapness of pipe, has made it a very valuable material in many constructions in the shop. The common usage for bannisters, railings, etc., is well known. Adjustable stands for electric lights are often made from gas-pipe, and we have seen the frames of plumbers' work benches built up entirely from pipe fittings. For many of these purposes discarded pipe is as good as new, and, of course, very much cheaper.—Editor.]

INTERESTING MOLDS FOR FINGER RINGS.

The accompanying half-tone engraving illustrates a phase of metal working which no doubt will interest men who are used to working in the cruder materials, but unfamiliar with the handling of precious metals. The illustrations show molds for casting finger rings, as used by jewelers. The material of which the molds are made is simply cuttle-bone.



Cuttle-bone, and Molds which are made from it for Casting Finger Rings.

Fig. 1 shows the rough bone in its familiar form, while Fig. 2 shows three parts of a mold ready to receive the impressions of the pattern. It is in the matter of making the impressions that one of the most valuable properties of the cuttle-bone is exhibited. A metal pattern slightly larger than the ring is to be, is employed. This pattern is simply placed between the parts of the mold shown in Fig. 2, and the parts are pressed together, the cellular structure of the bone permitting the pattern to indent the surface, producing a mold as shown in Fig. 3, where the pattern is still embedded in one part of the bone. It will be noted that the "seal" part of the ring is formed in the lower piece of bone, and the circular portions in the two upper halves. The pattern is now "drawn," and the gate cut as indicated. The mold is then wired together, as shown in Fig. 4, the alignment being preserved by the V-shaped metal pieces indicated in Fig. 3, which are pressed into the bone at the same time as the impression of the pattern is taken. The molten metal is

now poured; the effect of the heat is shown in the coloring of the bone, in Fig. 5. In one part of the mold in Fig. 5, the ring is shown in place after casting, with the sprue attached, and the completed ring is shown in Fig. 6. After casting, the rings are filed and engraved.

Some rings are cast in sand molds and some in metal molds, but cuttle-bone makes a very simple mold and does not require any venting, on account of its porosity. The writer is indebted to Mr. M. Lichtenstein, of 19 South 48th Avenue, Chicago, for the set of molds from which these photographs are taken.

Chicago, Ill. W. E. Morey.

UNIQUE TURRET LATHE TOOL.

It is required to finish a number of castings, as shown in Fig. 1. These castings are 10¼ inches in diameter, and provided with steps or recesses as shown. The castings are to be finished all over, and as turret lathes have only six holes in the turret for tools, the question presents itself how to finish the stepped face in one operation, if possible. The tool shown in Fig. 2 was constructed for this purpose, and is used in connection with the guide *C* in Fig. 3. The cutter shown in detail at *D*, Fig. 2, is made of high-speed steel, and the guide *C* of machine steel and case-hardened on the faces *B*. When machining the casting, two boring-bars are used, one for rough boring and the other for finishing the hole preparatory to reaming. These tools, together with the reamer, occupy three holes in the turret. In the fourth hole is inserted the stem of the stop *C* against which the end *E* of the cutter *D* rests when taking the cut. The holder for the cutter is held in the tool-post on the cross slide, and when the guide *C* is brought up against the end of the cutter, the spring *A* is compressed. The deepest recess of the work is now finished. It will be seen that as the end *E* of the cutter *D* moves outward on the guide *C* it will reach the first step, and, actuated by the spring, will slide down this step and finish the intermediate recess in the work. It then slides down to the lowest step on the guide, finishing the outside face or side of the work. The fifth and sixth holes in the turret are used for holding flat cutters for finishing the surfaces *F* and *G*, at the same time removing the rounded corner between the steps which is caused by the previous operation. In Fig. 4 is shown a gear blank faced on the hub and rim with the same tool in combination with a corresponding guide. The illustration shows plainly the manner of operation. This tool is particularly commendable in cases where the turret has not enough holes to receive all the tools required if a separate tool were provided for each surface. To be able to turn two surfaces by the same tool is therefore very essential in many cases, and is made possible by the tool construction shown.

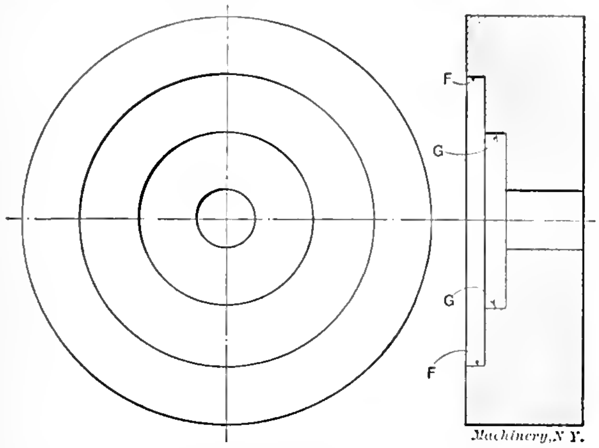


Fig. 1. Casting to be Finished.

Lowell, Mass. J. S. Scott.

RAPID STEEL ARMOR PLATE PLANING.

Some good planing was recently done in the shops of the Witkowitzer Bergbau und Eisenhütten Gewerkschaft. The piece was a hardened steel armor plate of Krupp's best make, 5.81 inches thick. In three hours and fifteen minutes, without re-sharpening the tool, there were removed 115.94 cubic inches of steel. The cutting speed was 16.76 feet per minute; the feed 0.12 inch; and the depth of cut 0.512 inch. The establishment mentioned, reports that this is the best work in this line yet done therein. It was, of course, performed by one of the numerous rapid-cutting steels which have sprung up all over Europe after the introduction of the Taylor-White process in 1900. G.

THE ACKNOWLEDGMENT OF ADVERTISING MATTER.

As you are doubtless interested in anything contributing to the efficiency of trade paper advertising, we take the liberty of suggesting a matter that is often brought to our attention by clients.

Advertising in the trade and technical papers brings inquiries of various sorts, some from people who are interested in the purchase of apparatus, others from persons who wish to inform themselves about the subject in question, and still others from people who appear to apply merely through curiosity, or the desire to get something for nothing. Now, the majority of manufacturers, while they often spend considerable money in the preparation and printing of their catalogues and other trade literature (the bare cost of printing alone often running up to 50 cents or 60 cents per volume) do not, as a rule, object to filling the requests of all three classes.

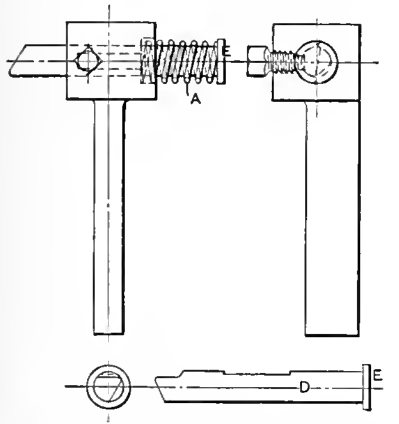


Fig. 2. Tool held in Tool-post on Cross-slide in Turret Lathe, for Finishing Casting in Fig. 1.

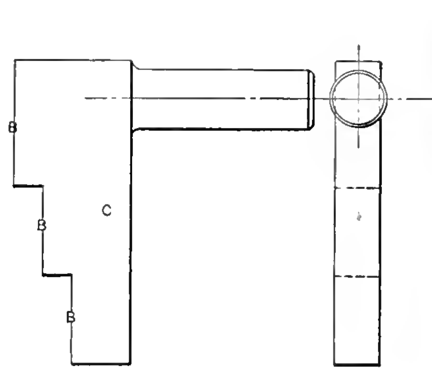


Fig. 3. Guide for Turning Recess in Casting, Fig. 1, used in Combination with Tool in Fig. 2.

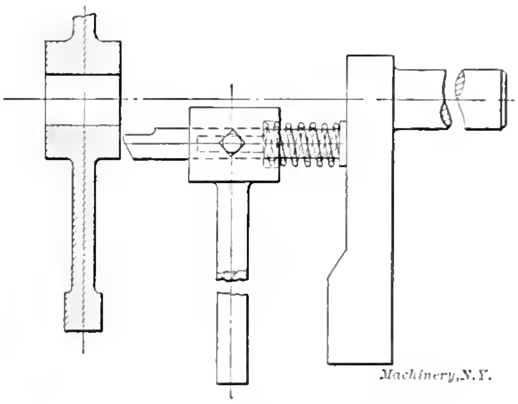


Fig. 4. Facing Hub and Rim of a Gear Blank by the Tools shown in Figs. 2 and 3.

However, the publication of advertising literature is only one step in the selling campaign, and once the prospect has been opened, the organization of selling forces is such that other steps should follow, as it were, automatically. The next thing, therefore, for the salesman to do after receiving an inquiry and sending the literature requested, is to call upon or write to the inquirer to find out what his needs may be. This frequently leads to much waste of time and money. The man who asks for a catalogue may not, as suggested above, be in the market, and if he is located in some out-of-the-way place, it costs a good deal to find this out by means of a personal call.

The point that we wish to bring out is that people who ask for catalogues should at least acknowledge receipt of the

printed matter, and of the letter which usually accompanies it, stating whether or not they expect to purchase in the near future. They rarely ever do this, thereby putting not only the manufacturer, but often themselves also, to some inconvenience and annoyance, inasmuch as the manufacturer has gone to the expense of printing this matter and of mailing it, a simple acknowledgment would seem to be in order, especially as many manufacturers now enclose return postal cards, oftentimes stamped, for this very purpose.

If you could consistently take this matter up in your reading columns and say something which would lead to a more general understanding of the situation on the part of the public, we believe it would lead not only to a lessening of the expense and labor involved in selling machinery, but also to the higher efficiency of trade and technical paper advertising.

New York. THE GEO. H. GIBSON CO.

SIMPLE WIRE-BENDING TOOL.

The accompanying half-tone engravings illustrate a piece bent from plain steel wire, and the appliance used in performing the various bending operations. The straight wire shown in Fig. 1 is 8 inches long, No. 6 gage.

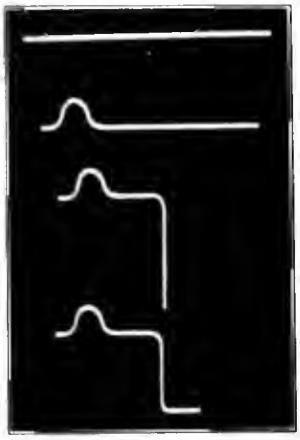


Fig. 1. The Successive Steps in the Bending Operation.

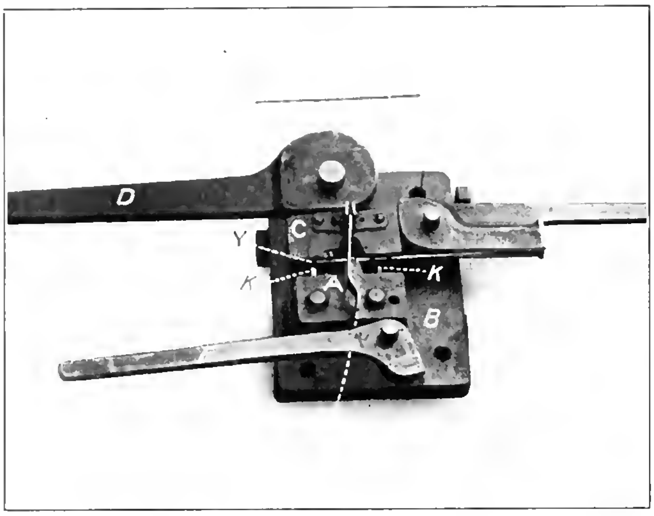


Fig 2. Jaws A and C, which form the First Bend, opened and Wire inserted.

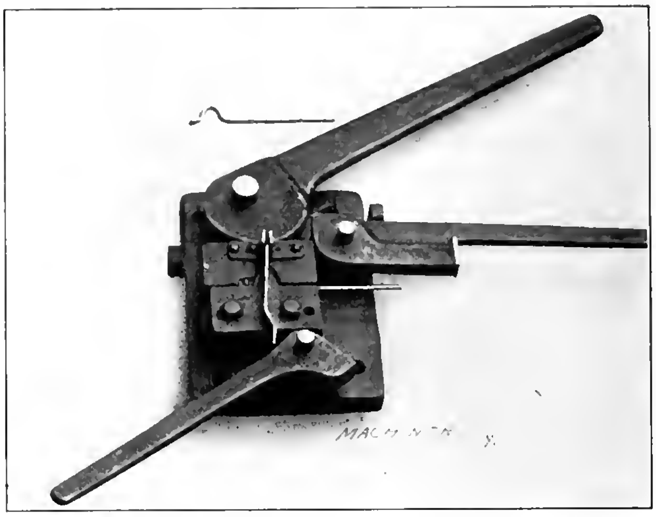


Fig. 3. Jaws closed by the Upper Lever, and First Bend made.

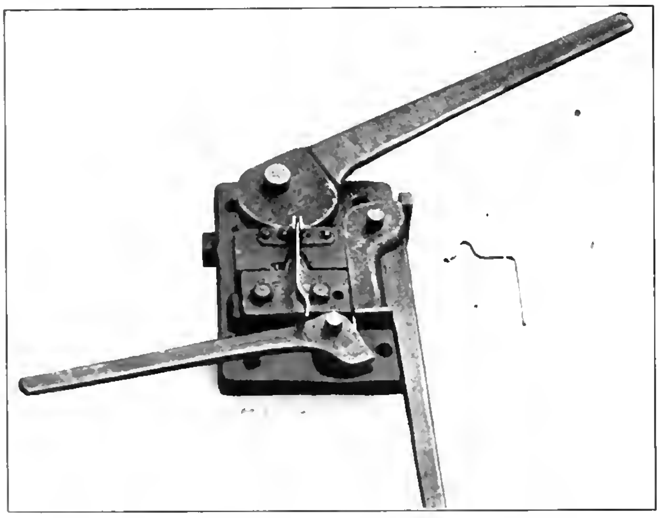


Fig. 4. First Right-angle Bend made by the Lever to the Right.

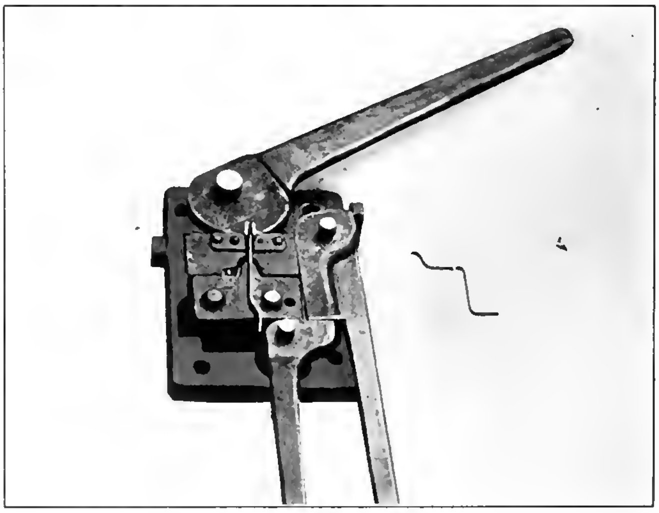


Fig. 5. Second Right-angle Bend made by the Lower Lever.

The shape of the wire after it has passed through the consecutive operations, is plainly indicated in the same illustration. Fig. 2 shows the appliance for performing the work, which is here shown in the position where the straight wire is placed in the opening between the jaws *A* and *C*. The inside former or jaw, *A*, is bolted to the bottom plate *B*, while the outside former slides back and forth on the pins *K*. A spring between the two jaws keeps them apart when the levers are in the position in Fig. 2. The two pins *K* also support the wire when placed in the tool by the left hand of the operator, and a small pin located at *Y*, in the sliding jaw *C*, acts as a stop for laying the wire at its proper place for bending. The lever *D* is now swung around by the right hand of the operator, to the position shown in Fig. 3. This brings the jaws together and produces the first bend. The part of the wire, which extends beyond the jaws, is now in position for the second bend. The operator takes hold of lever *E* with his left hand, and swings this lever downward against the fixed jaw *A*, making a second bend, as shown in Fig. 4. The operator now removes his right hand from lever *D*, and grasping the lever *F*, produces the third or last bend, as shown in Fig. 5. The latch on hook *G* holds the two jaws together after lever *D* is released, as shown quite plainly in Fig. 5. The direction of motion of lever *F* is now reversed. The end of the latch or hook *G* is beveled, so that when lever *F* is swung back, the hook is raised and disengaged from the jaw, thereby permitting the jaws to open. At the same time, springs, not visible in the illustrations, act on the levers *D* and *E*, causing them to return to their original positions, as shown in Fig. 2. The action of the device is very rapid and safe. The operator's hand is never in danger of being injured, because at no time does the operator place his fingers where they are liable to be hurt by the action of the mechanism. The simplicity of the tool and the safety of the device is a factor which should not be overlooked. It should be remembered that the output of a tool should not be the only consideration.

Yonkers, N. Y. G. P. CAMPBELL.

TO SET OVER THE TAIL-STOCK TO TURN A TAPER.

Referring to the article "To Set Over the Tail-Stock to Turn a Taper" in the September issue, if the only error is that caused by the depths of the center holes, these can be measured and subtracted from the length of the piece.

Another way would be to clamp a T-square or its equivalent in the tool-post or holder, set it against the foot-rule (see Fig. 1, ante) and clamp it there at the required angle; then put the work between the centers and set the foot stock over until the square bears along the side of the piece. (This is of course for pieces already turned cylindrical and truly centered.) The square must be at the height of the centers.

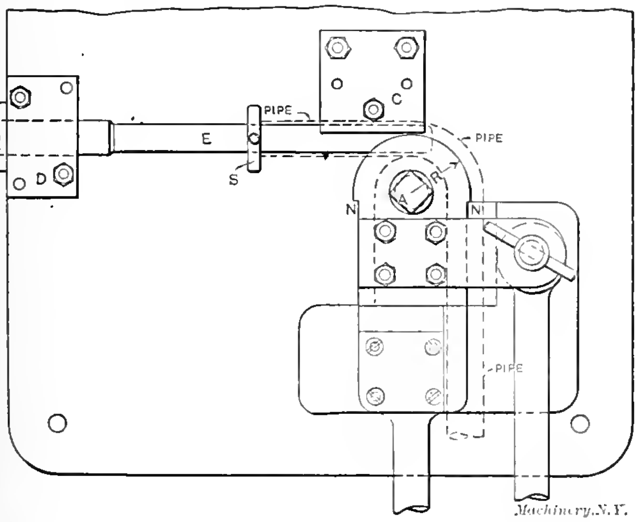
Dresden, Germany. ROBERT GRIMSHAW.

[Our correspondent doubtless knows that a correction made for the depth of the center holes, when figuring the set-over of the tail-stock for turning a taper, can only be approximate. The reason is that the location of the bearings of the piece on the centers always is uncertain, and unless the precise location of the bearings can be ascertained the calculation will be inaccurate.—EDITOR.]

PIPE BENDING DEVICE.

The writer read with interest the article in the September, 1908, issue of MACHINERY, entitled Pipe Bending Device. Having designed and followed the construction of this fixture myself, I wish to make a few suggestions which may be helpful to anyone wishing to construct a device of this kind. The success of the fixture depends entirely on the shape of the end of the horn or mandrel *E*. To get the correct shape requires a great amount of patience and experimenting, and it is not possible to give definite figures or dimensions for this shape. The pipe, in making the bend, must spin off the end of this horn, and a little too much or too little in the curvature of the end will prevent good results.

In the engraving shown in the September issue, the stop collar *S* was omitted. This collar acts as a stop for the end of the pipe, and is adjustable on the mandrel *E*. By means of this collar the bend in the pipe may be located at any required distance from the end. Backing-block *C* and mandrel *E* should be so placed that the pipe fits quite snugly between them. The mandrel should also be a good sliding fit inside of the pipe.



Plan of Pipe Bending Device, showing Position of Parts after making a Right-angle Bend.

The radius *R* of the swivel block *A* should project at least ⅛ inch beyond the center line of the pipe, and the block should be notched at *N*, bringing the outline back to the center line. The backing-block *C* then, of course, extends only to within ⅛ inch of the center line. With a fixture made in this way, the pipe may be bent to a complete return bend. It appears that the pipe needs some extra support beyond the center line, and only short bends can be made successfully without this support.

The distance which the end of the mandrel *E* extends beyond the center line of the swivel block *A* should be experimented with very carefully. After bending a few pieces with the end of the horn placed at various distances beyond the center of the swivel block, the preferable position of the mandrel is easily determined. When finally established so that the pipe bends without buckling, the collar and the mandrel are drilled and reamed in place, and a taper pin driven in. When once located, this collar should never be tampered with. R. B. LIBBY

Lansing, Mich.

A BIT OF RADIAL DRILL DESIGN.

Two methods of driving the spindle of a universal radial drill are shown in the accompanying engravings. Fig. 1 is the usual way, and Fig. 2 an improved method which has, in my opinion, sufficient advantages to warrant its universal adoption. Both Figs. 1 and 2 are sections through the center of the arm; *F* is the spindle, *G* the driving shaft in the arm, and *E* the face of the arm.

One of the worst features of the ordinary universal radial, is the short bevel gear shaft *H* (Fig. 1), upon the center of which the drill head swivels. It is impossible to make this bearing of good proportions, because as the distance *C* is lengthened the distance *B* is increased. Now it is an axiom in designing a radial drill, that the spindle must be as close to the arm as possible to minimize the twisting action, so that the designer is placed between the devil and the deep sea—he must sacrifice either rigidity or durability, or else compromise. He generally does the latter and evolves a machine that is neither rigid nor durable.

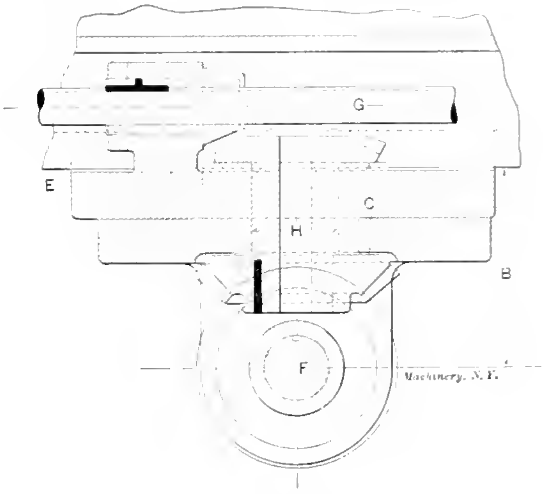


Fig. 1. A Common Form of Drive for Radial Drill Spindles

The new Bickford universal radial was designed to overcome these difficulties, and, as far as can be judged from illustrations and printed descriptions, a fairly satisfactory solution seems to have been attained. Long before I heard about the new Bickford machine I had been puzzling my brain for a more satisfactory method of driving the spindles of universal radials and my solution is shown in Fig. 2. On the arm shaft *G* is mounted the miter gear *J* which drives the miter *K*, the latter being forged solid with its shaft *P*. Keyed to the shaft *P* is the spiral pinion *L* which meshes with a spiral gear *M* keyed to the socket *N* in which the spindle *F* slides. The drill head swivels on the bush *O* which forms one bearing for the shaft *P*. Now let us compare Fig. 2 with Fig. 1 which represents actual practice. The length *C* of the bearing *H* is 3¾ inches, while the over-all length *D* of the bearings for shaft *P* is 11 inches, or nearly three times as long. The dimension *B*, which represents the distance from the center of the spindle to the face of the arm, is 8 inches, while *A* is only 6 inches, so that we are 25 per cent "to the good" here. Summing up, then, we find that the new type is practically 300 per cent more durable and nearly 25 per cent more rigid.

The end of the shaft *P* lends itself very conveniently for driving the feed motion, either by belt cones, as shown, or a gear box. Another advantage is that the spindle, being offset to the left of the fulcrum *D*, will go very close to the column and thus give a greater horizontal movement of the head on

the arm, though, of course, this extra length will have to be put onto the outer end of the arm. The only objection to this arrangement, so far as I know, is that the drill head will have a tendency to swivel on the fulcrum *D* under the pressure of the cut. Personally, I think that the clamping bolts will take care of this, because the twisting moment tending to swivel the drill head is only one-twelfth of the moment which tends to twist the arm around the column when the machine is drilling horizontally at a radius of 60 inches, and most firms find that a V-clamp is sufficient to resist this.

In our practice, we provide a worm and worm gear for turning the arm around the column. This arrangement provides a positive stop for the column, which I think is necessary for universal radials, because if the spindle is at the outer end of the arm and swivelled to drill horizontally, the turning moment on the column clamp is enormous, and a friction clamp, in my opinion, is utterly inadequate for the work. Where very heavy cutting is to be done, it may be necessary to provide a similar arrangement for this form of drill head; but even if this had to be done, it would be very convenient for adjusting the angular position of the spindle.

Racquet.

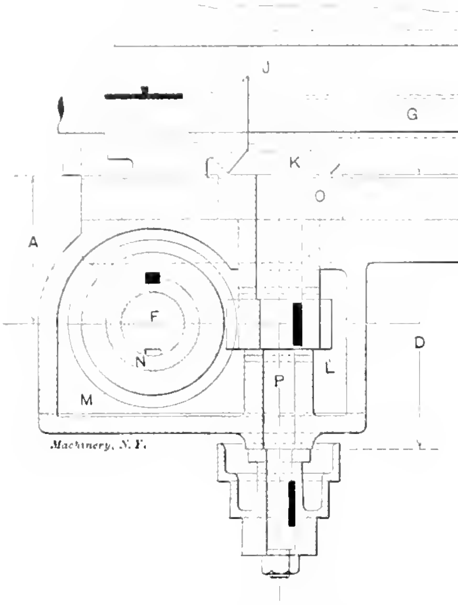


Fig. 2. An Improved Drive giving Greater Rigidity and Durability.

SETTING WORK ON THE FACE-PLATE.

A much more satisfactory way of setting the die-blank illustrated on Shop Operation Sheet No. 76, than that which is there given, is as follows:

When laying out the blank, inscribe a circle the size of the hole to be bored, heavy enough to be seen plainly. After the blank has been approximately trued up, and balanced as explained in steps 1 to 6, fasten a sharp scratch in the tool-post on a line with and facing the prick-punch mark. Bring this point (with the cross-feed) to the circle inscribed and adjust the blank until, by turning the face-plate, the circle will follow the point. The advantage of this method is a more accurate job, and if the work moves while being machined (as it is liable to do), it will be seen at a glance, and can be easily adjusted again. In truing up with a prick-punch mark, you have no way of telling if the work moves, and no way of truing it if it did. Prick-punch marks are never satisfactory for accurate work.

A Subscriber.

[It is doubtful whether the method of setting work advocated in the foregoing, has any advantage over that given in the Shop Operation Sheet referred to. If a circle the size of the hole to be bored is first scribed and the blank set by it, it is probable that the setting will not be as accurate as when the datum or central point from which the circle is scribed, is used, provided, of course, that a center tester is available. The die-blank in question, however, was laid out from a master templet, and the circular ends might have been set with a pointer without locating a central point. This method could also be employed in case the work shifted; or, assuming that part of the hole had been trued, a test indicator could be used instead.—Editor.]

LOCK-NUTS USED IN ENGINEERING PRACTICE.

The engraving shows two forms of nut-locks. I use the term advisedly, for most of the devices illustrated in the September Data Sheet are means for locking nuts rather than lock-nuts proper. The nut shown in Fig. 1 is made from a coil of square steel bar; it is shaped by punching and finished by milling. The hole is tapped a little below nominal size.

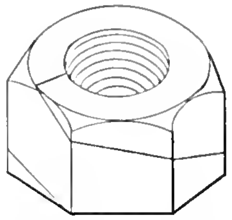


Fig. 1. Helicoid Lock-nut.

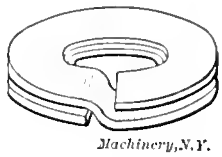


Fig. 2. Spring Washer.

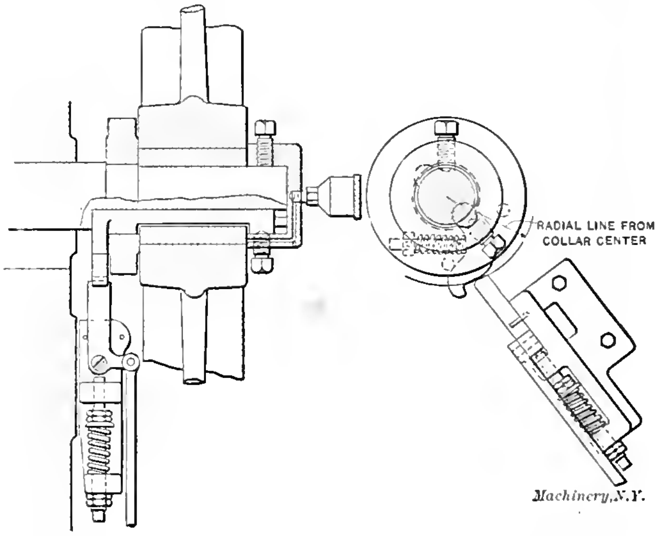
Screwing the nut on a bolt expands the coil which grips the bolt tightly. These nuts are employed, in many cases, for engine connecting-rod bolts. If properly fitted, they never work loose.

The spring washer shown, is used on rough, cheap work, as, for instance, on the ends of bench vise screws, with an ordinary nut, to retain the screw in position and to automatically take up wear on the front collar of the screw.

Nutlocks.

BLISS POWER-PRESS CLUTCH.

In the November issue of Machinery, engineering edition, we find an article entitled "Clutches for Power Presses," by Mr. Frank Mossberg (being an abstract of his discussion of the American Society of Mechanical Engineers' paper by Mr. Henry Souther, on clutches). In this article is illustrated the Bliss clutch, Fig. 4, and we wish to call attention to the fact that the illustration does not properly show the Bliss clutch, being wrong in several details. The accompanying illustration correctly shows the Bliss clutch, and by comparison with Fig. 4 in the article referred to, several differences will be noted. A few of these are as follows:



Bliss Power-press Clutch.

The wheels are all fitted with bronze bushings. The construction of the end collar is not correctly shown in the previous illustration, the wheels in all regular fly-wheel presses being fitted with two locking points and not three; three locking points are used only when the press is geared. The end collar is fitted with a set-screw by which the clutch can be locked, in which position it is impossible to trip the press. This has been found of service when setting dies in the press. Instead of the cap bolt, shown in the illustration referred to, for holding the end collar in place, there is a grease cup by which the shaft bearing is oiled.

Brooklyn, N. Y.

Joseph B. McCann,
E. W. Bliss Co.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

TURNING SOFT RUBBER SAWING CAST IRON UNDER WATER.

The following questions are submitted to the readers for answers:

L. M.—What is the best method of turning soft rubber in a lathe, and what form of tools are required? Is a lubricant necessary, and if so, what is best?

H. M. Co.—We have been doing some experimental work sawing cast iron under water with a regular hack-saw. The cast iron surface seems to become glazed and the saw blades refuse to attack the metal, simply sliding upon it as though it were a hardened surface. Can you suggest any way of avoiding the difficulty when it is necessary to saw under water?

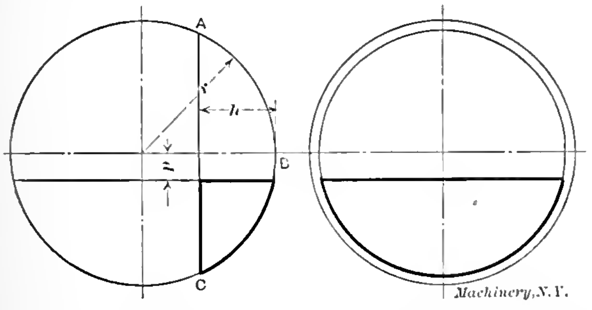
MULTIPLE THREAD SPECIFICATIONS.

P. G. and T. W.—An order came to our shop for a job in which the instructions for a square thread were as follows: "Double square thread, two per inch." We cut the thread ½ inch pitch and 1 inch lead. Our customer contends that it should have been cut ½ inch lead, or two threads per inch, then doubled. Which is correct?

A.—The customer's instructions were indefinite and could be interpreted either way. The case illustrates the confusion that arises from the indiscriminate use of the terms "lead" and "pitch." What the customer evidently desired was a double square thread, ¼ inch pitch and ½ inch lead, and if the order had specified this the mistake could not have been made. In all specifications for multiple-thread screws it is highly essential to specify both lead and pitch to avoid confusion and mistake.

OBTAINING VOLUME OF PART OF A SPHERICAL SEGMENT.

F. M. S.—I would like to submit the following problem to the readers of MACHINERY. Given the volume of a spherical segment, to determine the volume of the portion obtained by placing a plane through the segment perpendicular to its base, as indicated in the accompanying engraving. Here the volume required is that of the portion shown in the heavy lines; the values known are *r*, the radius of the sphere, *h*, the height of the segment *ABC*, and *p*, the distance of the cutting plane from the center of the segment.



CAUSE OF DIMINUTION IN VOLTAGE FROM A GENERATOR.

J. T.—We have a direct-current 10-kilowatt, 125-volt, 80-ampere Westinghouse generator running at 1,350 R.P.M., which we used occasionally last winter. On starting up the machine, the voltage would keep steady at 120 volts for perhaps thirty minutes, then it would gradually fall to about 110 in the course of thirty minutes more. Then, if we turned the rheostat to bring up the voltage, it would gradually fall again the same as before. In the meantime the whole machine would warm up a little, but the longer it ran the weaker the voltage became. If the machine was stopped long enough to let it cool off, it would start off with the voltage strong as usual, but the longer it ran the weaker the voltage became. We carry about 75 lights, and have tried cutting out the lights when the voltage dropped, but it would not rise to normal until the machine had been stopped for some time. We know that the trouble was not caused by a slipping belt or loss of speed. What is the cause?

Answered by Wm. Baxter, Jr.

A.—The action of your generator is normal, and does not indicate that anything is out of order. When the machine starts up, the current flowing through the wire heats it, and the rise in temperature increases the resistance, so that less current passes through the field coils and as a result the magnetic strength is reduced, and this causes the voltage to drop. When you turn the rheostat to cut out resistance, the current is increased and the voltage rises. The proper thing to do to save unnecessary adjusting is to set the rheostat, at the start, so as to develop a voltage a trifle higher than the normal; then the field coils will heat up faster, and will have to heat up more before the voltage is reduced to a point where it has to be increased again. It after the machine has run long enough to get warmed up to the normal running temperature, the voltage cannot be raised to the required point by cutting out all the rheostat, it indicates that the speed is too low, and the remedy is to speed up. The increase in velccity should be made a trifle more than the increase in voltage that may be desired; thus if the voltage can only be run up to 120, and you want 125, increase the speed five or six per cent.

SPIRAL GEAR PROBLEMS.

C. K.—Kindly work out and illustrate the following problems: 1. Find the essential dimensions for a pair of spiral gears, velocity ratio 3 to 1, center distance between shafts 5⅛ inches, angle between shafts 38 degrees. 2. Find the essential dimensions of a pair of spiral gears, velocity ratio 8 to 3, center distance between shafts 9 5/16 inches, angle between shafts 40 degrees. 3. Find the essential dimensions for a pair of spiral gears, velocity ratio 5 to 2, center distance between shafts 4 1/16 inches, angle of shafts 18 degrees. 4. Give rules for calculating the change gears for connecting the dividing head and lead-screw of the milling machine table, when cutting leads that are not given on the tables furnished by the builders.

A.—1. All three of the spiral gearing problems you have given us can be solved by a simple modification of the plan described in the May, 1906, issue of MACHINERY, in an article entitled "A Method of Procedure in the Design of Helical Gears." This article, which is also reprinted in MACHINERY'S reference series No. 20, should be referred to in connection with this description.

The following reference letters will be used:

C = center distance between the axes of the gears,
D_a = pitch diameter of the pinion,
D_b = pitch diameter of the gear,
N_a = number of teeth in pinion,
N_b = number of teeth in gear,
P'' = diametral pitch of cutter,
α_a = tooth angle of pinion,
α_b = tooth angle of gear,
γ = angle between the axes of gear.

First obtain a preliminary solution by the diagram shown in Fig. 1. Draw lines AG and AG_1, making an angle with each other γ equal to 38 degrees, the angle between the axes. Locate the ratio line AE by finding any point such as O_1 between AG and AG_1, that is distant from each of them in the same ratio as that desired for the gearing. In the case shown, it is 6 inches from AG_1 and 2 inches from AG, which is in the ratio of 3 to 1 as required. Through O_1 draw line AE which may be called the ratio line. Select a trial number of teeth and pitch of cutter for the two gears, such, for instance, as 36 teeth for the gear and 12 for the pinion, and with 5 diametral pitch for the cutter. The diameter of a spur gear of the same pitch and number of teeth would be $36 \div 5 = 7.2$ inches. Find the point O on AE, which is 7.2 inches from AG_1. This point will be 2.4 inches from AG, if AE is drawn correctly.

Now apply a scale to the diagram, with the edge passing through O and with the zero mark on line AG, shifting it to different positions until one is found in which the distance across from one line to another (DD_1 in the figure) is equal to twice the center distance, or 10.25 inches. If a position of the rule cannot be found which will give this distance between lines AG and AG_1, new assumptions as to number of teeth and diametral pitch of the gear and pinion must be made, which will bring point O in a location where line DD_1 may be properly laid out. DD_1 being drawn, the problem is solved graphically. The tooth angle of the gear is B_1OD_1, or α_b, while that of the pinion is BOD, or α_a. OD_1 will be the pitch diameter of the gear, and OD the pitch diameter of the pinion.

To obtain the dimensions more accurately than can be done by the graphical process, the pitch diameters should be fig-

ured from the tooth angles we have just found. To do this, divide the dimensions as OB and OB for gear and pinion, by the cosine of the tooth angles found for them. If they measure on the diagram, for instance, 21 degrees 50 minutes and 16 degrees 10 minutes respectively (note that the sum of α_b and α_a must equal γ) the calculation will be as follows:

$$
\begin{aligned}
7.2 \div 0.92827 &= 7.7563 = D_b\\
2.4 \div 0.96046 &= 2.4988 = D_a\\
\hline
&10.2551 = 2C
\end{aligned}
$$

The value we thus get, 10.2551 inches, for twice the center distance, is somewhat larger than the required value, 10.250 inches. We have now to assume other values for α_b and α_a, until we find those which give pitch diameters whose sum equals twice the center distance. Assume, for instance, that α_b = 21 degrees 43 minutes, then α_a = 38 degrees — 21 degrees 43 minutes = 16 degrees 17 minutes. We now have:

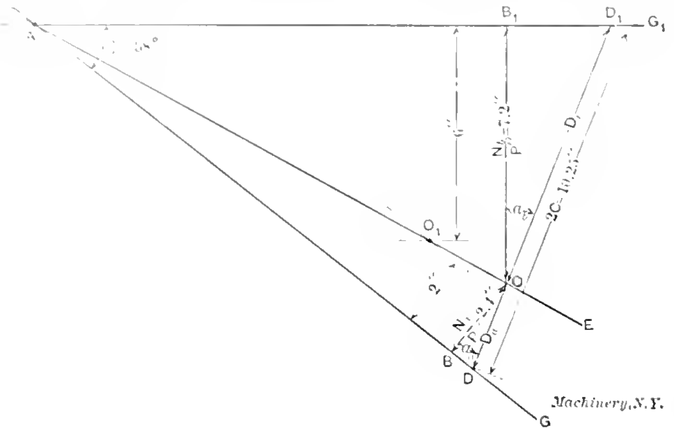


Fig. 1.

$$
\begin{aligned}
7.2 \div 0.92902 &= 7.7501 = D_b\\
2.4 \div 0.95989 &= 2.5003 = D_a\\
\hline
&10.2504 = 2C
\end{aligned}
$$

This value for twice the center distance is so near that required that we may consider the problem as solved. The other dimensions for the outside diameter, lead, etc., may be obtained as for spiral gears at right angles, and as described in the article previously referred to.

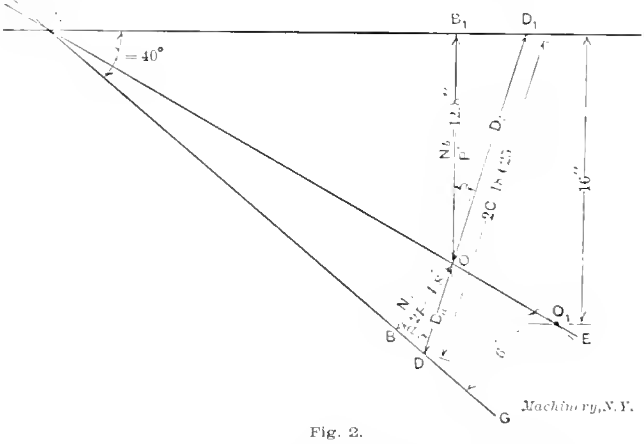


Fig. 2.

2.—The diagram for solving this problem is shown in Fig. 2. The axis lines AG_1 and AG are drawn as before and the ratio line AE is drawn in the ratio of 8 to 3, or 16 to 6, by the same method as just described. A point O is found having a location corresponding to 64 teeth and 5 pitch for the gear, and 24 teeth for the pinion. This gives distance OB = 12.8 inches and OB = 4.8 inches, by which position O is so located that a line DD_1 can be drawn through it at a convenient angle, and with a length equal to twice the center distance, or 18.625 inches. We measure the angles for a preliminary graphical solution as before, and then by trial find the final solution as follows, in which angle α_b is 17 degrees 45 minutes, and α_a is 22 degrees 15 minutes:

$$
\begin{aligned}
12.8 \div 0.95240 &= 13.4397 = D_b\\
4.8 \div 0.92554 &= 5.1862 = D_a\\
\hline
&18.6259 = 2C
\end{aligned}
$$

This gives the value of twice the center distance near enough for gears of this size.

3.—The diagram for solving this problem is shown in Fig. 3. The axis lines AG_1 and AG are drawn as before, and the ratio line AE is drawn in the ratio of 5 to 2, by the same method as just described. A point O is found having a location corresponding to 45 teeth and 8 pitch for the gear, and 18 teeth for the pinion. This gives distance OB_1 = 5.625 inches, and OB = 2.250 inches, in which position O is so located that line DD_1 can be drawn through it at a convenient angle, and with a length equal to twice the center distance, or 8.125 inches. We measure the angles for a preliminary mathematical solution as before, and then by trial find the final solution as follows, in which angle α_b is 16 degrees 45 minutes and α_a is 1 degree 15 minutes:

$$
\begin{aligned}
5.625 \div 0.95757 &= 5.8742 = D_b\\
2.250 \div 0.99976 &= 2.2505 = D_a\\
\hline
&8.1247 = 2C
\end{aligned}
$$

It is often a matter of great difficulty, when the center angle γ is as small as in this case, to find a location for point O such that standard cutters can be used, and that line DD_1 can be drawn of the proper length through O without bringing D to the left of B, or D_1 to the left of B_1. It will be noticed in this case that to make the center distance come right, angle α_a had to be made very small, so that the pinion is practically a spur gear. In some cases, to get the proper center distance, it may be necessary to so draw line DD_1 that one of the tooth angles is measured on the left side of BO or B_1O. Such a case, for instance, is shown in the position of d_1Od. When a line has to be drawn like this, the tooth angles α'_a and α'_b are opposite in inclination, instead of having them, as usual, either both right hand or both left-hand. In Fig. 4 are shown gears drawn in accordance with the location of line DD_1 of Fig. 3, while Fig. 5 shows a pair drawn in accordance with dd_1 of the same diagram, which will illustrate the state of affairs met with in cases of this kind. This expedient of making one spiral gear right-hand and one left-hand should never be resorted to except in case of extreme necessity, as the construction involves a very wasteful amount of friction from the sliding of the teeth on each other as the gears revolve.

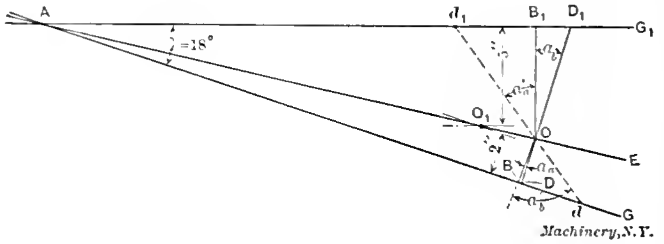
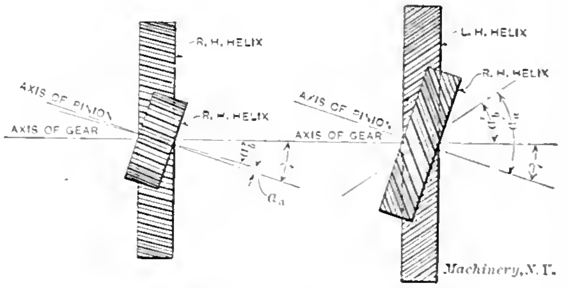


Fig. 3.

4.—Your request for information relating to the figuring of leads for cutting spirals in the milling machine was quite fully answered in the "How and Why" Department of the June issue of MACHINERY. The same subject is also discussed on page 36 of MACHINERY'S Reference Series No. 18. You will also be assisted in selecting gearing which very closely fits the required ratios by studying the article entitled "How to Obtain Approximate Fractions by the Method of Continued Fractions," by Mr. Mitchell Dawes in the August, 1908, issue of MACHINERY.



Figs. 4 and 5.

INSTRUCTION OF APPRENTICES IN THE CINCINNATI MILLING MACHINE CO.'S SHOPS.

The need of a more systematic method of training apprentices than that in vogue during the last decade, has been keenly felt by all manufacturers of machines, because of the growing lack of skilled and properly trained workmen. A great deal has been written about industrial education and about apprenticeship schools, but most of what has been said of the latter has been applicable to very large shops where it was possible to devote a special department to the instruction and training of apprentices. The medium and small-sized shop would encounter the difficulty of heavy expense, if the systems followed in very large establishments were inaugurated. For this reason, any method which will successfully solve the problem of apprenticeship instruction in a medium-sized shop, will undoubtedly be of interest to all who have given this subject attention, and the following outline of the system in use in the works of the Cincinnati Milling Machine Co., Cincinnati, O., may prove suggestive to those who are contemplating the inauguration of some instruction for apprentices in their own plant.

Fig. 1. One Section of the Cincinnati Milling Machine Co.'s Apprentice School in Session.

The apprenticeship school of the Cincinnati Milling Machine Co. was organized in May, 1907, and has thus been established long enough to make it possible to form an opinion about the results obtained. The apprentices work the larger part of the time in the shop under the supervision of the regular department foremen, but receive instruction along more theoretical lines, having practical application, for two hours once a week. Forty apprentices are enrolled and divided into two sections of twenty each. Each of these sections receives instruction Tuesday and Thursday mornings, respectively, from ten to twelve A. M. The boys are paid their regular contract wage during the school hours. A large room in the main office building is utilized as a school room, and is equipped in a manner as shown in the accompanying half tone Fig. 1.

The phase of this particular system of instruction which is of the most interest, is the manner in which the knowledge is imparted to the boys. It would seem at first that two hours a week is entirely too short a time to obtain adequate results, particularly when twenty boys are to be instructed. This difficulty made it important for the instructor to devise some method by means of which all the boys could be kept employed, working on individual problems, leaving the instructor free to devote himself to each of them in turn; the difficulty was overcome by designing so-called "jig sheets," of which two are shown in Figs. 2 and 3. As will be seen from the illustrations, these sheets cover practical subjects, and are made up in such a form as to outline for the boy where to place the answer which he is required to obtain, and, in a general way, the manner in which it is to be arrived at. The name "jig sheet" has been adopted for the reason that the original instruction sheet contains simply the statement of the problem and spaces to be filled in by the student. The "jig," with its explanatory drawings, is drawn on heavy bristol board and is intended to serve as a guide from which the boy is to work—hence the name. The boy places a thin bond paper sheet over this jig and traces all the lines and the illustration on the jig, on this bond paper, the paper meanwhile being attached to the bristol board by means of paper clips. The size of the bristol board is 11 by $8\frac{1}{2}$ inches, so as to permit using regular typewriter letter-size paper for the tracing. When the boy has traced the jig onto the letter paper, he carries out the required calculations,

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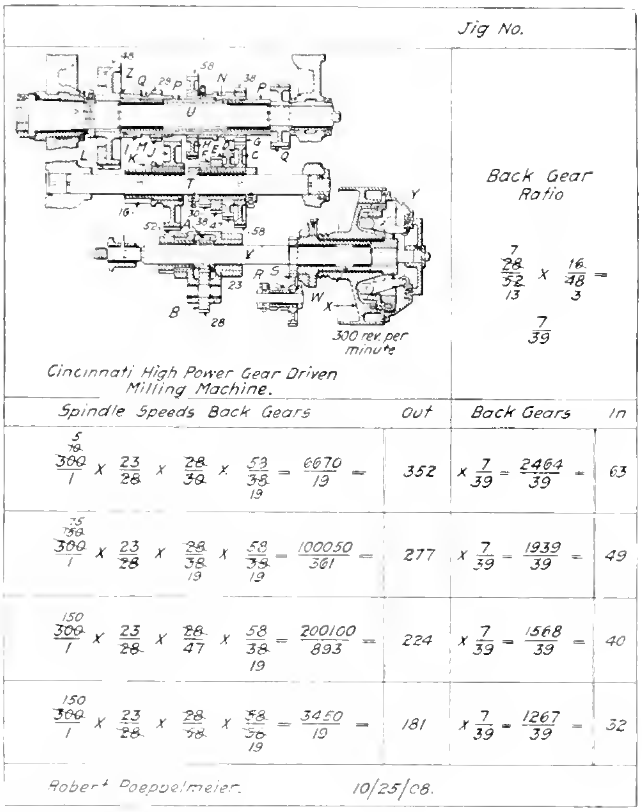
* For additional information on this subject see the following articles previously published in MACHINERY: Evening School of Trades—Rindge Manual Training School, Cambridge, Mass., July, 1908; Can a Boy Learn a Trade in a School? April 1908; Promoting Industrial Education, May, 1907; Vital Needs of Industrial Schools for Industrial Workers, January, 1907; A Step Toward Increased Facilities for Industrial Education, December, 1906; An Experiment in Industrial Training, September, 1906.

placing the results of the whole calculation in the spaces provided. The method employed not only gives the boy an opportunity of acquiring the habit of neatness in copying from an original and an ability to copy simple drawings, but it also provides a neat and permanent record of his work.

Another important feature of this method of instruction is that there is no necessity of a definite outline of a complete course which is likely to fail to arouse the interest of the boy. On the contrary, each boy can be given a problem to work on which has some connection with his regular shop work, and his interest is thereby stimulated. Individuality is given full play, and the boy is permitted to select for himself out of a list of jigs the one that interests him, after which the instructor sits down beside him and endeavors to explain the principles involved. Should the problem require more knowledge of fundamental mathematics than the boy as yet possesses, it gives a good opportunity to instruct the boy in pure mathematics without making it tiresome or wearying to him, the boy realizing that the mathematics he is being taught are absolutely necessary for the solution of the practical problem which he has selected for himself. Thus, for instance, it was found that a boy who took but little interest in exercises in the division of decimals, worked contentedly for one full month carrying out divisions to six decimal places, calculating the angle of tapers, when the length and the diameter were given, and the tangent for the angle required.

The boys are given full liberty to ask any questions and also to propose any problems occurring in their regular work which they desire to have solved, and the instructor makes "jigs" for these problems in the order in which they are proposed, referring back to former exercises when required. It will be seen that in this manner mathematics, mechanics, strength of materials, machine design, drawing, etc., may be taught simultaneously with their practical application, the boy acquiring a working knowledge of these subjects in a way which makes it possible to arouse and continually hold his interest. Mr. J. Howard Renshaw, who is the instructor of the apprentices' classes referred to, states that the system works out very successfully in practice.



Jig No.

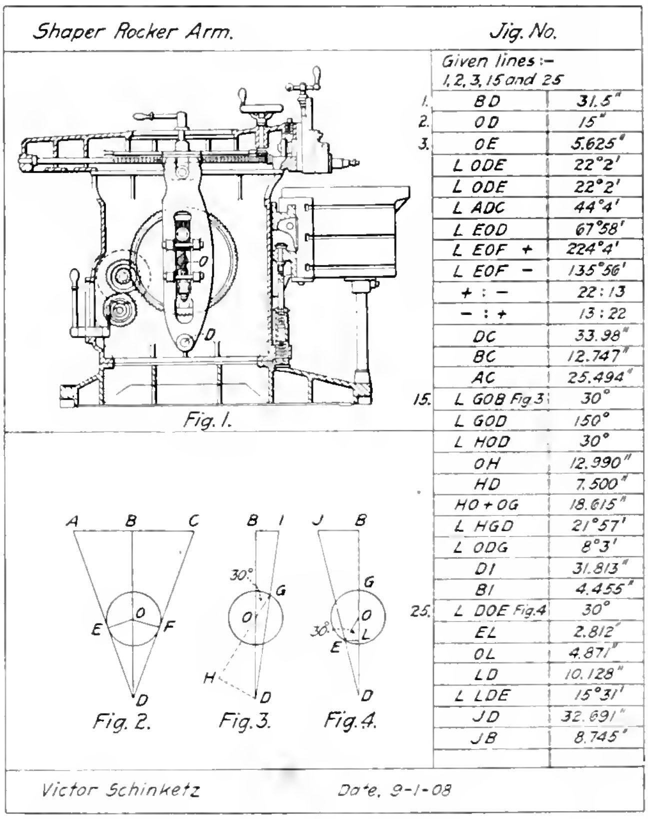
Back Gear Ratio

$$\frac{\overset{7}{\cancel{28}}}{\underset{13}{\cancel{52}}} \times \frac{\cancel{16}}{\underset{3}{\cancel{48}}} = \frac{7}{39}$$

Cincinnati High Power Gear Driven Milling Machine.

Spindle Speeds Back Gears	Out	Back Gears	In
$\frac{\overset{\overset{5}{\cancel{10}}}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{\cancel{30}} \times \frac{58}{\underset{19}{\cancel{38}}} = \frac{6670}{19} =$	352	$\times \frac{7}{39} = \frac{2464}{39} =$	63
$\frac{\overset{\overset{75}{\cancel{150}}}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{\underset{19}{\cancel{38}}} \times \frac{58}{\underset{19}{\cancel{38}}} = \frac{100050}{361} =$	277	$\times \frac{7}{39} = \frac{1939}{39} =$	49
$\frac{\overset{150}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{47} \times \frac{58}{\underset{19}{\cancel{38}}} = \frac{200100}{893} =$	224	$\times \frac{7}{39} = \frac{1568}{39} =$	40
$\frac{\overset{150}{\cancel{300}}}{1} \times \frac{23}{\cancel{28}} \times \frac{\cancel{28}}{\cancel{58}} \times \frac{\cancel{58}}{\underset{19}{\cancel{38}}} = \frac{3450}{19} =$	181	$\times \frac{7}{39} = \frac{1267}{39} =$	32

Robert Poeppelmeier. 10/25/08.



Shaper Rocker Arm. Jig. No.

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

	Given lines :— 1, 2, 3, 15 and 25	
1.	BD	31.5"
2.	OD	15"
3.	OE	5.625"
	∠ ODE	22°2'
	∠ ODE	22°2'
	∠ ADC	44°4'
	∠ EOD	67°58'
	∠ EOF +	224°4'
	∠ EOF −	135°56'
	+ : −	22 : 13
	− : +	13 : 22
	DC	33.98"
	BC	12.747"
	AC	25.494"
15.	∠ GOB Fig 3	30°
	∠ GOD	150°
	∠ HOD	30°
	OH	12.990"
	HD	7.500"
	HO + OG	18.615"
	∠ HGD	21°57'
	∠ ODG	8°3'
	DI	31.813"
	BI	4.455"
25.	∠ DOE Fig.4	30°
	EL	2.812"
	OL	4.871"
	LD	10.128"
	∠ LDE	15°31'
	JD	32.691"
	JB	8.745"

Victor Schinketz Date, 9-1-08

Figs. 2 and 3. Samples of Jig Sheets used in Apprentice School of Cincinnati Milling Machine Co. Designed by J. Howard Renshaw, Instructor. Sheets reduced from 7 1-2 x 9 1-2 inches.

In order to supplement the instruction and keep the interest of the boys, a branch library was secured from the public library of the city, numbering sixty volumes which circulate among the apprentices, the books being selected by the instructor. The cooperation of the public library has been valuable in that many books particularly adapted to apprentice education have been purchased by the public library since the inauguration of this apprenticeship school.

The president of the Cincinnati Milling Machine Co., Mr. Fred Geier, takes a personal interest in the apprenticeship school, receiving reports and information concerning each individual at regular intervals, and this has had the effect of making the boy feel that if he is successful and makes progress, his employer will know about it and take a direct interest in him. This feature is very valuable and of great importance in creating ambition and a desire for progress.

If the apprenticeship school is conceived with the object in view of not only realizing the possibility of education but with the wider view of creating mechanics who realize the full extent of their duties as well as their rights, then the inauguration of such a system of teaching apprentices as outlined above will create a different spirit among the boys. Instead of being antagonistic toward the firm, as many were when they started the course, they have come to realize that the fundamental principle of business is cooperation and that ultimately their progress and the success of the firm are closely connected. To prove a complete success, every apprenticeship school must connect the pure utilitarian studies with an understanding on the part of the students of the ethical side of their relation to their fellow-workers in the industry, whether the latter be high or low on the industrial ladder of success.

[A comprehensive selection of the "jig sheets," referred to above, will be compiled by Mr. Renshaw with full instructions, and published by MACHINERY. We believe this system fills a gap that has existed in industrial educational literature, and that it will be an important forward step in the instruction of apprentices and shop men generally who desire to better their condition. Full announcements of the plan will be given in succeeding issues.—EDITOR.]

* * *

Wireless telegraphic communication with balloons has successfully been maintained at Brussels where an air navigator exchanged signals with a station erected on a tower in the city. Signals sent from the French military station on the Eiffel Tower in Paris were also intercepted.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

PEERLESS AUTOMATIC MULTIPLE-SPINDLE SCREW MACHINE.

A very interesting multiple-spindle screw machine (or automatic lathe, as the builders call it) has been placed on the market by the Peerless Automatic Machine Co. of Cleveland, Ohio. It follows the usual construction of such machines in being provided with a revolving spindle head, which indexes and rotates the several bars of stock, and in having a multiple tool slide and cross-slides which present cutting tools to the bars of stock in succession as they are indexed. Aside from this general plan, the machine incorporates a number of new and ingenious features in its mechanism, and is worthy of detailed study.

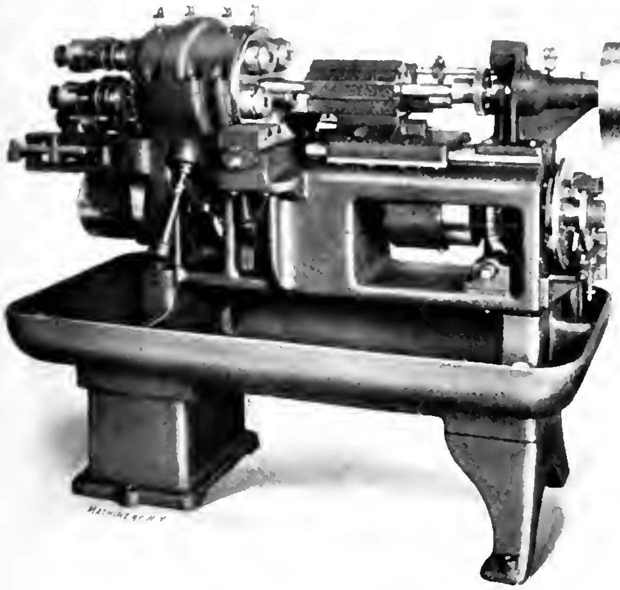


Fig. 1. The Peerless Automatic Multiple-spindle Screw Machine.

The Controlling Mechanism of the Machine.

Fig. 1 shows the front view of the machine, and Fig. 2 the rear view. The motions of the machine are all controlled by cams on a cam-shaft driven by the high-speed driving pulley shown near the base of the machine at the left of Fig. 2. This pulley may either be clutched directly to the worm driving the tool slide cam-shaft, or it may be connected with the worm through reducing gearing and change gears, mounted on the outside of the casing containing the change mechanism, as shown in Fig. 2. The change gears provide for ten rates of feed, varying from 0.004 to 0.026 inch of advance per revolution. This change of speed gives the cam-shafts, and therefore the operating mechanism of the machine, either a slow movement for feeding, or a rapid one for such operations as indexing and locking the spindle head, operating the collets and feeding the stock, withdrawing the tools from the work, bringing them up to a cutting position, etc. The change from fast to slow cam-shaft movement is effected by dogs adjustable to any position around the periphery of the plate mounted on the cam-shaft at the extreme right of Fig. 1, and the extreme left of Fig. 2.

Taking the parts on the cam-shaft in their order as seen at the right in Fig. 1, the disk just at the left of the speed-changing dogs carries cams controlling the threading mechanism, which will be described later. The worm-wheel on the shaft just inside the frame, drives the cam-shaft from the variable speed device previously described. The large cam in the base of the machine operates the tool slide for feeding the tools to the work. The spur gear at the left of the tool slide cam meshes with the one seen at the left of the rear cam-shaft in Fig. 2, thus driving the two sets of cams in unison. The plate seen under the rear cross-slide in Fig. 2 carries cams for operating the front and rear cross-slides. These cams operate through swinging sectors with teeth cut in their periphery, meshing with racks on the cross-slide. The next cam to the right operates the locking pin for locating the spindle head, which is indexed by the large sprocket wheel and chain shown. The cam at the extreme right opens and closes the collets and feeds the stock. As in all machines of this type, it will be seen that one revolution of the cams produces a finished piece of work, the rear cross-slide cutting off a finished piece for every indexing of the spindle head.

The Design of the Spindle Head.

Coming to a description of the details of the machine, one of the points of interest is the method of indexing and locking the spindle head. This is effected by the mechanism seen in Figs. 1 and 2, but is more clearly shown in the line drawing, Fig. 3. The sprocket-wheel *A*, as previously described, is directly connected by a chain with a sprocket-wheel fast to the spindle head *B*. Sprocket-wheel *A* is normally loose in its seat on cam *C*. In a slot cut in the latter is pivoted dog *D*. One end of this dog is adapted to engage a recess inside the hub of sprocket-wheel *A*, while the outer or projecting end is in position to be operated on by stationary cam *E*. Normally, dog *D* is out of engagement with sprocket-wheel *A*, but for a fifth of a revolution (there are five spindles in the head, which therefore has to be indexed a fifth of a revolution at a time) the cam throws the dog into engagement with the sprocket-wheel, thus revolving the latter and the spindle head to a new position. Cam *E* disconnects the dog when this new position has been reached.

The turret is locked in position by a decidedly novel arrangement of locking bolt and bushing. The bolt itself, *G*, is of the usual construction. It is forced into its seat by the spring shown, and is raised by cam *F*, operating lever *H*. The cam allows it to drop into place as soon as the indexing is completed. Bolt *G* is seated in a bushing *J* in the main casting of the machine, and its conical point engages plugs *K*, equidistantly spaced about the periphery of the spindle head. Bushing *J* and plug *K* are milled as shown in the small detail in Fig. 3, so that the tapered seat for the end of bolt *G* is formed half in one of them and half in the other. By means of this arrangement the accurate positioning of the spindle head does not depend on the closeness of fit of the cylindrical part of the locking bolt in bushing *J*. The seating of the bolt half in *K* and half in *J* insures a close fit at all times, even though the fit between *G* and *J* should wear. This combination of indexing and locking mechanisms is said to give a very easy and smooth engaging and disengaging action. This is due in part to the easy and smooth action of dog *D* in lock-

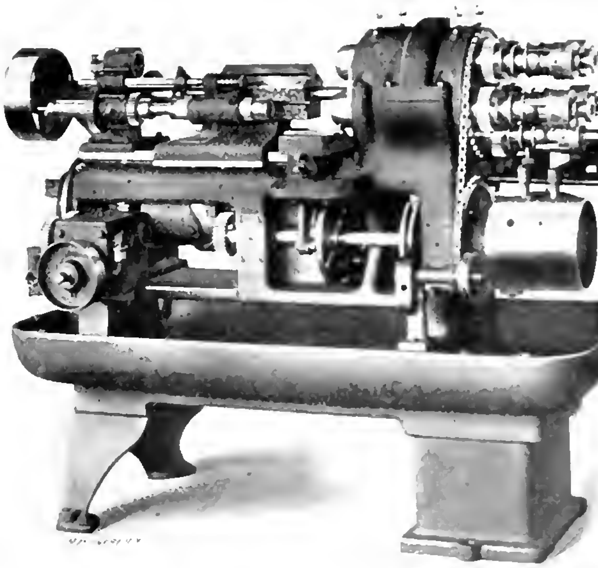


Fig. 2. Rear View, showing the Cam-shaft Drive, and the Operating Mechanism.

ing the sprocket to the cam drum, and is accomplished by the shape of engaging surface used, and by the shape given to the acting surface of cam *E*.

The collet-operating and stock-feeding mechanisms are of the standard construction, with the exception of the provision made for changing the length of feed of the stock. The adjustment for this is shown at the front of the machine, Fig. 1, at the left. It consists of a cam lever, connected to the stock-feeding lever by a slotted link, provided with an adjustment for increasing or decreasing the amount of lost motion thus allowed. When the lost motion is entirely taken up, the feed is at its maximum. The feeding of each bar of stock is effected when it reaches its lowest position. In this position the spindle is opposite the adjustable stop shown in the base of the tool slide in Fig. 1. The feeding is thus done accurately to length, and the feed cam needs never to be removed or adjusted. Since the stock feeding is done while the cutting tools are in operation, the lost motion device just described entails no loss of time.

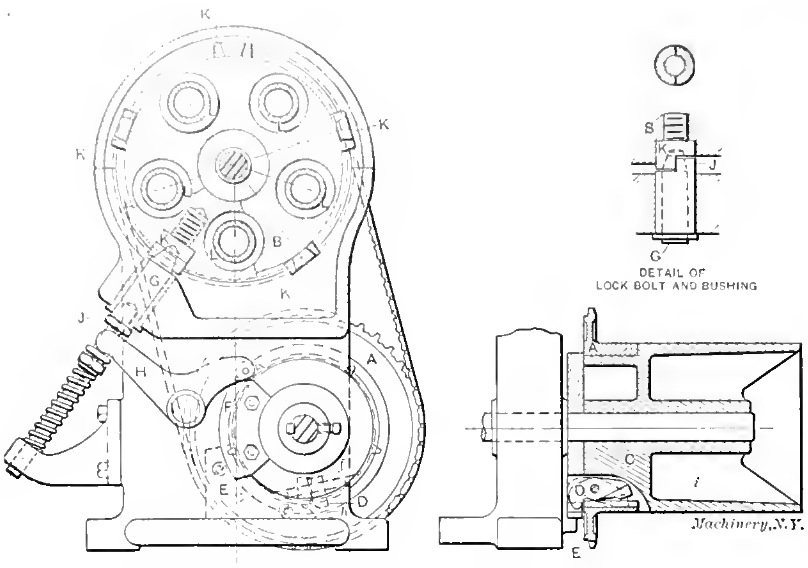


Fig. 3. The Method of Indexing end Locking the Spindle Head.

Ample provision has been made for oiling the spindle heads. The four oil cups shown in the various indexing positions of the head drop the oil into the spindle bearings. The oil flows from these bearings into oil ducts seen at *L* in Fig. 3, where it has no other escape than back through the bearings again. Oil may be independently introduced into these spaces, as well. The five main spindles are of crucible steel running in phosphor bronze bearings, the front bearing being of the taper construction with means of compensation for wear.

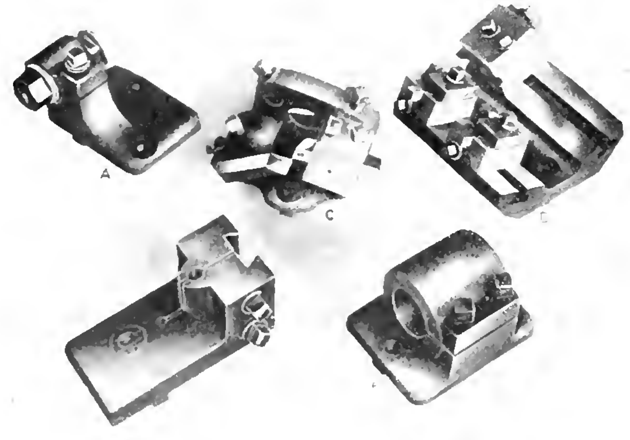


Fig. 4. A Set of Tools.

The Threading Mechanism.

The threading mechanism is best seen in the rear view, Fig. 2. The tap or die is secured to a revolving spindle carried by a tool-holder mounted on the tool slide. This revolving spindle may be connected, by either of the two pairs of gears shown, with the driving shaft of the machine, which is in turn positively geared to the spindles. The ratio of the two sets of gearing is such that one of them drives a tap or die at a slightly slower rate of speed than the work, but in the same direction, while the other drives the tap or die slightly faster than the work, and in the same direction. In the first case, the tap or die is threaded onto the work, and when the clutch connection is operated to connect the other set of gears, the higher speed releases or backs off the threading tool. With this arrangement it is possible to cut threads at about one-third the peripheral speed used for the other cutting tools, and it obviates as well the necessity for stopping and starting any of the revolving parts.

Facilities are provided for using two threading spindles, though but one is shown in the photographs. The second or auxiliary threading spindle is placed directly above the one shown and operates in the same manner, so that two dies, two taps, or a tap and die may be used. Both threading spindles can be independently adjusted and timed to cut any length of thread within the capacity of the machine. They are withdrawn from the work without reference to the movement of the tool slides. This threading mechanism is controlled, as previously mentioned, by cams on the disk at the outer end of the camshaft, just below the driving pulley.

Tools and Tool-holders.

Fig. 5 shows a close view of the machine, with the tool-holders set in position. A set of tools is shown in Fig. 4. As may be seen, the form of tool slide used does away with the necessity for holding the tools by shanks, as in the common form of turret. The long clamping surface provided at each station makes it possible to secure one or more tools on each tool-carrying face, and these may be adjusted backward or forward to suit requirements. In Fig. 5 it will be seen that the cross-slides are provided with an adjusting screw for setting the depth of cut independently of the height of the cams on the cam disk at the rear of the machine; a positive stop is also provided so that in forming down to a finished diameter, the tool slide is tightly held between the point of the cam and the stop, insuring accurate work. The two cross-slides are independent of each other in their movements.

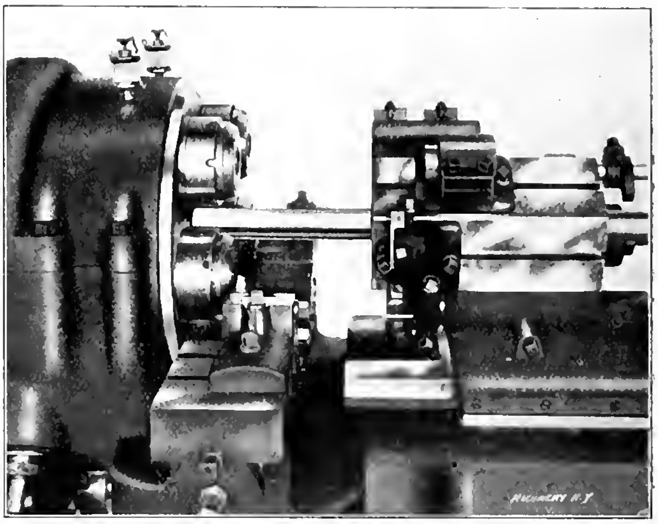


Fig. 5. Detail View of the Tool Slidee.

Of the tools shown in Fig. 4, *A* is a circular forming tool-holder for the cross-slide, and *B* is a straight forming tool-holder, also for the cross-slide. *C* is a roughing box tool; *D* is a finishing box tool provided with back rests and two blade holders (more may be used if desired), and *E* is a simple holder for such tools as drills, reamers, etc.

General Features.

As to the general features of the machine, it may be mentioned that the construction of the frame insures rigidity

and durability, as the spindle head bearing and the bed are cast in one piece. This bed is mounted on an oil pan base of large capacity, with a three point bearing, so that the machine is not thrown out of alignment no matter what the condition of the shop floor. A large oil reservoir is cast in the pedestal leg, into which the lubricant is strained, free from chips, and from which it is pumped back to the cutting tools. It will be noted that all the mechanism is accessible, the frame having been specially designed with this end in view. All the adjustments are made from the front. The inherent simplicity of the multiple-spindle machine is also plainly evident, and this simplicity has been preserved in the design. The machine illustrated has a capacity for work up to 1 inch diameter by 5 inches long. Machines of less or greater capacity can be furnished.

F. E. WELLS & SON CO. TAPPING AND THREADING MACHINE.

Fig. 1 shows a tapping and threading machine having a capacity for threaded diameters up to 5/8 inch, made by F. E. Wells & Son Co., Greenfield, Mass. This machine resembles the common type of light tapping machine in being provided with a friction forward and reverse drives, which may be engaged as desired by pressing in or drawing back on the work. It differs from the conventional type of machine, on the other hand, in being driven by a cone-pulley, allowing variations of speed to suit different sizes of taps; in obtaining the reverse by means of back-gearing contained within the cone-pulley; and in the improved facilities provided for holding and feeding the work. The machine is also provided with an oil pump and pan.

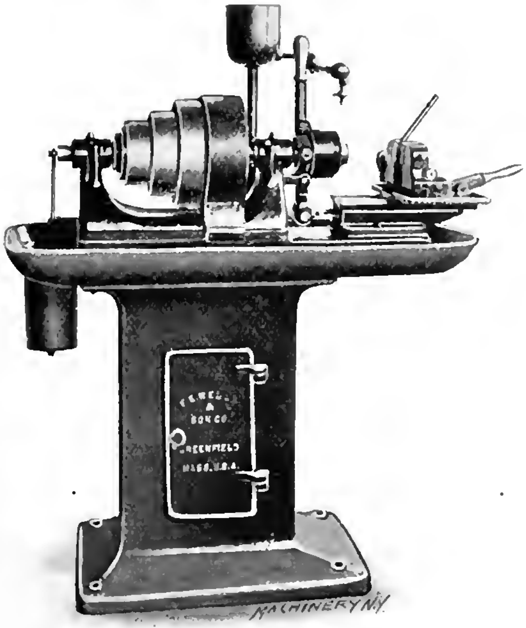


Fig. 1. A Combined Tapping and Threading Machine for Diameters up to 5-8 Inch.

The three-step cone-pulley carries an internal gear within its large diameter, which, through an intermediate rawhide pinion on a stationary stud, is connected with a smaller gear revolving freely on a spindle. A friction clutch arrangement, operated by shifting the spindle bodily, engages the spindle with the cone gear for the forward motion, or with this loose gear for the backward motion. The ratio of the gearing is such that the reverse is at a much higher rate than the forward movement. The shifting of the spindle for reversing may be effected by operating the lever shown at the front of the headstock, or by simply drawing back on the work, or stopping its further progress when its proper length or depth has been cut. A positive adjustable stop has also been provided for the work-slide, which throws the lever over and reverses the spindle at any length.

The work-slide is, as may be seen in Fig. 4, provided with two jaws operated by a right- and left-hand screw, thus making provision for centering the work. It will be noted that the bearing of the screw at the right of Fig. 4 is seated in a bracket, which is itself adjustable along the jaw guides. By shifting the position of this bracket the work may be held in any desired eccentric position, or the jaws may be brought up to the center again. The work slide is provided with a hand-lever as shown, for pressing the work against the tap in starting. This is only necessary for large tapping, up to nearly the capacity of the machine. For lighter work, the slide is pushed back and forth by hand directly.

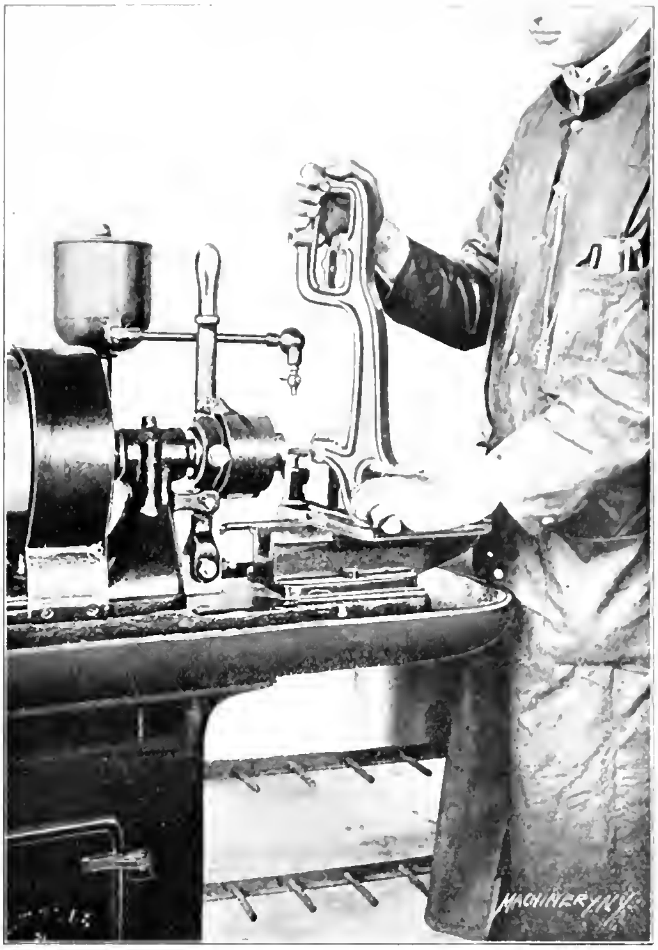


Fig. 2. Tapping a Casting held by the Hand.

Figs. 2, 3 and 4 show various operations for which the machine is adapted. In Fig. 2 a comparatively large casting is being tapped. The part of the casting operated on is backed up against the face of the vise jaws, and the whole slide is pushed by hand against the tap. When the proper depth has been reached, the adjustable automatic throw-out reverses the spindle and the tap is backed out. Smaller pieces are held by the fingers against the front end of the jaws, which are machined for the purpose. When operated in this way, the machine is as rapid on small work as the lighter machines commonly used for the purpose.

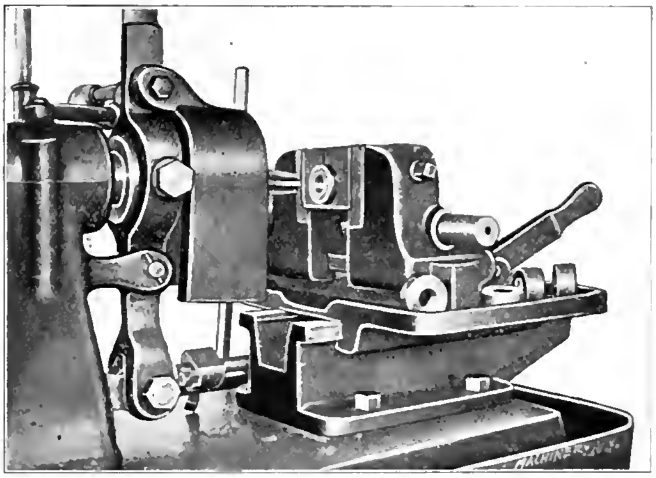


Fig. 3. Tapping a Finished Nut held in Special Soft Jaws.

Fig. 3 shows how special soft jaws may be used in the vise to suit special work. The piece in this case is a nut, smooth finished on the outside diameter. The jaws are machined to exactly fit the work and hold it without marring. There is movement enough in the work-slide so that a long shank taper tap can be used for threading nuts if desired, in which case they may be strung on the shank of the tap, from which they are removed without taking time to reverse the spindle. Fig. 4 shows how the machine may be used for external threading as well as for tapping. Arranged as shown, it makes a convenient and serviceable bolt threading machine.

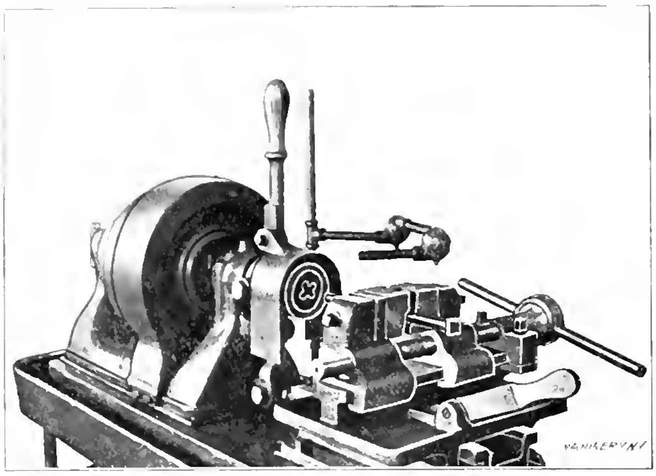


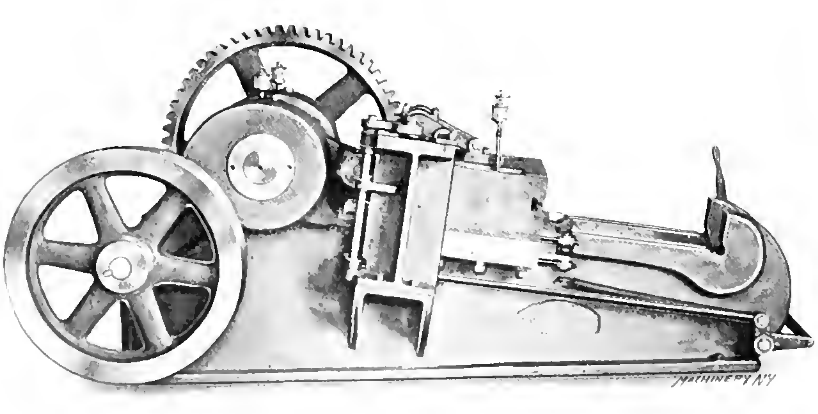
Fig. 4. Using the Machine as a Bolt Threader.

The oil pump is of the plunger type, driven directly from the rear end of the spindle. It feeds into the small tank shown at the rear of the machine, which gives a quiet, even flow of oil that does not spatter and is easily regulated. This supply tank is, of course, provided with an overflow back to the oil tank.

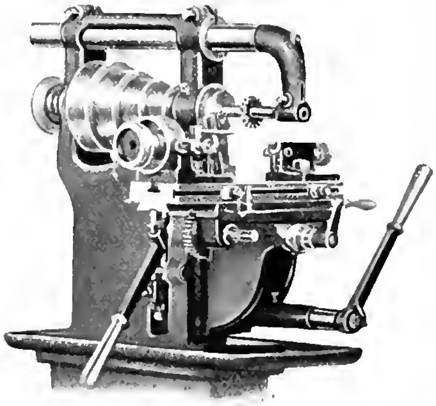
The capacity of the machine provides for tapping or threading up to 5/8 inch in diameter. As furnished by the builders, the machine is provided with a hardened steel vise for holding round or square stock, and a special positive drive tap chuck. This drives the tap by the squared part, and at the same time centers it by the shank.

AJAX HIGH-SPEED STOP-MOTION BULLDOZER.

An improved form of bulldozer, which is provided with a one-revolution clutch mechanism similar to that used on power presses, has been designed by the Ajax Mfg. Co. of Cleveland, Ohio. The use of a one-revolution clutch permits a much more rapid movement of the machine while still allowing the operator full control of its movements. For the No. 1 machine the movement of the cross-head takes place at the rate of 60 strokes per minute, while the time for a stroke of the largest or No. 6 size is at the rate of 45 strokes per minute. This rapid action allows a greatly increased output of work. The clutch is operated either by a foot pedal or hand lever, as may be most convenient for the operator.



Ajax High-speed Stop-motion Bulldozer.



Dalin No. 2 Hand Milling Machine.

The bed is a steel casting set on an angle to permit bringing the stock easily into place against the lower die. The cross-head is long, with ample bearing surfaces, and gibbed to take up wear in all directions while still keeping the cross-head in alignment. The gears are machine cut, and all the wearing parts and bearings are lined or bushed with bronze.

The machine is designed especially for bending work cold, and on stock which is of such material as to stand a cold bend a great saving of fuel is accomplished. The No. 3 machine will easily bend, cold, a 5/8 x 3-inch arch bar, with a pocket 8 inches deep, forming the four corners at a single operation. While it is primarily a bending machine, it can be arranged with dies to be used as a press or shear as well.

The No. 1, or smallest machine, has a cross-head travel of 5 to 8 inches (5 inches, standard); the face of the cross-head is 16 x 4 inches, and the machine weighs approximately 2,200 pounds. In the largest, or No. 6 machine, the corresponding figures are: 5 to 14 inches (10 inches, standard), 60 x 10 inches, and 24,000 pounds.

NO. 2 DALIN HAND MILLING MACHINE.

In the department of "New Machinery and Tools" of the September, 1907, issue of MACHINERY, we described the No. 1 hand milling machine built by Dalin Bros. of Rockford, Ill. A No. 2 machine of the same type has recently been designed by this firm. As may be seen in the engraving below, it differs from the older type in being provided with an over-hanging arm, and in having a larger base. It is also fitted with a small dividing head which materially increases its usefulness.

As in the older machine, stops are provided for the vertical movement of the knee on the column and for the traverse of the table on the saddle. Fine pitch screws are provided for the close adjustments of the stops, and the abutting surfaces are so placed that they will be free from chips. The spindle is regularly fitted with a draw-in sleeve and a ½-inch collet or chuck for straight shank arbors.

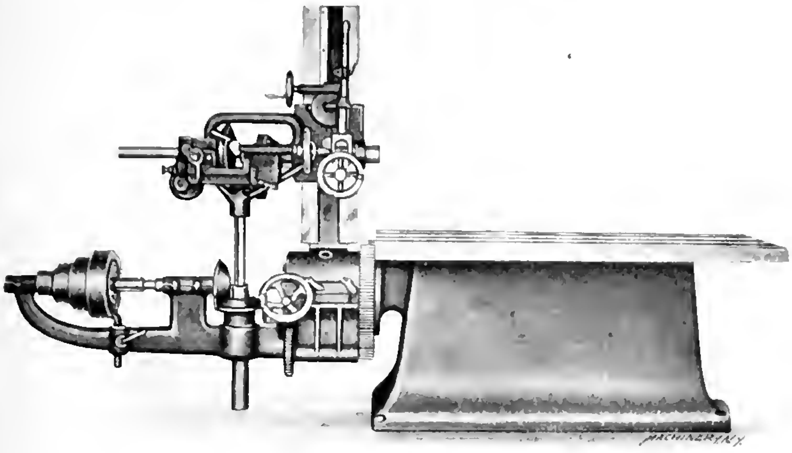
BARNES NO. 3 HORIZONTAL RADIAL DRILL.

W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., makes the horizontal radial drill shown herewith. This is similar in some respects to the builder's No. 1 machine of the same type, though it is of larger capacity, and has been provided with a number of new features which add to its usefulness and to the facility with which it can be operated.

The machine is, as its name indicates, a horizontal radial drill; that is to say, the spindle has all the movements and adjustments that a radial drill would have if the axis of its column were horizontal instead of vertical. The work table of the machine is, of course, left horizontal, and the only adjustment not provided for is that corresponding to the raising and lowering of the arm on the table. This is unnecessary owing to the fact that the horizontal table allows this work to be clamped in a position that will correspond to the vertical adjustment of the arm in the ordinary radial drill. The arm carrying the spindle head and all of the driving and feeding mechanism, is supported by a sleeve which swivels about a cylindrical stub cast solid with the base of the machine. This swiveling adjustment is controlled by a gear fast to the bed, meshing with a pinion, journaled in the sleeve and operated by a worm and worm-wheel, which allows the

swiveling adjustment to be obtained with great accuracy. The spindle head is adjusted up and down the column by a rack and pinion movement, also controlled by worm gearing and hand-wheel.

The driving shaft (with the four-step driving cone and the enclosed back gears used on all the Barnes back-geared drilling machines) is placed concentric with the axis of the swiveling adjustment, so that the belt center distance is not disturbed by any of the movements of the machine. This shaft is connected by gearing with the spindle, which thus is provided with eight speeds. A tapping device is also provided, permitting the operation of taps up to 3 inches in cast iron, or up to 2½ inches for pipe taps. Three rates of positively geared feeds are provided. The drilling capacity is for holes up to 3 inches in diameter out of the solid, in cast iron, or 2 inches in steel.


Barnes No. 3 Horizontal Radial Drill.

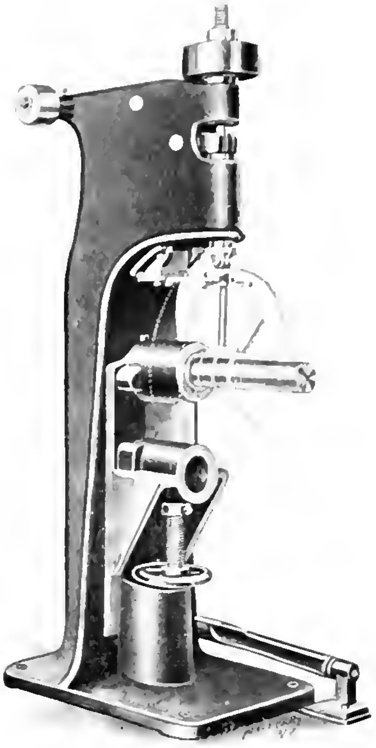
The maximum distance from the table to the center of the spindle is 29½ inches; the minimum is 2⅜ inches. The table is 24 inches wide by 65 inches long. The spindle is 1 15/16 inch in diameter and is provided with a No. 5 taper hole. It has a traverse of 18 inches. The machine weighs about 3,300 pounds. It is especially useful on work that can not readily be placed under an upright or radial drill, and is thus adapted to general machine shop use, as well as to such special lines as the manufacture of automobiles, safes, motors and engines. This type of drilling machine has been found particularly valuable for use with boring jigs, the horizontal table being much better adapted for chucking large irregular castings than a vertical angle plate.

GRANT RIVETING MACHINE FOR STEEL PULLEYS.

The Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn., has designed the riveting machine shown herewith for the special work of riveting the spokes of steel pulleys to the rims. The spokes used in these pulleys are made of round steel, 1⅛ inch in diameter, with a shoulder at the end cut down to ⅞ inch in diameter where it enters the rim. When the shoulder is made of a length to project through the rim with the proper amount of stock for heading over, the action of the machine is such that the heading can be done with scarcely any surplus metal left to be removed by grinding when finishing the wheel. The action of the machine is uniform, and will give the same results continuously, if the amount of stock left for heading is uniform.

The pulley is placed on a projecting arbor in a seat bored in the adjustable knee of the machine. Two of these seats are provided, as shown, one for large and the other for small pulleys. A wide range of work is thus provided for. The hand-wheel and screw adjusts the knee to any intermediate position to cover the range from the smallest to the largest work. Several arbors are provided, ranging in size from 2½ to 4½ inches in diameter, to support the hubs of different sized pulleys.

In this machine, the rivet is headed by a pair of rollers mounted on a horizontal pivot in the end of a forked spindle, which, in turn, revolves about a vertical axis. When this forked spindle with the rollers mounted in the end is pressed down on the top of the work, the rollers spin over the end of the stock to form the head which holds the parts together. The action of the machine being purely rotary, it is noiseless. The character of riveting is the same as that produced on bicycle chain rivets, on which work the process has been generally used for years.


Grant Riveting Machine for Steel Pulleys, etc.

COLLIS HIGH-SPEED DRILLS.

The High Speed Drill Co. of Dubuque, Iowa, has spent two years developing a process of welding high-speed steel to a shank of low carbon steel. This has been considered a very difficult operation, but in the hands of this firm a process is said to have been developed that is commercially successful and uniformly satisfactory in its results. The specific use made of the process is in the manufacture of the Collis high-speed drills, having blades of high-speed steel and shanks of low carbon steel. The use of these two metals in this way combines the advantages of the high-speed steel for the cutting edge, while it allows the shank to be easily machined by ordinary processes to form a taper shank with a tang such as has proved to be the most satisfactory for driving drills. In samples of the work of this firm which we have seen, the welding is so well done that it is difficult, if not impossible, to see on the finished work where it is done. The details of the process are not made public.


Fig 1. Fig. 2.
Collis High-speed Drills.

Figs. 1 and 2 show a flat and a twisted drill, respectively, made by this process. They are especially effective when used in connection with air motors or electric drills, which often run at a higher rate of speed for a given size than would be allowable for drills of carbon steel. Under these conditions, the high-speed drill will work continuously for many hours without regrind-

ing, while a tool of the older material would fail at once. The flat drill is adapted for drilling iron and steel plate, structural steel and similar work. For regular machine shop work, the twisted drill is recommended. This is ground closely to size to compete in the matter of accuracy with the best makes of twist drills. Very severe service may be exacted of it, owing to its uniform section, and to the fact that the grain of the steel follows the twist.

These drills are made in a variety of styles of shanks for blacksmith's drills, bit-brace use, etc., as well as for the regular taper shank. It is thus necessary to have special holding chucks for them. The manufacture of these tools is the main business of the makers, and every care is given to the development of the processes of manufacture which tend toward accuracy and efficiency in tools. The matter of hardening and tempering is particularly looked out for, a very complete and highly organized hardening department having been installed for this work.

VARIABLE SPEED DRIVE FOR THE GRAY PLANER.

The demand for a variable cutting speed for the planer, coupled with a constant speed for the quick return, has resulted in the past few years in the designing of a great variety of driving mechanisms. The G. A. Gray Co. of Cincinnati, Ohio, to meet the need for a variable planer drive, built, about two and a half years ago, the arrangement shown in Figs. 1, 2 and 3. Since that time the drive has been thoroughly tried out in their own shops, with results so satisfactory that they are now placing it on the market.

As may be seen, the drive consists primarily of a pair of four-step cones, of which one is mounted on the constant speed shaft (which also carries the return pulley), while the other is mounted on the variable speed shaft with the forward driving pulley. The constant speed shaft may be driven either by a belt, directly from the line shaft through a pair of tight and loose pulleys, or, as shown herewith, it may be geared to the motor shaft, making a self-contained motor drive. The mechanism includes suitable means for shifting the endless belt over the cone pulleys, for making the changes in the forward speed, and for tightening the belt after the change is made.

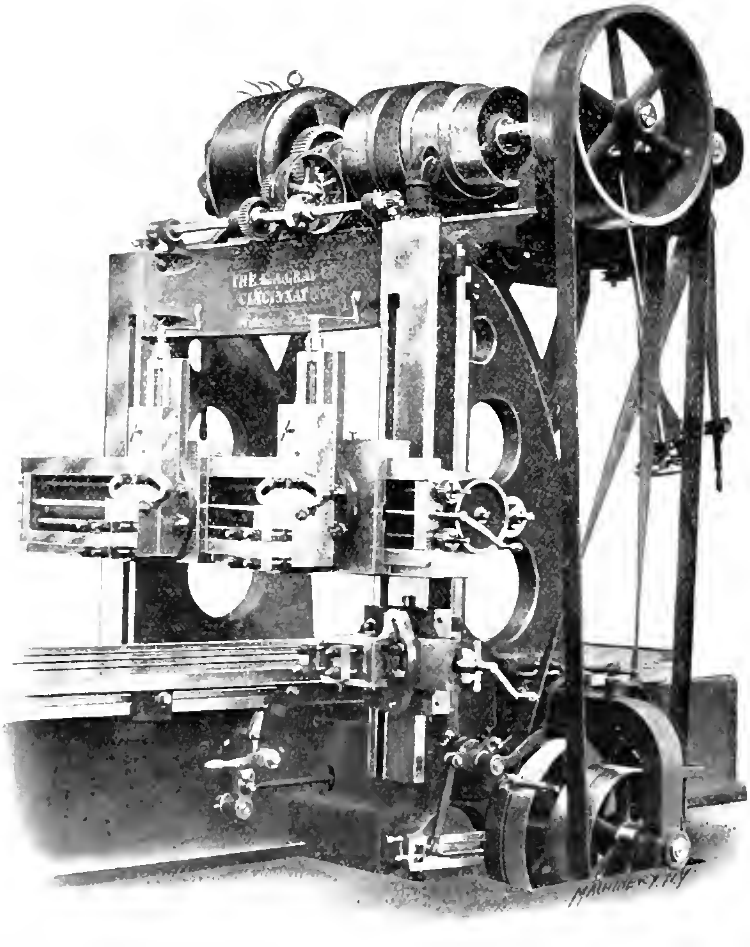


Fig. 1. Gray Planer fitted with a Four-speed Variable Forward Drive.

Fig. 1 shows a front view of the planer housings with this device mounted upon it. Fig. 2 shows a rear view, while Fig. 3 is taken from above the machine, to show the arrangement in detail. Referring to Fig. 3, the motor is geared to the constant speed shaft, which is the farther one of the two in this view. At the left-hand end this carries the heavy balanced-rim, reverse driving pulley, which thus always runs at constant speed. On this shaft is also mounted the 4-step cone shown, connected by an endless belt with the mating cone on the variable speed shaft in the foreground. This latter shaft carries the driving pulley for the forward movement, on its left-hand end. It is mounted in sliding bearings which are operated by links connected to levers on the rock-shaft shown. The long lever which depends from the rock-shaft at the left thus provides means for moving the variable speed shaft in or out, loosening or tightening the belt connecting the two cones. A clamp handle is provided for holding the adjustment at the proper tension when it has once been set. The proportions of the levers are such that it would be difficult to place a too severe strain on the belt, and the latter is of such proportions that it will transmit ample power for cutting without requiring an over-strain.

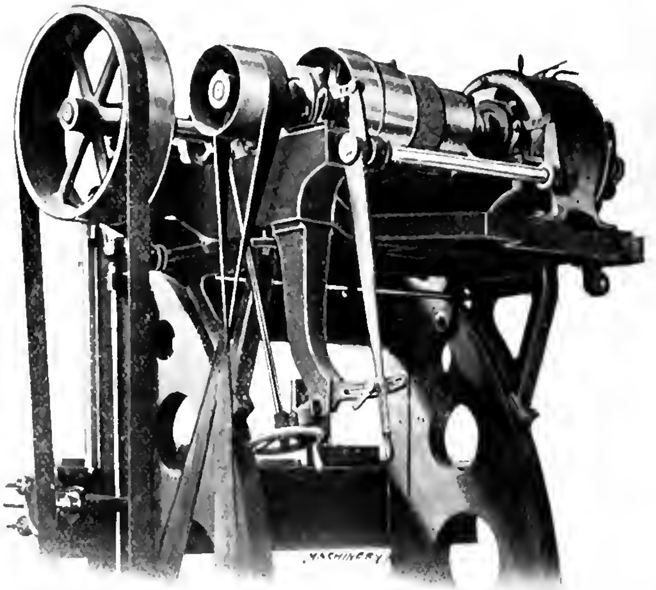


Fig. 2. Rear View of Housings, surmounted by Variable Speed Device.

In changing the forward speed, the belt is first loosened by the means just described, shifted to the desired step, and then tightened again. The shifting is effected by the hand-wheel seen just behind the lower end of the tightening lever in Fig. 3. It is also seen in Fig. 1, and more plainly in Fig. 2. This hand-wheel is connected by a shaft and bevel gears with a cam-shaft parallel to the two driving shafts. The cylindrical cam on this shaft controls belt shifters on both the idle and driving sides of the cone belt. The cam is so arranged that one end of the belt is shifted onto the smaller step of one cone before the other end is shifted onto the larger step of the mating cone. Owing to this arrangement, the shifting is effected without appreciable injury to the belts, the operation being identical with the movement of a trained mechanic in shifting a belt by hand. To further facilitate the shifting, the shoulders of the cone steps are beveled off as shown. The original belt placed on the first speed variator in the shops of the builders, two and

a half years ago, has been in use up to the present time. It has never been shortened, and has never been removed from the pulleys for any purpose since it was installed. It operates a 56-inch by 27-foot planer in the hardest kind of service.

The stationary pedestal bearings of the constant speed shaft are fitted with phosphor bronze bushings, automatically lubricated by ring oilers. The sliding pedestals for the variable speed shaft are provided with well-made ball-joint casings, also fitted with ring oiling phosphor bronze bearings. This arrangement forms a rigid universal swiveling bearing, insuring perfect alignment of the shaft bearings under all conditions. The whole device is rigidly built and, as may be seen from the illustrations, is simple and devoid of complicated or delicate parts.

The following advantages are claimed for this mechanism. There are no frictions to wear or require adjustment, and no clutches to be bruised or broken; there are no gears running loose on their shafts and thus liable to stick or cut; there are no sliding gears to be battered if carelessly shifted. The speed can be changed without stopping the motor, saving the considerable time otherwise necessary for allowing the armature and pulley to come to rest. The momentum of the two cones, supplementing that of the heavy fly-wheel pulley, reduces the strain on the motor at the moment of reversal. And, finally, the elimination of a complicated geared mechanism running at a high rate of speed, not only insures an almost noiseless drive, but does away, as well, with the vibration often met with in self-contained geared devices.

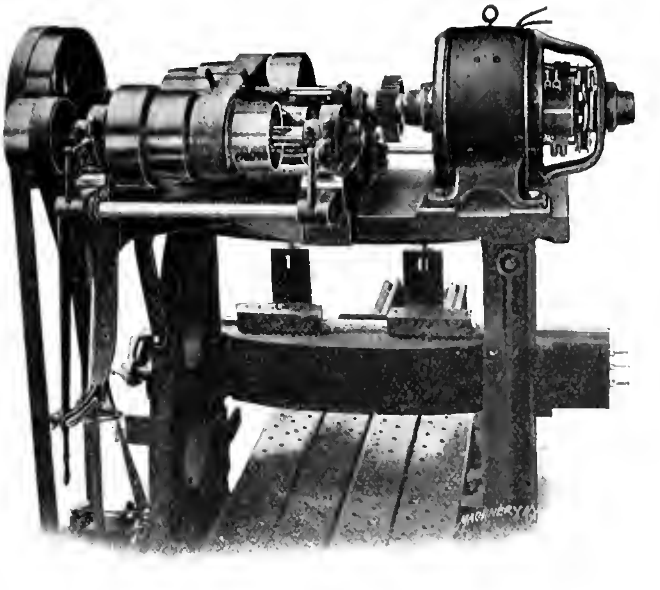


Fig. 3. Another Rear View of the Mechanism.

FERRACUTE ROLLING MILL.

The Ferracute Machine Co., Bridgeton, N. J., has recently built for the mint of a foreign government the rolling mill shown herewith. This mill was designed by Mr. Oberlin Smith, the president and mechanical engineer of the company. While the rolling mill as a machine is so simple that little latitude is allowed the engineer in designing it, the one here shown incorporates some features of interest and novelty.

As to general design, it will be noted, first, that the machine is motor-driven. A General Electric 50 H. P., 220-volt motor is used, the ratio of the gearing being 19.2 to 1, which gives 44 revolutions per minute to the rolls. The housings are bolted to the cast iron base or bed plate, and are provided with phosphor bronze boxes for the roller bearings. The rolls themselves are made of a substantial metal of a close texture. They are ten inches in diameter, and the distance between the housings is nine inches, thus adapting the mill for rolling strips of metal nine inches in width and from 0 to ½ inch in thickness. It will be noted that the gears and roller ends are protected by guards and all the working parts are accessible.

The adjustment of the rolls constitutes a particular point of interest in this machine. The upper roll is supported by four heavy springs under a compression considerably in excess of the weight of the roll so that it is supported at all times against its abutment, whether or not there is any stock passing through the mill. This prevents the formation of a film of oil between the journal and its bearing, and the consequent inaccuracy in the thickness of the rolled metal. The adjustment in each housing is effected by wedges. These wedges are shifted by a screw operated by the crank shown in the detail view, Fig. 1. The screw which moves the wedges in and out is connected by a train of gears with the dials, in such a way that these latter indicate accurately the thickness of the rolled strip. The dial at the left reads to hundredths of an inch, and the one at the right to ten-thousandths. One revolution of the crank moves the dial hand on the left one notch or 0.01 inch. If it should be desired, for instance, to roll a strip 0.2506 inch thick, the crank would be turned until the dial hand at the left pointed to 25, and the dial point at the right to 6.

Fig. 1. Dials for Reading the Adjustment of the Rolls.

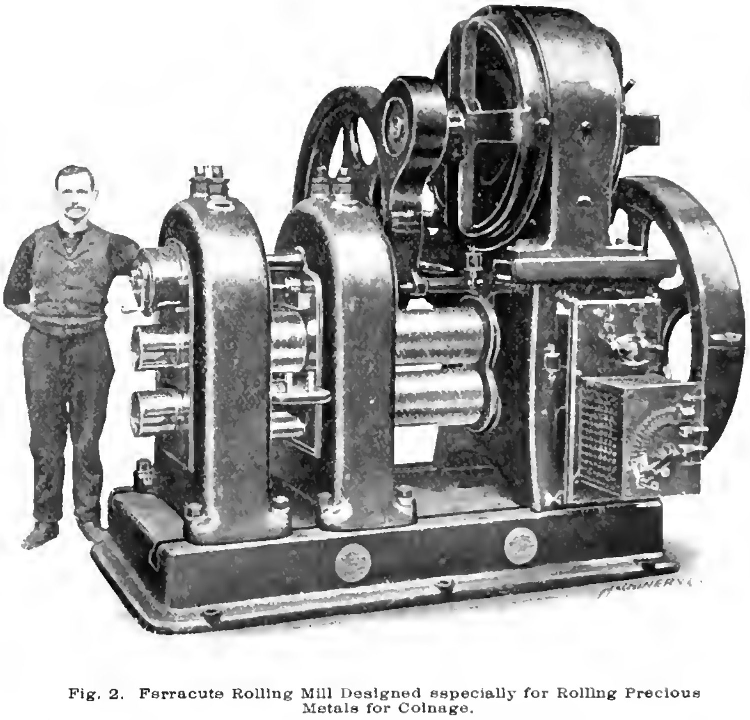


Fig. 2. Ferracute Rolling Mill Designed especially for Rolling Precious Metals for Coinage.

The extreme length of the machine from right to left is 8 feet 1 inch, the width is 6 feet 8 inches and the height 7 feet 9 inches. The total weight, including the motor, is 25,000 pounds.

BULLARD 24-INCH VERTICAL TURRET LATHE.

The Bullard Machine Tool Co. of Bridgeport, Conn., is building the 24-inch vertical turret lathe shown herewith. This machine is, in its general features, a smaller size of the 36-inch turret lathe, described in our department of "New Machinery and Tools" in the October, 1907, issue of MACHINERY, to which reference should be made for a general description of this type of machine. It has been found that this tool, on account of its smaller size, can be handled more rapidly than the 36-inch machine. This means that the production is materially increased on work within its range, as will be understood by anyone who has watched the operation of a turret lathe of this type, and has thus had an opportunity to see to what a remarkable extent the actual cutting time can be reduced.

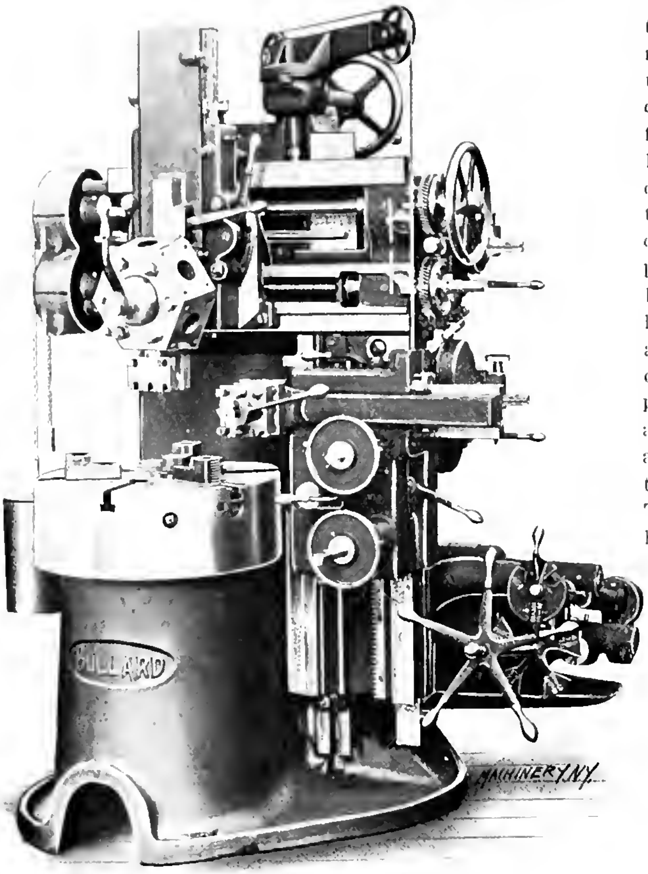


Fig. 1. Front View of the Bullard 24-inch Vertical Turret Lathe.

The arrangement of the controlling mechanism is identical with that of the larger machine. The speed changing mechanism was described in detail with reference to the first machine to which it was applied (see the December, 1907, issue of MACHINERY). As will be remembered, this gives 15 changes of speed, by means of handles which can be operated instantly, and which are so interlocked as to make it impossible to make a false move. A brake is incorporated in the mechanism, which stops the table automatically in making changes that cannot be effected at high speed. It gives the operator, as well, the use of the brake in stopping the table quickly for removing or adjusting the work. These speed changes are effected by means of the pilot wheel and levers shown at the right of the base of the machine in Fig. 1. The feed changes and control are entirely independent for the main and side turrets.

Improvements in Details.

Among the changes which have been made from the design of the larger machine, may be mentioned the improvement of the bed construction, which has been widened out to directly support the ways for the side rail, and to generally increase the stability of the machine. A heavy support has also been furnished for the lower end of the table spindle, which tends to reduce the torsional strains on the bed. The principle of providing narrow guiding surfaces for all sliding parts has been employed throughout the machine. The cross and side rails have been made a unit and are guided on one continuous narrow bearing which serves to maintain positive alignment at any height of adjustment.

Another improvement to which attention may be called, is the construction of the friction clutches used throughout the machine in the control of the feed and machine changes, and the rapid movements. This new form of clutch is shown in detail in Fig. 4, which illustrates the cone of gears giving the five spindle speeds controlled by the pilot wheel shown in Fig. 1. Each of these five gears *A*, revolves loosely on a clutch ring *B*, which is in turn supported on a collar *C* keyed to the hollow shaft *D*. Rings *B* are expanded to cause the different gears to drive the shaft, by levers *E* operated by a plunger *F* which passes through the shaft in its central bore. In this central bore is seated the plunger *G*, which is shifted lengthwise by rack teeth cut on its outer extension, engaging a pinion at the end of the pilot wheel shaft. The inner end of this plunger carries a series of five plugs *H* which, as the plunger is shifted lengthwise, raises the five plungers *F*, one after the other in succession, connecting the five gears, one after the other, to the shaft *D*. A particularly ingenious feature of this clutch is the means provided for adjusting it. These five plugs *H* back against adjustable headless screws, by means of which they may be set out more or less. In adjusting the clutch, therefore, the plunger is removed from the machine and taken to the bench, where the plugs for the clutches requiring adjustment are set out. The adjustment is then locked by means of the locking screws provided, after which the plunger is returned to the machine. It will be seen that the clutches themselves are adjusted by what may be called an "absent treatment." In the older machine, an adjustment was provided at the ends of clutch levers *E* which, however, were made slender enough to have considerable

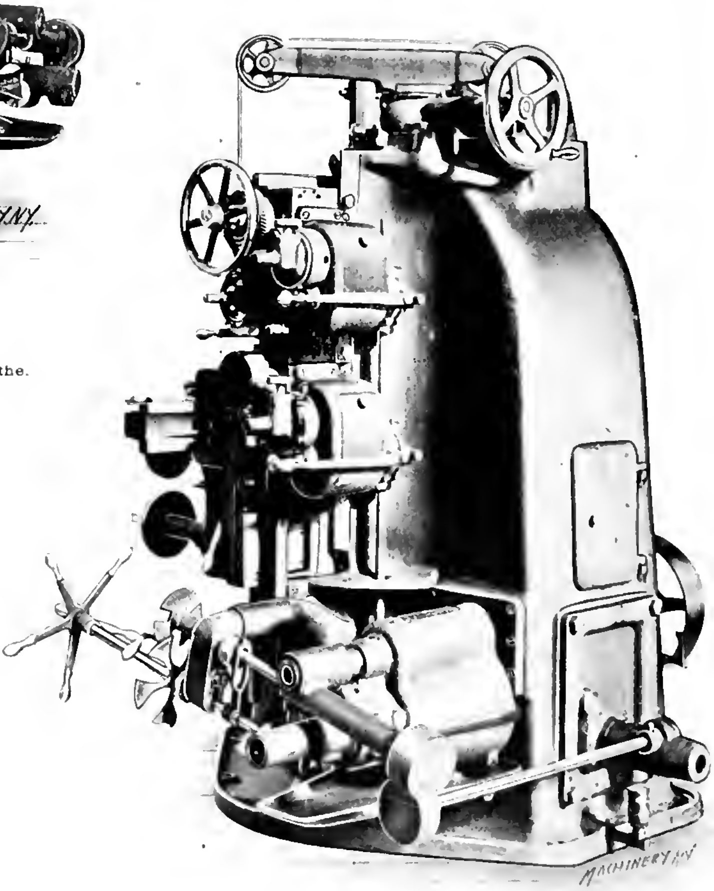


Fig. 2. The Driving and Feed Mechanism of the Bullard Turret Lathe.

spring, the idea being that it would thus not be necessary to adjust them during the life of the machine. It has been found more satisfactory, however, to make these levers stiff and strong, and to provide an easily effected adjustment.

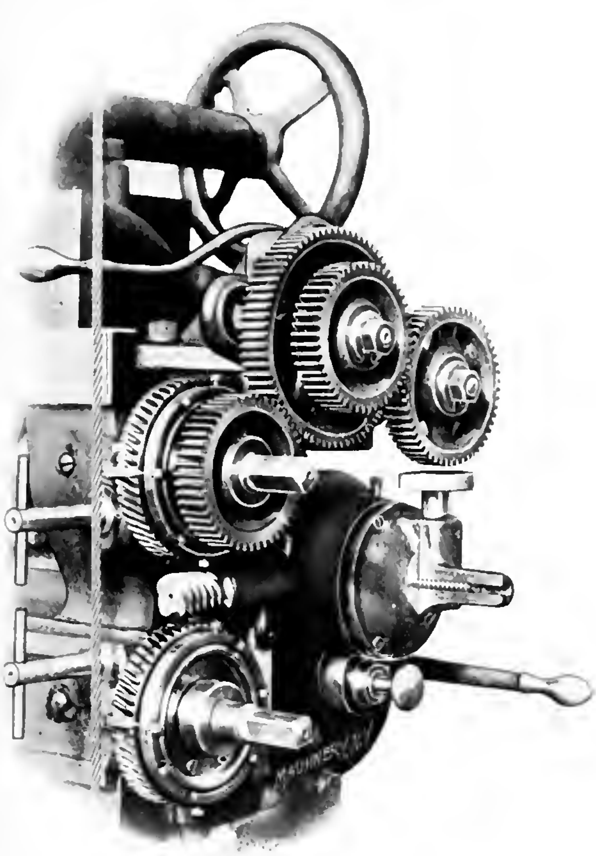


Fig. 3. View of Feed Gearing Set up for Thread Cutting; Indicator Clips for Setting Tools and Stopping Cuts are also shown.

The clamping of the side head has been improved. The clamp lever acts on the head by a cam movement, giving first a rapid action for bringing it down into place, and then a slower action for firmly locking it in position. It is unnecessary with this arrangement to swing the lever around so far that there is any possibility of interference with the work or the turret tools.

Another new feature is the provision made for running the turret head beyond the center stop on the cross rail. This is best seen in Figs. 6 and 8, the latter of which shows an example of an operation in which this comes into use. In this case it is convenient to move the head beyond the central position to allow the simultaneous use of the side head on the other side of the work. The center stop, as shown in Fig. 6, is in the form of a half bushing, which is swung into place between the nut on the turret slide, and an adjustable threaded nut abutment at the left-hand bearing of the cross-feed screw. This half bushing is thrown back out of the way by a conveniently placed knurled knob, whenever it is desired to move the turret beyond the central position.

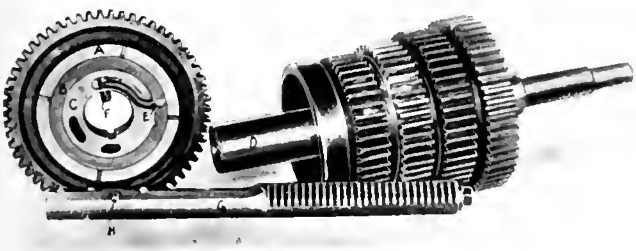


Fig. 4. Construction of the Clutch generally used in the Machine.

An improvment has also been made in the matter of gibbing the turret slide. This is now provided with a universal adjustment (see Fig. 5) so as to provide for taking up lost motion in any direction, making it possible to keep the holes accurately centered with the axis of the table throughout the whole life of the machine. Owing to the provision of an adjustable abutment for the center stop, no jib is necessary at the left-hand side surface.

Conveniences of Operation.

The usefulness of the rapid traverse for the vertical and cross movements of the turret on a machine as small as this, might perhaps be questioned by a mechanic who has never seen it operated to its full capacity. The use of multiple tools, high speeds, and heavy feeds, can be carried to such an extent that the operating time becomes a matter of the utmost importance. The workman easily gets into the habit of setting the tools entirely by the rapid traverse, throwing the power feed in as soon as he has thus brought the cutting tool to position. More important than this, however, is its relation to the matter of the accuracy and rigidity of the machine. As is well known to mechanics, where the slides have to be adjusted by hand the gibs are almost sure to be left much more loosely adjusted than is demanded by the requirements of accuracy and rigidity. By keeping the gibs firmly adjusted, and using power to move the slides rapidly against the resistance of this firm adjustment, the best results are obtained.

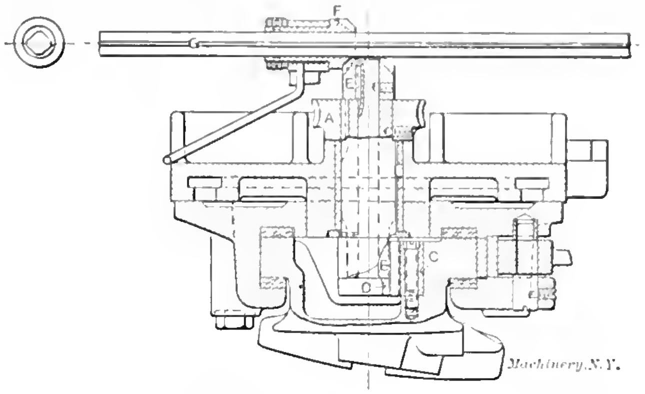


Fig 5. Horizontal Section through Turret Slide showing Counterbalance Connection.

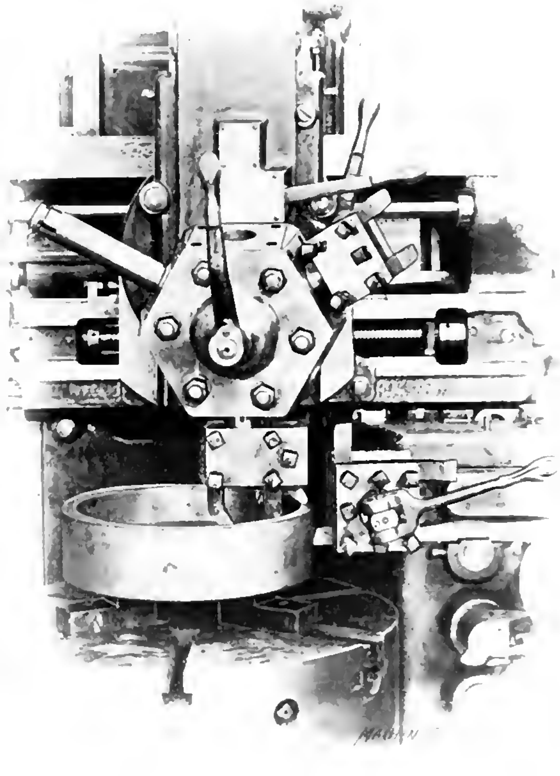


Fig. 6. The First Operation in Machining an Automobile Fly-wheel.

Fig. 3 shows the feeding end of the cross rail as arranged for thread cutting. When so arranged, the gear box is cut out and the connection between the feed shaft and cross feed screw is made by change gears, as shown. The feed shaft revolves with the work table in the ratio of 1 to 1, and the

connection with the screw is made by a one-tooth clutch. By using this clutch lever in connection with the rapid traverse device, it is not necessary to stop or reverse the spindle, the operation being similar to that which is possible on some makes of lathes where the corresponding mechanism is provided.

Fig. 3 also shows very plainly the indicator clips used on the large dials provided for each of the cross movements. These clips are numbered to correspond with corresponding faces in the cross and vertical turrets, and are used both for setting the tools, and for limiting the feeding movements. Automatic stops are not provided, as the workman is kept so busy that he could not run two machines under any circumstances, and it would be difficult to devise a system of automatic stops which would give the requisite range of action, and still preserve the accuracy which may be obtained by this method of reading the dials.

An ingenious method of counter-weighting the turret slide is used on this machine, which, so far as we know, has not been previously described. It is best seen in Fig. 5, which is a section on a horizontal plane through the rack pinion shaft which controls the turret slide. The feed for the turret slide is received from the splined shaft of the cross rail through worm gearing at *A*. Worm-wheel *A* is keyed to the sleeve *B*, whose inner end has pinion teeth cut on it meshing with the rack *C* of the turret slide. A narrow pinion *D* also meshes with this rack. This pinion has a shank extending through the sleeve *B*, and has keyed to it at the other end a bevel pinion *E*, meshing with a similar mate *F*, which is supported by the saddle and fits the squared shaft *G*. The outer extremity of this squared shaft at the left-hand end of the cross-rail, carries a sprocket over which runs the chain from which the counter-balance is hung (see Fig. 1). It will be seen that by this arrangement perfect freedom of position is allowed the slide, without interference with a system of wire loops and idler pulleys. At the same time, back lash is entirely taken up, as rack *C* is always firmly held against the resistance of pinion *B* in one direction, operated by the feed, and pinion *D* in the other direction, controlled by the counter-weight. It will be noted from Fig. 5 that the turret head is set at an angle in both the horizontal and vertical planes. This is done to clear, with over-hanging tools, both the rear of the tool slide and the side head as well.

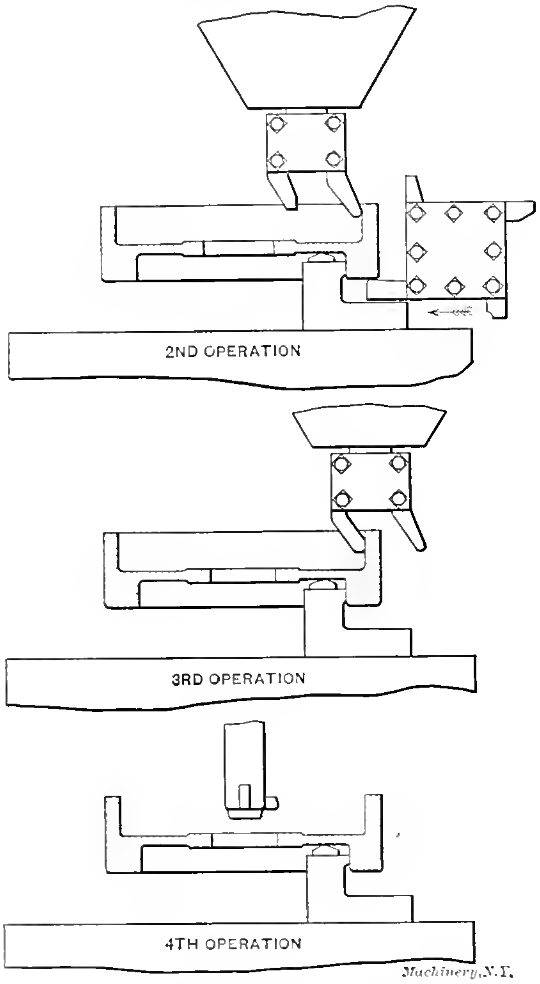


Fig. 7. The Remaining Operations on the First Setting.

Figs. 6, 7 and 8 illustrate typical operations on this machine. The work in question is the machining of an automobile flywheel which has to be finished all over. The first operation employs four tools acting simultaneously. The three in the main turret, face the hub, the web and the rim of the pulley, while the tool in the side head turns the outside diameter. The outside diameter is finished and carefully rounded by other tools in the side head. In the second operation, the under face of the rim is finished and the inner diameter of the rim is rough turned. In the next operation the side head is moved out of the way, and the same tool-holder in the turret is used for finishing the inside of the rim. The final operation at this setting is the boring of the central hole, which is done with the bar, noted in this department in the last month's issue of MACHINERY. It carries interchangeable single-ended and double-ended boring blades, making possible the complete finishing of a hole at one setting of the turret.

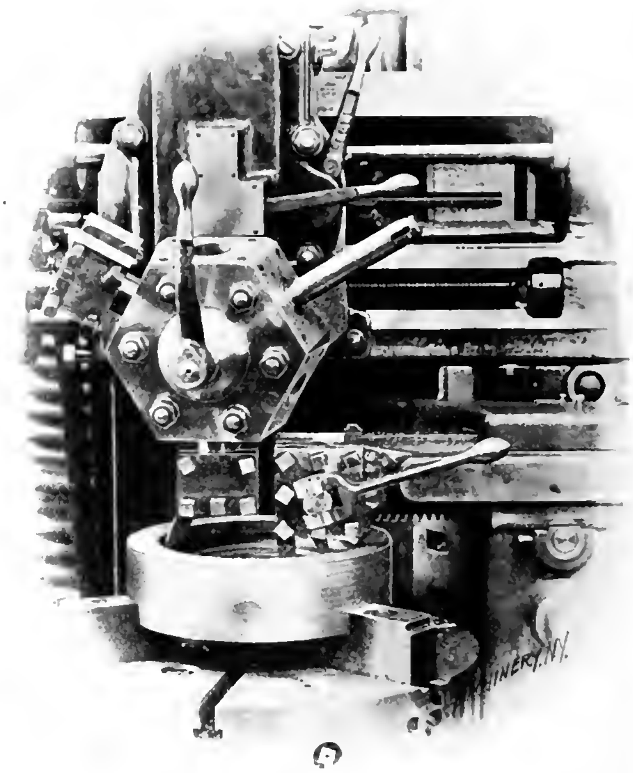


Fig. 8. The Machinery as arranged for Completing the Work on the Second Setting.

The remaining operations are made with the work reversed and held in soft jaws, accurately bored to fit the finished outside diameter of the wheel. The turret head, as shown in Fig. 8, finishes the inside of the rim, while the side head carries tools for facing the web and hub, and for rounding the corners of the rim.

General Features and Dimensions.

It will be seen that this machine is essentially, as the manufacturers claim, a turret lathe, the matter of its being vertical not changing its nature, and merely resulting in a rearrangement of the position of the handles and driving mechanism, and the rearrangement of some of the sliding surfaces. It is intended for exactly the work done on the horizontal turret lathe. The completeness of adjustment and facilities provided, are the result of long experience. It is not probable that any firm which had not been building machines of this type for many years, would have had the courage to carry all these adjustments and operative facilities into the design of a machine as small as this one.

The machine swings 26 inches in diameter, 18 inches in height under the cross rail, and 26½ inches under the turret

face. The main turret has a vertical movement of 18 inches, and will face work 26 inches in diameter. The side head has a vertical travel of 19 inches and a horizontal travel of 13 inches. The net weight of the machine is 7,800 pounds.

GENERAL ELECTRIC CO.'S ELECTRICAL FURNACE FOR HEAT TREATMENT OF STEEL.

The General Electric Co. of Schenectady, N. Y., has designed a furnace for general use in annealing, hardening, and tempering steel. The advantage of a furnace of this construction for annealing and hardening is that it gives the prime requirement—a furnace of constant temperature. It is difficult to do this with coal and gas furnaces, owing, for one reason, to the large area for radiation, exposed to the air. The electric furnace also presents the advantages of more simple and accurate temperature regulation. In this new design the work is placed in a bath of metallic salts which are reduced to the liquid state by means of an electric current. As soon as these salts reach a liquid condition, the temperature may be easily regulated by varying the amount of current passing through the bath. An alternating current is used, which is transformed to give the proper current strength for this work.

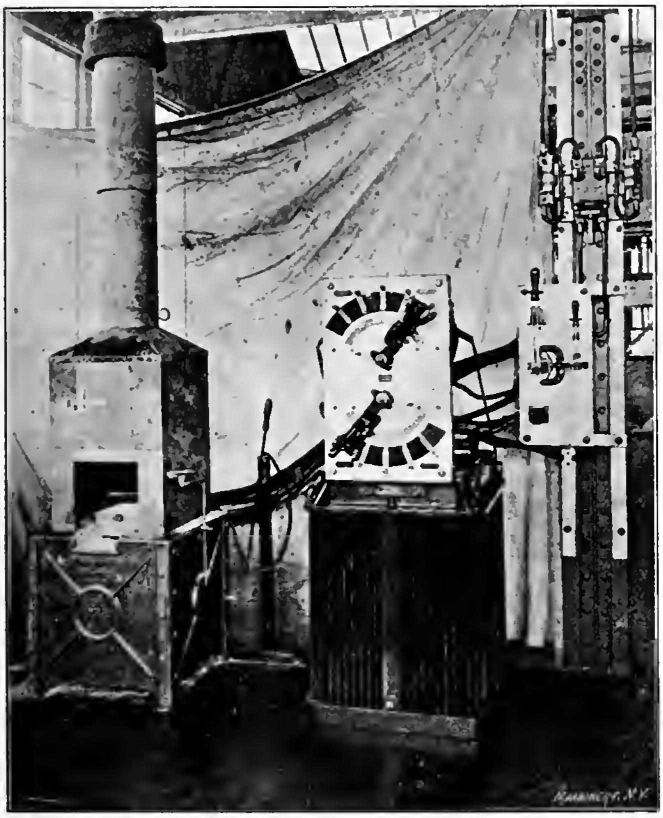


Fig. 1. Apparatus for the Treatment of Steel in an Electrically-heated Bath.

By means of this method of regulation, a temperature from 250 to 1,350 degrees Centigrade may be obtained. This temperature will remain uniform throughout the bath, except at the surface, where, owing to radiation, it is slightly lower.

The outfit, as shown in Fig. 1, is that installed in the die department of the Schenectady works of the builders. As may be seen, it consists of the furnace with its hood suspended from above; a regulating transformer with the controlling switch; the switchboard with the necessary ammeter and voltmeter; and the connecting line with its fuses. The regulating switch is provided with a sufficient number of contact points, to give, as stated before, practically any desired temperature between the limits of 250 and 1,350 degrees Centigrade.

A sectional view of the furnace is shown in diagram form in Fig. 2. It consists of a fire-clay crucible surrounded with an insulating material, usually asbestos, which rests in a fire-clay box. The whole is supported in an enclosing case of iron. Two electrodes are provided, one at each side of the crucible, and in direct contact with the bath at all times. To start the furnace, an arc is established across the broken mass of salts by means of an auxiliary electrode, as shown. In a very short time the solid mass is in a molten condition. After the bath has reached its proper temperature, that portion of the material which is to be hardened, is submerged in it and is allowed to remain until it attains the same color as the bath, when it is removed and tempered in oil or water, as the case may be. The bath completely fills the crucible and, in the Schenectady works, consists of equal portions of barium and potassium chloride. The ultimate temperature depends on the relative proportions of the chloride. The higher the percentage of barium used, the higher the temperature may be carried. When using the bath for softening steel, it should be maintained at a temperature of 250 degrees Centigrade.

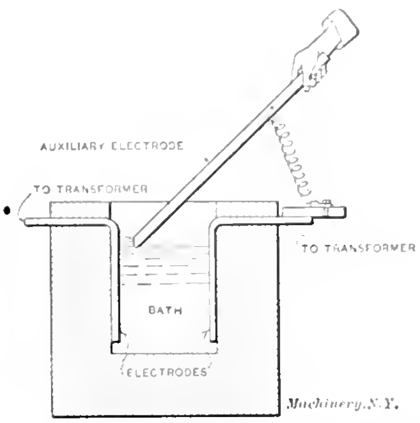


Fig. 2. Starting the Arc for Melting the Salts in the Bath.

The advantages of an electrical furnace for hardening and tempering may be summed up as follows: There is little chance of oxidation, as the material, while being heated, does not come in contact with the air. All parts of the tool are subjected to the same degree of heat at all times, thus preventing any possibility of over-heating or of internal strains due to differences of temperature. There is practically no danger from fire, as the outer walls of the furnace are never hot. In fact, when running at a temperature of 1,300 degrees Centigrade, the hand may be placed on the outside of the furnace without being burned. It is so simple and requires so little care and attention that it may be operated by an ordinary workman. The metallic salts have no effect on the composition of the steel, and the operator never comes in contact with dangerous fumes as in the cyanide bath. It is stated, also, that in efficiency and low cost of operation, it is superior to the gas furnace.

ELECTRIC CONTROLLER & MFG. CO.'S TYPE SA LIFTING MAGNETS.

The first commercial lifting magnet was designed about thirteen years ago by Mr. S. T. Wellman. The design was later improved upon by Mr. E. B. Clark, and the manufacture of lifting magnets of both the Wellman and Clark types was taken up by the Electric Controller & Mfg. Co., Cleveland, O., more than ten years ago. Magnets of the Clark type have given excellent results in the handling of smooth, homogeneous material such as plates, blooms, and slabs, but are useless for handling rough and detached material such as pig-iron and scrap. Many attempts were therefore made to perfect a magnet which would handle these materials, and the first commercially successful lifting magnet of this kind was placed on the market by the Electric Controller & Mfg Co., in March, 1905. An improvement on this magnet has now been brought out, and is shown in the accompanying line-engraving Fig. 1. This is known as the type SA magnet.

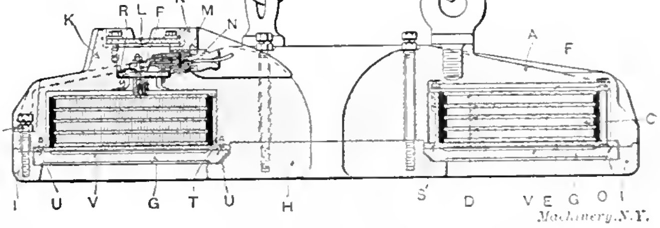


Fig. 1. Sectional View of the Type SA Lifting Magnets.

In the illustration *A* is the body or frame of the magnet. This frame is an angular casting of special "electrical" steel, substantially ribbed on both its upper and outer surfaces. Besides strengthening the casting, the ribs serve to dissipate the heat. The core of the magnet is surrounded by the winding *C* which is composed of a series of coils each wound with a conductor in the form of a copper ribbon or strap, the turns of which are insulated with asbestos ribbon. Neighboring coils are separated and insulated by the disks *D*. The coils are wound on a heavy brass form *E*, which resembles a spool having one head removed. This form supports the coils during the winding. After the last or uppermost coil is wound and the outer disk of insulation is in place, the winding is clamped to the form by means of straps *F*, thus making the winding and the brass form a rigid unit. The winding is then dried under vacuum and then impregnated with a plastic insulating compound, first under vacuum and then under compressed air, and finally again dried under vacuum. This makes the winding not only fire-proof but also thoroughly water-proof. The completed winding is then placed in the magnet case.

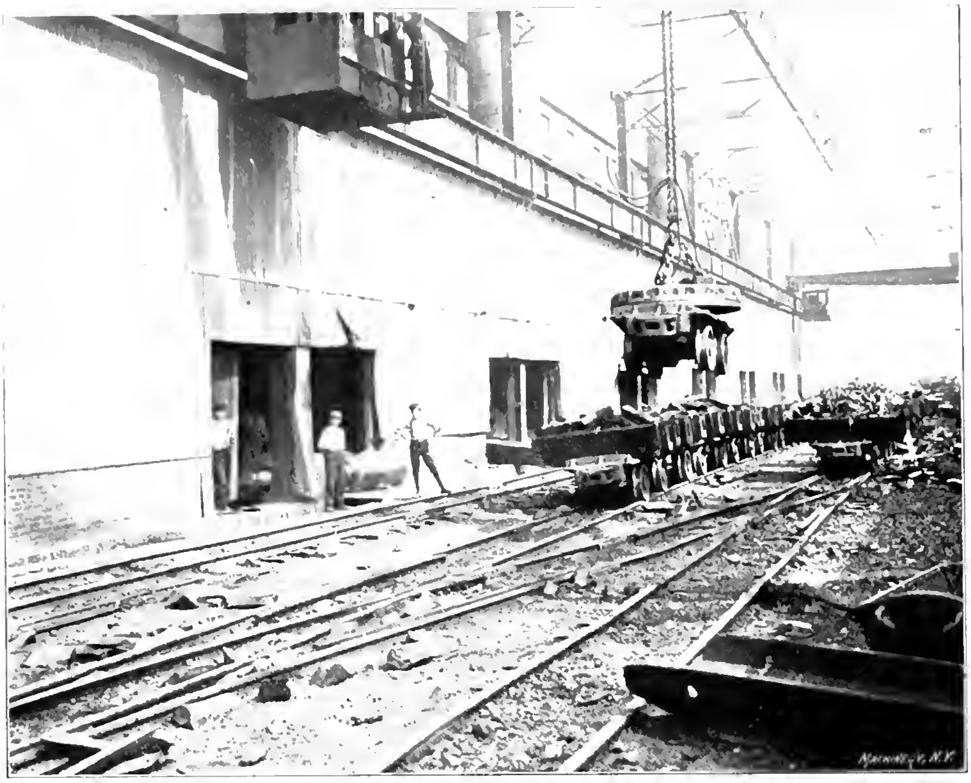


Fig. 2. Striking Example of the Capacity and Adaptability of Lifting Magnets.

It will be noted that the form *E* is provided with an outer flange *O* and an inner flange *S* in addition to the central flange *T* extending upward and supporting the winding. The inner and outer flanges are carefully finished and fitted to finished surfaces on the inner and outer pole faces of the magnet case. This seals the lower face of the winding chamber, and a water-tight joint is insured by clamping the flanges in place by the screws *U* which are spaced four inches apart all around the flanges *O* and *S*. This clamping arrangement, together with the clamps *F* already mentioned, holds the winding rigidly and prevents displacement.

Fig. 3. The Magnet used for Transferring Scrap from Shop Car to Railroad Car.

With the winding thus assembled in the magnet case, the lower face of the coil form *E* is covered by a heavy annular plate *G* of non-magnetic manganese steel, which in turn is held in place by the pole shoes *H* and *I*. Both of these pole shoes are provided with shoulders, thereby protecting the bolts from shearing stress. The heads of the outer clamping bolts *J* are protected by the ribs of the frame between which they are located. It will be noted that the manganese steel plate *G* is provided with raised shoulders around its inner and outer peripheries, which provides for a seat against the magnet poles and an air space or cushion under the winding at *V*. By this means the shocks taken by the outer plate *G* will be transmitted directly to the magnet frame instead of being taken by the winding. The magnet pole shoes are so constructed with regard to the outer plate *G* that none of the clamping surfaces can become battered, and, if required, the plate *G* can therefore always be easily renewed. The entire lower wearing face of the magnet can also be renewed without difficulty at any place where the magnet may be in use, there being no necessity of exposing or disturbing the winding, or breaking the water-tight joint between the coil form *E* and the frame of the magnet.

The terminals in the lifting magnet shown are also of interest. The terminal cavity is surrounded by raised walls *K* which are cast integral with the magnet case, and of sufficient strength to withstand any stresses which may be placed on the walls when the magnet is in use. The terminal cavity is closed at the top with a heavy steel cover *L* seating against a gasket and forming a water-tight joint. The heads of the bolts, by means of which this cover is held in place, are protected by the projecting walls of the cavity. The terminals themselves are of the plug type, which permits of quick

attachment and detachment of service wires. Several improvements have been made in the details of the construction over previous designs. The female members *M* of the terminal are enclosed in an insulating tube so that a ground or short circuit cannot result even if the service wires should be left hanging from the crane with the current on. The insulating tubes are each encased in a steel tube to prevent abrasion of the insulation. These steel tubes fit closely in babbitted openings *N* in the side of the terminal chamber. The male members *P* of the plug connectors are mounted upon a heavy plate *R* of fire-proof insulating material which closes the entrance to the winding chamber and is seated upon a gasket effecting a water-tight joint. The plugs and the plate *R* may be removed without throwing any strain on the connection to the winding, the connections consisting of loops of very flexible copper ribbon, as indicated in the engraving, and placed in the box-like ends of the terminal studs. This construction makes it impossible for the flexible leads which connect to the two ends of the magnet winding to come into accidental contact.

As an example of the capacity of these lifting magnets it may be mentioned that a magnet of the new type, 40 inches in diameter, known as No. 4 type SA magnet, lifts practically the same amount as a magnet 50 inches in diameter, of the older designs, but weighs 2,000 pounds less. This means that for the same power consumption the magnet can lift a much greater load, inasmuch as the dead weight of the magnet must constantly be taken into account.

The accompanying half-tones Figs. 2 and 3 show two interesting applications of these magnets. In Fig. 2 the capacity and adaptability of the magnet is strikingly illustrated; in Fig. 3 its capacity for lifting scrap is plainly in evidence.

YEMCO QUICK-ACTING WRENCH.

Figure 1 shows a quick-acting wrench made by the York Electric & Machine Co., 30-34 N. Penn St., York, Pa.; Fig. 2 shows the method of operating it. In closing the wrench, the construction is such that the sliding jaw may be pushed freely forward until it fits the nut, when it is securely locked in position. Pressure on the plunger in the sliding jaw releases it, so that it may be withdrawn from the nut and adjusted to a larger size. The operation of opening or closing may be performed with one hand.

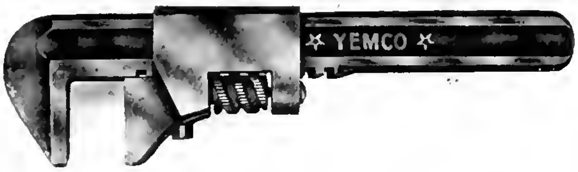


Fig. 1. Quick-acting Wrench made by the York Electric & Machine Co.

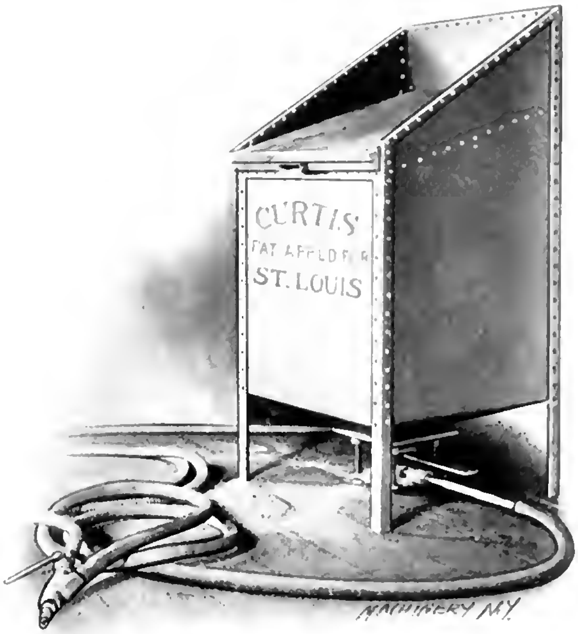
Fig. 2. Method of Operating the Quick-acting Wrench.

The construction is shown in Fig. 2. The screw is double-threaded and of steep pitch, engaging angular grooves cut in the body of the wrench; in pushing the jaw forward, this steep-pitch screw revolves freely. When reverse pressure comes on it, however, a coiled spring contained within the nut, presses it forward so that its conical front bearing is forced into its taper seat, with sufficient pressure to lock it by friction against any possible rotation from movement of the jaw. When sliding the jaw forward this screw is pushed by the pressure away from this taper seat, against the resistance of the spring, so that it is free to revolve. When it is desired to push the jaw backwards, the plunger shown is pressed. This pushes the ball against the conical bearing of the screw and forces it out of contact so that it is free to revolve and allow the jaw to be drawn back.

This wrench is eight inches long, made of a high quality of steel drop forging and is case-hardened with a mottled finish.

CURTIS SAND-BLAST OUTFIT.

The Curtis & Co. Mfg. Co., St. Louis, Mo., makes the improved form of sand blast shown herewith. It varies radically in its construction and operation from other apparatus of this kind on the market, particularly in the fact that the screening apparatus is incorporated in the design of the device, and in the fact that the sand is not under pressure either in the reservoir or in the hose which leads it to the nozzle.



A Sand Blast Apparatus in which the Supply is taken from an Open Tank.

The reservoir or tank is open at the top, but is covered with a screen of such mesh as to allow dust and sand of the proper size to fall through, while pieces of castings or other foreign matter roll down the incline and fall through the screen. Before the sand has a chance to drop into the tank, the dust is separated from it by means of a small air jet, so that only the sand itself, of the right size, enters the hopper. In the center of the cone-shaped bottom of the tank is an opening of about hand-hole size. Underneath this is the plate shown attached by four studs. The sand drops freely through the hole onto this plate, where the cone-shaped pile thus formed stops the opening and prevents overflowing. The air and sand hose are separate, being joined only at the nozzle. The blast of air through the nozzle creates a partial vacuum in the sand hose, which draws the sand by suction from the pile on the plate at the bottom of the tank. The air supply alone is regulated, and this is done by the air valve at the nozzle in the operator's hands. The supply of sand regulates itself automatically.

Among the advantages claimed for this arrangement are the following: A complete and effective screening attachment; the possibility of filling the machine when the blast is in operation; the avoiding of the trouble from moisture in the air, accomplished by keeping the sand out of contact with the air blast until it has reached the nozzle holder; the regulation of the machine from the operator's working position; the possibility of cleaning the sand blast hose while the machine is in operation, by pressing the nozzle to the floor for a few seconds; the use of a cheap grade of sand blast hose, made possible by the fact that the sand is drawn through by suction instead of forced through by high press-

ure, and a reversible construction for the nozzles. The New York address of the builders of this apparatus is 30 Church Street.

WIZARD QUICK-CHANGE DRILL-CHUCK AND COLLET.

The McCrosky Reamer Co. of Meadville, Pa., is manufacturing the "Wizard" quick-change drill chuck and collet shown in Figs. 1 and 2. This tool is of the type which permits drills, reamers, taps, counterbores, etc., to be placed in or removed from a machine spindle without stopping it. Its special advantages lie in the firmness with which the collets are held, and the ease with which they may be inserted. Special pains have also been taken to put the highest grade of material and workmanship into their construction.

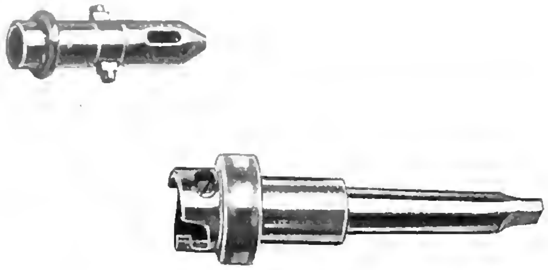


Fig. 1. The "Wizard" Quick-change Chuck and Collet.

The chuck and the collet, separated, are shown in Fig. 1. The chuck has a Morse taper shank, fitting the spindle of the machine, with a seat at the outer end to receive the collet. The latter is ground accurately on the outside diameter to fit this seat, and is provided, as well, with a conical point which assists in inserting it in the chuck, and firmly centers it after it is seated. When the collet is pushed into the chuck, as shown in Fig. 2, the driving lugs on the side of the collet ride up the inclined cam surfaces and strike against the entrance of an angle slot in the collar on the lower end of the chuck. The revolving spindle causes this collar to rotate slightly when grasped by the hand, as shown in Fig. 2, allowing the driving lugs of the collet to enter the slots in the chuck. The releasing of the hand then permits the sleeve to fly back under the influence of a spring contained within it, locking the lugs of the collet securely in place by a principle identical with the bayonet lock of the Springfield rifle. As the locking surface is made angular, the collet is forced with considerable pressure back into its seat, so that it is accurately centered by its tapered point. In releasing the collet, the collar is grasped by the hand, when the revolving of the spindle opens the lock and permits the collet to drop freely or be taken out. It will be noticed that the collets are provided with a collar, which is used against the hand as a shoulder, when placing the tools in the chuck or in catching them when released. The form of lock employed makes the chuck useful for back-facing as well as for straight drilling or counterboring.

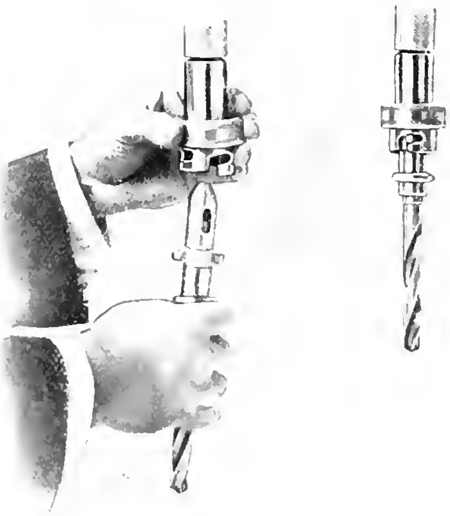


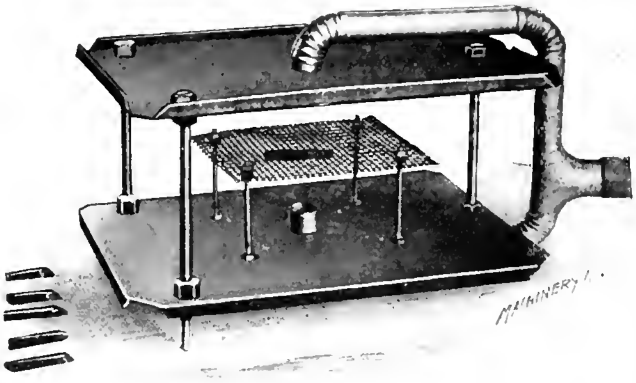
Fig. 2. Inserting a Collet in the Chuck.

These collets are drop-forged from high grade steel, machined, hardened, and ground. The whole collet, including the driving lugs, is a solid piece of steel. They are furnished either with standard Morse holes or sent blank. The blank collets are not hardened, and may easily be bored to receive straight shanked drills, taps, reamers, etc. If desired, these are sent 0.003 inch over size so that they may be hardened and ground after being fitted to the tools. Various ways of fitting special tools to these collets may be employed. One of the most convenient ways is to drive a hardened pin through both collet and tool shank. Set-screws may also be used, or a tang and drift slot may be formed in the tool shank and the collet. In all cases it is best to bore blank collets to a driving fit. The chucks are hardened and ground inside and out.

Chucks are made in three sizes, for collets 15/16 inch in diameter with a maximum hole of Morse taper No. 2 for the smallest size up, to collets 1¾ inch in diameter with Morse hole No. 4 for the largest. When required, the chucks will be sent with the shank left blank, so that they may be turned to fit the tail-stock of a lathe, or other irregular taper holes.

KRIEGER TOOL & MFG. CO.'S AIR HARDENING STAND.

The Krieger Tool & Mfg. Co., 83 West Randolph St., Chicago, Ill., has designed a stand for the air cooling of cutters in hardening. The special purpose of the arrangement is to subject the tool being hardened to a blast of air from every side, and thus harden it evenly all over. As may be seen from the engraving, the cutter to be hardened is placed on a screen. This is supported between the openings of two blast pipes, which direct the air onto it from each side. By placing on the blast pipes special top and bottom nozzles having elongated openings, it is possible to harden several objects at a time, and thus increase the capacity of the device.



Air Cooling Stand arranged to Direct the Air Blast on all Sides of the Work.

DIAMOND AUTOMATIC DIE-HEAD.

The accompanying half-tone illustrates a new self-opening die-head brought out by the Diamond Power Specialty Co., Detroit, Mich. This die-head embodies several new features of which the four most important ones are: the arrangement for discharging the chips; the method of preventing unequal wear of the chasers; the range of the capacity of each size of head; and the relatively small size of the die-head for its capacity.

The first of these features, the discharging of the chips, is accomplished by providing ample openings back of the chasers through which the chips are flushed out by the oil used for cutting the thread. Unequal wear on the chasers is provided against by mounting them on pivots in the body of the die so that when they are drawn together by the adjusting ring, the outer end, where the heaviest wear takes place, closes in faster than the portion nearer the pivots, thus compensating for the unequal wear in the length of the chaser, and making possible the producing of threads of uni-

form diameter throughout their length. This is a most important improvement in this class of dies. The construction of the die-head permits right- and left-hand threads, whether of U. S. standard shape or square, Acme, Whitworth, pipe, or special threads of various pitches to be cut with the same die-head on stock within the limits for which the head is suited simply by changing chasers. The die-head can also be used as a forming tool for small articles by using special blades of required shape. The fourth feature of this die-head, to which special attention is called, is its small size in comparison with its range. The closing ring is placed outside of the chasers, and has its bearing on the latter immediately over the point where the greatest cutting stress comes. Any wear between this closing ring and the chaser holder is taken up in adjusting the die for size, so that this wear does not accumulate with the use of the die.

A Compact Self-opening Die-head.

The length of the thread cut is adjusted closely by an internal stop-pin actuated by the work, thus enabling it to be used in an ordinary turret or automatic screw machine. When the stop-pin is removed, a thread of any desired length can be cut. For heavy, rough work, a stop can be furnished which permits taking two cuts in producing the finished thread. The die-head is closed either by hand, or by fastening a small piece of steel on the turret slide, to actuate the closing lever on the backward motion of the turret.

WALTHAM AUTOMATIC ESCAPE-WHEEL CUTTING MACHINE.

The cutting of escape wheels for watch movements requires several operations, to form the teeth accurately to their somewhat complex shape. In all except the largest watch factories, the cutting of these wheels is done on machines similar in principal to the larger automatic gear cutters used in the machine shop, excepting that a turret containing a number of spindles is used instead of the single spindle found in the larger tool. In the commercial form of automatic gear cutter, this turret is indexed by hand after each cut around the work. Some of the largest watch factories have designed machines of their own which index automatically, not stopping until the entire cutting has been accomplished. These machines, however, are not on the market. The Waltham Machine Works, Newton St., Waltham, Mass., has recently produced the machine shown in Figs. 1 and 2, which is entirely automatic in its action and is built for sale to the trade generally.

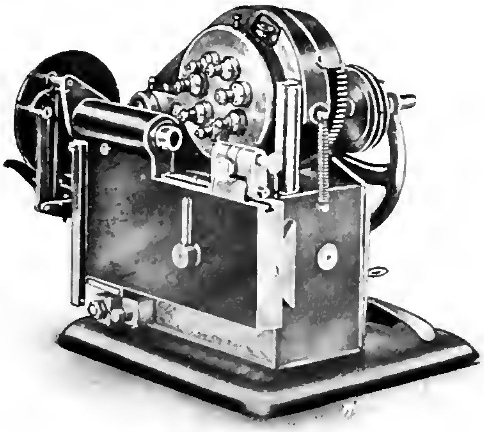


Fig. 1 Automatic Machine for Cutting Escape Wheels for Watches.

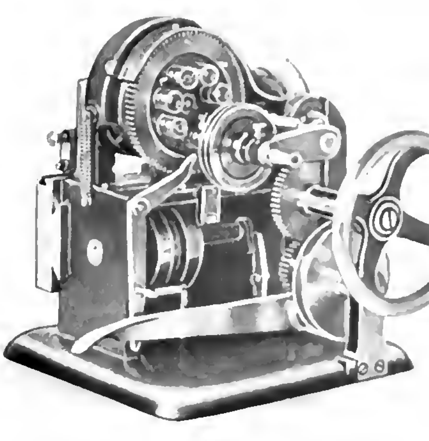


Fig. 2. View showing Mechanism within the Base

The base of the machine encloses the cam mechanism which governs its movements, as shown in the illustration Fig. 2. On the base is mounted a spindle turret, of cylindrical form, containing, in this case, seven spindles (less than seven spindles may be used in cutting shapes of wheels in which so many cuts are not required). In operation the machine takes the first cut around the wheel, indexing automatically, step by step. When the last tooth has been cut, the drive is disconnected from the cam-shaft, and engaged with the turret spindle revolving mechanism. When the turret has been indexed to a new position, the feed is again connected, when the second cut proceeds as did the first one. The last time around, at the completion of the last cut, the machine is stopped.

The spindle head swings upward about its pivot on the return stroke of the work and the indexing of the latter takes place during this movement. The periphery of the cylinder which carries the spindles, carries also a series of adjusted screws for regulating the depth of cut for each cutter. For longitudinal position, each cutter is adjusted by turning the threaded quills that serve as bearings for the spindles. Each cut is thus independently adjusted. A swing feed stop is provided for supporting the work arbor. The index mechanism is of the standard form used by this firm.

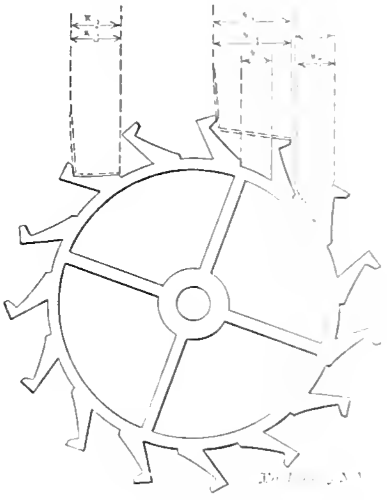


Fig. 3. Shape of the Teeth and Layout of the Cutting

Fig. 3 shows the shape of teeth produced and the layout of the cutting. It will be noted that there are in this case fifteen teeth, and that seven cuts are required to complete each tooth, making 105 cuts in all. As explained, this is done entirely automatically, and the machine stops at the completion of the 105th cut.

ARMSTRONG KNURLING TOOL.

The knurling tool shown in the accompanying illustration is made by the Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, Ill. Its construction is evident from a glance

at the illustration. Exclusive of the rolls and pins, it is composed of but two parts the shank, and the rocking holder for the rolls. The holder fits into a tongued and grooved circular seat in the shank, being retained in place there by a pin passing through a circular groove in the tongue formed on the shank. The holder is thus free to swivel when brought in contact with the work, so that both of the rolls bear on the metal with even pressure. This method of self-centering gives practically no lost motion, and the joint has ample bearing to resist the strains of both end and side thrust.

Armstrong Knurling Tool of Simple and Rigid Design.

This tool is furnished with either coarse, medium or fine knurls. The knurls and pins are made of hardened tool steel. The other parts are drop forged or bar steel, hardened.

NEW LINE OF POOLE BORING AND TURNING MILLS.

The J. Morton Poolé Co., Wilmington, Del., has designed a new line of boring mills for sizes from 7 to 14 feet swing. The accompanying illustrations show the general features of this new line. It is intended to meet the requirements of general shop use. The various sizes are liberal in their dimensions, and are carefully designed as to distribution of metal and weight to give the maximum efficiency at high speed. The journals and bearings are carefully scraped; bronze gears and bushings are used throughout wherever necessary. A particular point is made of ease of operation, all rapid movements being effected by power, insuring rapid production of work.

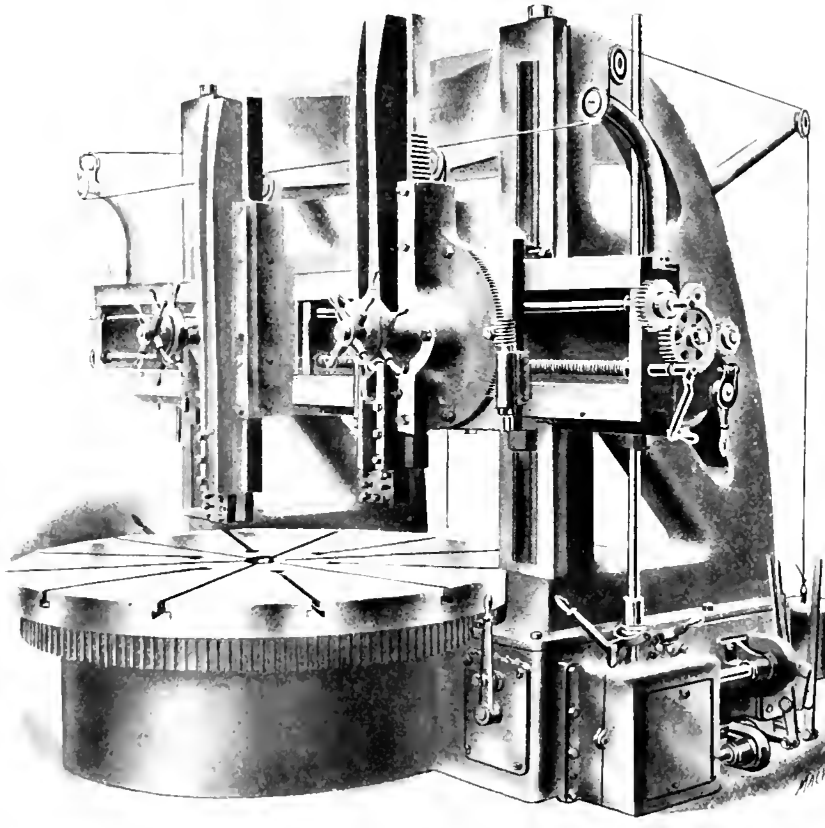


Fig. 1. Poole Boring and Turning Mill, 7 to 14 feet Swing.

A general view of one of these machines is shown in Fig. 1. It will be seen that the bed is unusually deep; it is of box construction, and is braced with internal ribs to give the required stiffness. The uprights are securely bolted to the bed, and are properly dowelled and connected by a stiff cross base. The cross rail housings and top brace can be removed from the machine, when a sweep can be attached to the table for boring large castings. Under these conditions there is no part of the machine projecting within the travel of the sweep, thus adapting it, particularly, for such work.

The drive of the machine is best seen in Fig. 2, which shows the back gearing with the cover removed. The 3-step cone shown is connected by a silent chain with the driving shaft of the back gearing. This latter, by means of positive and friction clutches, gives four changes of speed. This, with the three-step cone and two-speed counter-shaft, gives 24 table speeds in all. It will be noted that the back gear shafts are not journaled in the sides of the bed, but are set in pedestal bearings, whose caps may be removed, thus permitting the removal of the entire gearing without dismantling the mill. All the gearing at the back of the machine is well protected with a heavy gear cover, which may be easily removed. For electrical drive, the cone pulley shown is replaced with a motor, which is connected to the driving shaft in the same way by a silent chain. By using a motor having a variable speed ratio of 2 to 1, the full range of speeds given by the belt drive is obtained, but with finer gradations.

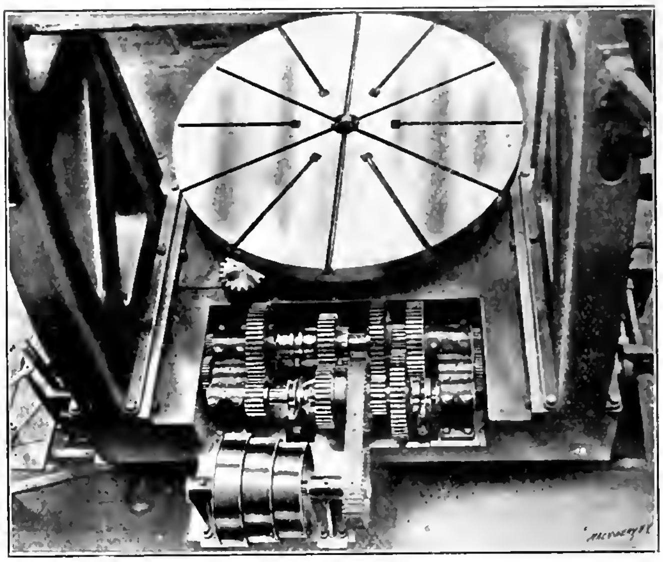


Fig. 2. Looking Down on Gear Drive from the Rear.

All the gearing is of steel, except the table gear and the driving pinion, the latter of which has 20 teeth. These are both made of a high-grade, close-grained cast iron, especially adapted for the gearing. They will be furnished with steel at an extra cost, if desired. The table is driven on a very large diameter, giving adequate power up to the full range of the machine. The table spindle is accurately finished by grinding on dead centers. It is carried in two bearings of large diameter, provided with taper bushings and adjusting screws to take up the wear. The lower bearing is supported in the bed by a heavy bonnet. Owing to the depth of the bed, the bearings can be placed far enough apart to insure stability.

The cross rail is of box girder form and of large cross section, circular in the center. It is held in position by clamps on the inside and outside edges of the uprights. It is raised and lowered by a power traverse, the mechanism of which is very simple, and is located within the bed, thus

adding to the neat appearance of the machine. The power traverse is also applied, in this machine, to the cross-heads and tool bars as well, which are handled by power in either direction, thus saving a great deal of time and labor. The rapid traverse shaft is driven by spur gearing from the intermediate back-gear shaft in both the motor- and belt-driven machines. It is impossible to throw in both the traverse and slow feed at the same time.

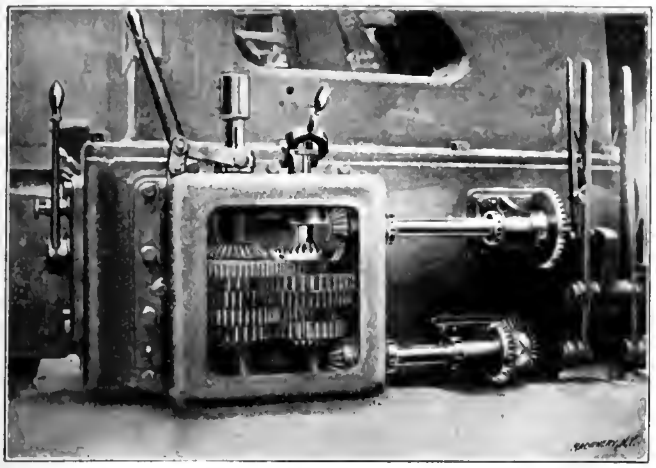


Fig. 3. Feed-box of the Poole Boring and Turning Mill.

The cross-heads are entirely independent in their movements as to direction and amount of feed; each one can be brought to the center for boring. The rams are very stiff and are separately counterbalanced by weights at each end of the rail. The counterbalance weight is connected at the rear of the frame, thus providing room for chains from overhead cranes. Each head is equipped with a forged steel square tool bar, secured by three binding screws and a set-screw. By the operation of the swivel worm, the heads can be set at any angle up to 50 degrees in either direction. Eight feeds are provided for each head, ranging from 1/40 inch to 1 inch per revolution of the table. Fig. 3 shows the feed box (there is one on each side of the table) with the cover removed. The eight changes are obtained in this box without stopping the mill. The feeds of the two heads are entirely independent. The gears are of cast iron and bronze, of coarse pitch and wide face, strong enough for the heaviest work they will ever be called on to perform.

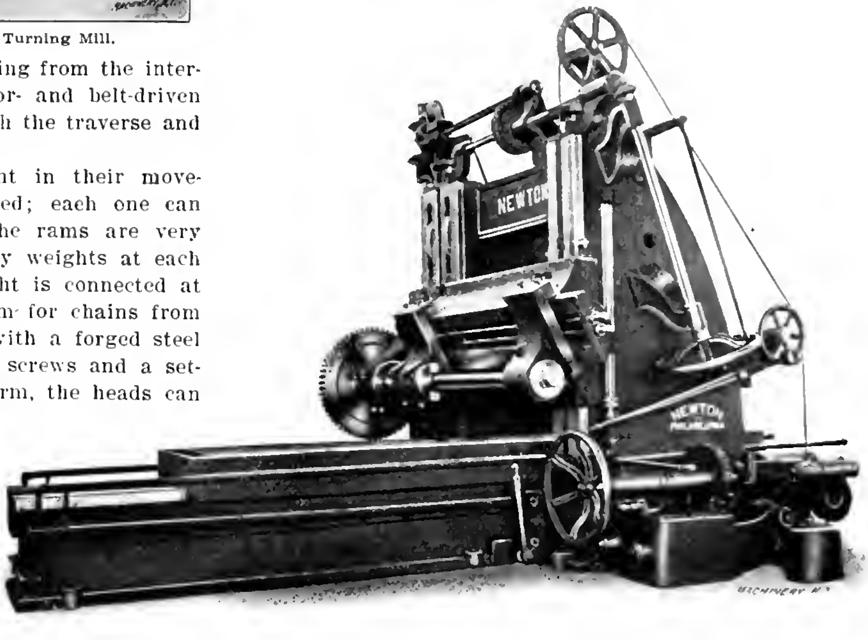


Fig. 1. Newton Horizontal Milling Machine from Operator's Side.

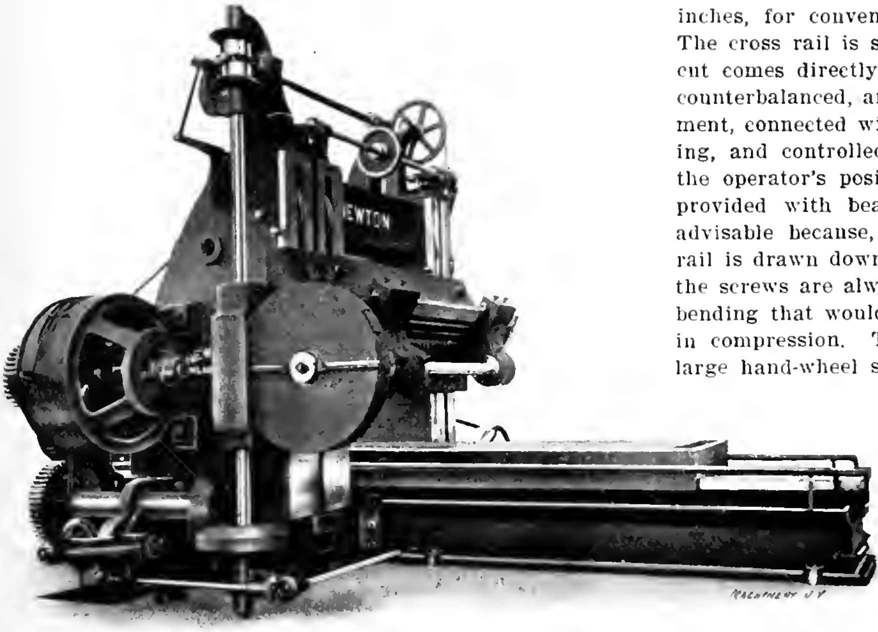


Fig. 2. Newton Horizontal Milling Machine from Motor and Worm-drive Side.

All mills of this make can be furnished with the following special attachments; threading and drum scoring, key-seating, and slotting, traveling or stationary head with revolving spindle, and special heads with various styles of tool bars for special work.

THE NEWTON NO. 7 HORIZONTAL MILLING MACHINE.

Figs. 1 and 2 illustrate the latest and heaviest designs of plain milling machines built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. It is provided with the builders' latest arrangements of feed and speed control, in which all the operating handles are located on the working side of the machine, as shown in Fig. 1. The machine is intended for the heaviest kind of slab milling.

The spindle is driven, as shown in Fig. 2, by a 50 H.P. motor, which is connected by spur and bevel gears with the splined vertical shaft, mounted on the left-hand housing. This shaft drives a hardened steel worm of very steep pitch, engaging a bronze worm-wheel keyed to the spindle, and running in oil. The spindle of this machine is 8¼ inches in diameter, and has a cross adjustment along the rail of 12 inches, for convenience in setting the cutters to the work. The cross rail is set at such an angle that the thrust of the cut comes directly against the broad bearing surface. It is counterbalanced, and is provided with a rapid traverse movement, connected with the vertical shaft on the left-hand housing, and controlled by the counter-weighted lever shown at the operator's position in Fig. 1. The elevating screws are provided with bearings at both top and bottom. This is advisable because, in forcing the cutter into the work, the rail is drawn downward and by placing bearings at each end the screws are always in tension. This avoids the danger of bending that would otherwise result from having the screws in compression. The hand adjustment is by means of the large hand-wheel shown on the angular shaft in Fig. 1. At the side of the housing in this engraving will be noted a threaded rod with four adjustable collars (only two shown) for determining the vertical position of the rail for duplicating depths of cuts in manufacturing work.

The power for the feeds is taken, as shown in Fig. 2, from the horizontal driving shaft at the base of the housing, through bevel gears and a clutch by which the shaft is reversed. This clutch is controlled through the small bevel gears and rock shafts shown, by a lever on the operator's side of machine in Fig. 1. The feed shaft drive comes through to this side, where it may be connected with the feed shaft,

[illegible] a high speed ratio for the rapid movements of the table, and through the feed change box shown, which gives nine rates of feed by the manipulation of the two handles provided. This change from rapid traverse to power feed is effected by a lever conveniently placed, which also serves to lock the table in position when set centrally, with the feed thrown out. This locking is convenient when cutting down into the work. The table is fed through a spiral gear and rack. Hand adjustment is obtained by the large hand-wheel shown on the horizontal shaft in Fig. 1.

The work table of this machine is 42 inches wide, and will [illegible] 8 feet in length. The distance between the uprights, and the distance from the center of the floor to the top of the work table is 50 inches. The approximate net weight of the machine is 96,000 pounds.

NEWTON HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

Figs. 1 and 2 show two views of a horizontal boring, drilling and milling machine built by the Newton Machine Tool Co., Inc., Philadelphia, Pa., for the Japanese government. These machines are interesting because of their range of capacity and the completeness of the speed, feed and rapid traverse movements incorporated. Particular attention has also been paid to bringing the various controlling handles within reach of the operator.

The machine is driven by a 7½ H.P. motor, with a speed ratio of 3 to 1. This motor is mounted on the left of the machine, and is best seen in Fig. 1. The power is transmitted from this through raw hide and steel spur gears, splined shafts and bevel gearing, to a driving shaft in the head, parallel with and above the spindle. This connection is made through a bevel gear reversing device, seen in Fig. 1, operated by a handle near the front end of the spindle, within convenient reach of the operator. The driving shaft may be set to drive the face-plate directly through the internal gear, or, for high speeds, by a longitudinal shifting of the driving shaft; the spur gear keyed to it may be engaged with a similar gear keyed to the spindle. For the face-plate drive, the pinion is cut from the solid metal of the shaft. The speed range is from 10.44 to 31.44 revolutions per minute for the face-plate drive, and from 33.75 to 101.25 revolutions per minute for the high-speed connection.

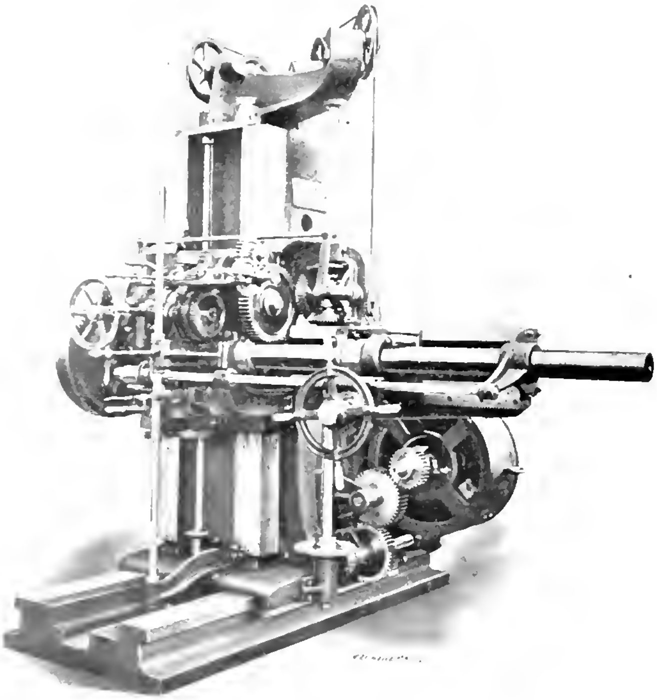


Fig. 1. Newton Horizontal Boring, Drilling and Milling Machine.

The feeds are taken from the driving shaft, through the train of gears shown. The feed operates through a bevel gear [illegible] mechanism which applies to all the feed movements in the machine. The hand-wheel on the heads gives a fine adjustment for all the machine settings. At this station the manipulation of suitable levers applies the feed either to the longitudinal traverse of the bar, the vertical traverse of the head, or the horizontal traverse of the column on the bed. The traverse of the column on the bed is effected by a spiral rack and pinion movement. In this case, the handles for throwing in the rapid movement and the power feed, interlock with each other, so that the simultaneous application of both is impossible. All the rapid movements are derived from the horizontal shaft shown below the motor in Fig. 1. The rapid movement of the spindle is by hand, through the wheel shown in the extreme right of Fig. 2. With the construction of spindle feed slide provided, the length of the bar and the length of its traverse can be increased to any amount required by the work of the purchaser.

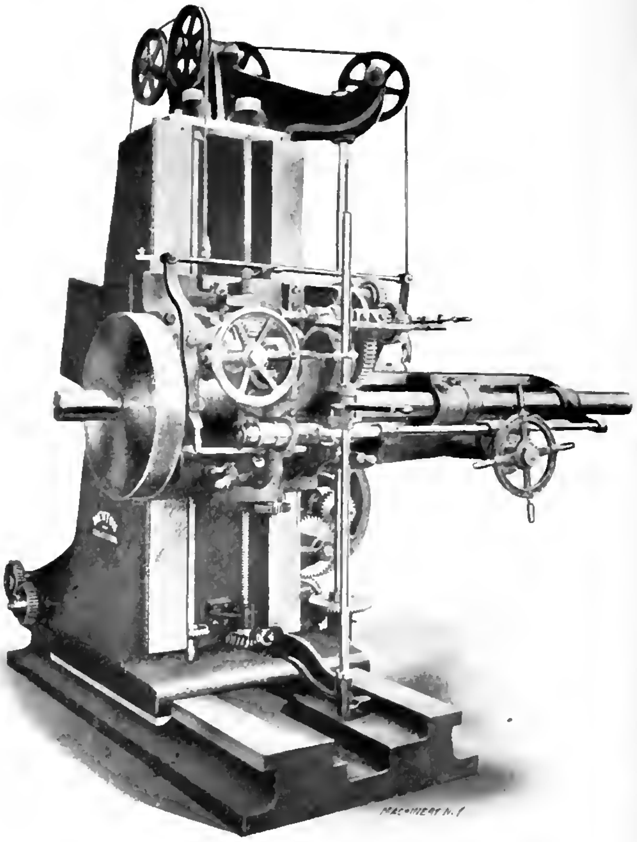


Fig. 2. Newton Horizontal Boring, Drilling and Milling Machine.

The spindle of this machine can be adjusted from 20 inches to 60 inches above the floor plate. The upright in this particular case has a horizontal movement of 4 feet, although this can be increased if desired. The face-plate of the machine is 28 inches in diameter over all. The spindle is 4½ inches in diameter and has a continuous power feed 32 inches in length; it is provided with a No. 6 Morse taper.

THE NEW BRITAIN MACHINE CO.'S POLISHING FRAME.

The polishing frame shown herewith is built by the New Britain Machine Co., New Britain, Conn., for those who prefer the form in which the spindles run in conical bearings in maple blocks. The frame is a large section, with a suitable amount of overhang, allowing tubes, cylinders, hollow ware and irregular shapes to be finished without the interference met with where straight frames are used. The weight is sufficient to avoid trouble from vibration. The base, while giving a large supporting area, is narrow and does not obstruct the work of cleaning up or sweeping the floor.

The frames are bored to take wood blocks two inches in diameter. The adjustment of these blocks is locked by set-screws, which do not, however, bear directly on the wood. Each of these set-screws is provided with a swiveling, drop

forged handle, which is always in place and may be swung out of the way so as to not interfere with the work. The belt may be led from an overhead or a rear countershaft, as desired.

The height of this machine from the center of the spindle to the floor is 32 inches; the length of arbor used is about 12 inches; and the shipping weight is 250 pounds. The arbor is not regularly furnished, but any form suitable to the customer's work will be supplied at extra cost.

A Polishing Frame for Wood-centered Spindles.

SLOCOMB REFERENCE DISKS.

The J. T. Slocomb Co. of Providence, R. I., is now furnishing reference disks similar to those used for testing micrometers, but arranged in sets for general use. The set shown in the illustration ranges by sixteenths from one-quarter inch to two inches. The disks are provided with handles for convenience in using; the quarter inch and five-sixteenths sizes are made in one piece with their handles, while those for the other sizes are detachable.

Set of Slocomb Reference Disks for General Use.

These disks are made of a good quality of tool steel, hardened very hard, and properly seasoned before finishing. This finishing is done with a high degree of accuracy. They are also made with considerable thickness to give them durability. Each of them is marked with the common fraction and decimal equivalent for the size, in such a manner that the dimensions are plainly see when the cone is open. The plugs on which they are placed are also numbered to correspond. The whole outfit regularly comes, as shown, in a serviceable morocco case, though the disks will be furnished singly, if desired.

WILLIAMS, BROWN & EARLE BLUE-PRINT DRYING FRAME.

The accompanying illustration shows an arrangement for drying blue-prints, made by Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa. The difficulty of obtaining the blue-prints quickly is one that is of common occurence, and has been met by all draftsmen. Where a print is required for immediate use, it is almost impossible to dry it quickly in the old-fashioned way, by hanging it on a line and allowing it to drip onto the floor or into a sink, especially if the air of the room is saturated with water. This device saves half the time in drying, and gives the further advantage of drying the prints flat, leaving them in the best possible condition for use.

As may be seen, the apparatus consists of an inclined tray, with a draining trough at the bottom. The blue-print is spread on the back of this tray, where the extra water is removed by the rubber scraper, as shown, which also flattens it against the back of the frame. The tray at the bottom can be connected with a drain pipe, or the water can be drained off into a bucket, thus keeping the floor perfectly dry. The arrangement shown has a drying box equipped with a heater for either artificial or natural gas. It can also be furnished without the heater, and with any desired size of tray.

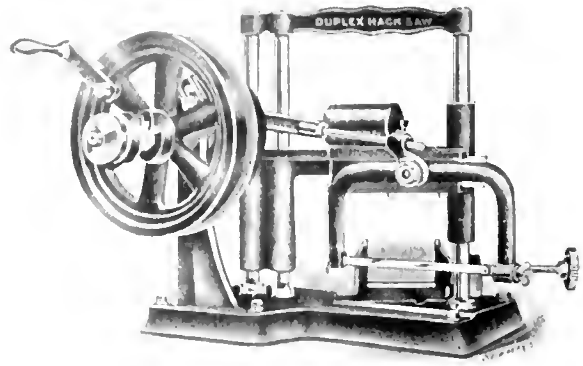
Frame for Drying Blue-prints quickly.

BUFFALO SPECIALTY CO.'S DUPLEX HACK-SAW.

The hack-saw shown herewith is built by the Buffalo Specialty Co., Buffalo, N. Y. It is unusual in that it is designed to be used either by hand or by power. It may be placed on the work bench, where it will take up no more room than the ordinary bench vise. It is thus adapted for use in garages, stock-rooms, tool-rooms, steamship engine-rooms, round-houses, and bicycle and other repair shops.

As a hand machine, it is much easier to operate than a hand hack-saw, owing to the fact that the momentum of the fly-wheel tends to steady the movement, and owing to the fact also that the hand does not have to guide the hack-saw frame. The slide bearing on which the arm operates is made

of such proportions as to insure accurate alignment and durability, thus reducing the breaking of saw blades. This bearing is adjustable to allow wear to be easily and quickly taken up. The connecting rod is adjustable, permitting saw blades to be used their entire length; the stroke is also adjustable to permit the sawing of large work, it being possible to set it

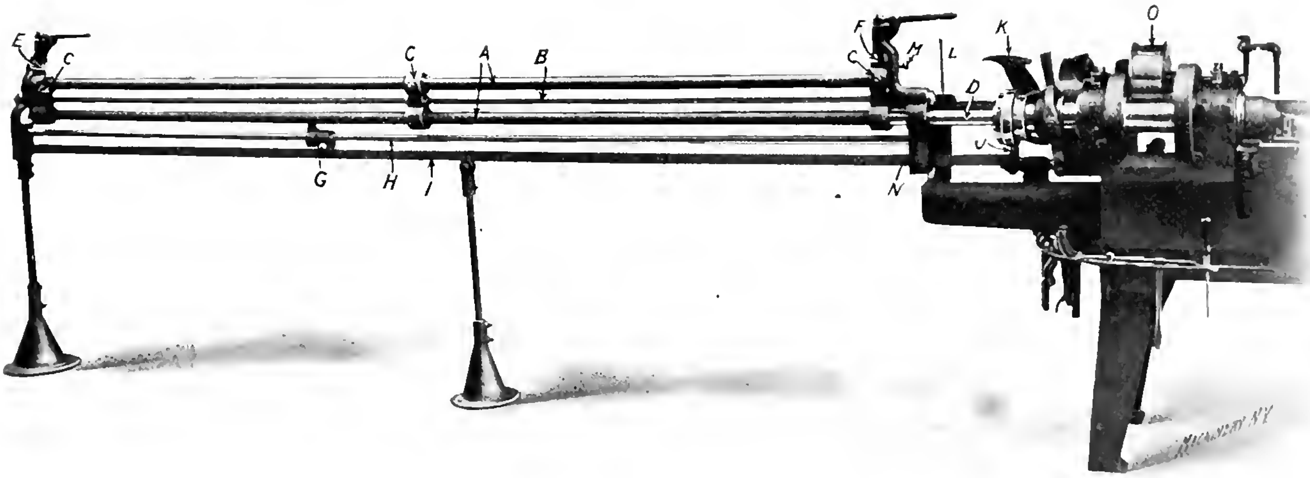


A Small Hack-saw adapted to either Hand or Power Drive.

for any stroke between 3 and 5 inches. The capacity of the machine is for stock up to 4 inches square. The length of the saw blade used is 9 inches. The speed, when power-driven, should be from 85 to 100 revolutions per minute. The net weight of the machine is 80 pounds.

MAGAZINE ATTACHMENT FOR CLEVELAND AUTOMATIC SCREW MACHINE.

The Cleveland Automatic Machine Co., Cleveland, Ohio, has recently designed a magazine attachment for use with its automatic screw machines, which is adapted to using material that hitherto could only be used at a considerable loss of time. That is to say, it may be employed for feeding, automatically, to the machine irregular lengths of stock, such as short ends of bars, tubing, pipe, etc. The machine will work these up into screw machine parts, cutting them off to exact length and discarding all that will not finish out. It handles, also, anything that is nearly parallel, such as castings and drop forgings. It is made double, so that one of the holding tubes can be filled while the other is in operation, thus involving no loss of time in stopping the machine. Another important feature is the fact that it can be attached to any of the builder's plain machines without requiring it to be rebuilt.



Automatic Screw Machine fitted up for Using Short Bars of Stock, Castings, etc.

The magazine consists of a revolving barrel composed of two steel tubes *A*, mounted on a shaft *B*, by means of three castings *C*. The lower tube is in line with the spindle of the machine and meets a tube *D* of similar size which extends through the spindle and reaches to the rear of the chuck jaws. These two tubes *A* may be revolved about the bearings in the extensions of shaft *B*, so as to bring one or the other of them in line with the spindle, when they may be locked in position by means of the two plungers *E* and *F*, seen at each end of the tubes in the photograph. These plungers may be drawn out by means of the horizontal handles shown above them. Underneath the lower tube *A* is a carrier *G*, which is free to slide on the fixed shaft *H*. Directly underneath this carrier will be seen the rack *I* which has saw-shaped teeth milled the full length of the upper edge. This rack is reciprocated by the feed lever *J* to which it is attached, this lever being operated by the regular stock feed cam which is a part of the machine. The ratchet teeth of this rack, as it is reciprocated, engage a pawl in carrier *G* and move it forward step by step, pushing the short bars of stock or individual castings through the tube and the spindle and into the chuck, one after another, as fast as the work is done. The rod *L* is an automatic stop for the machine, which is actuated by carrier *G* when this has reached its extreme forward position.

A special spindle drive is used on the particular machine illustrated, the particular features of which are a wide belt and a powerful drive through differential gearing enclosed in driving pulley *O*, which drive is thrown into action for the threading operation. When the machine is on the cutting operation, the rear train of spindle gears is used, giving a fast speed for cutting off. This change is controlled by a sliding gear arrangement operated by a lever at the rear of the spindle head.

Time Recorder, made by E. Howard Time Recorder Co. This recorder is driven by a Howard clock movement, in which the record is made on a flat sheet by stamps controlled by an arm swinging around a numbered dial.

A Loose Pulley Oil Cup, made by the Lawson Mfg. Co., Buffalo, N. Y., employs the novel plan of using the centrifugal effect of a loose piston in the oil cup to force the oil into the journal of the pulley.

A Sheet Metal Punch for general shop use on light work has been brought out by the Queen City Punch & Shear Co., Cincinnati, Ohio. This is a quick-acting punch with a narrow jaw, to permit handling light work.

An Automatic Wire Cutter which will handle brass, iron or steel wire up to 7/16 inch in diameter, is built by the Narragansett Machine Co., Providence, R. I. It will cut off lengths of wire up to 2 feet at the rate of 260 per minute.

A New Pressure Blower has been placed on the market by the Natural Power Co. of St. Louis. The particular feature of this blower is the design of the runner, which gives, it is claimed, a high-pressure with a very low rotative speed.

An Alternating Current Motor Brake has been developed by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa. This

brake is held open by an electro-magnet and is closed by springs, though the braking force is increased by the rotation of the brake drum itself.

A Portable Milling Machine for truing up the pedestal bearings of car truck frames is built by H. B. Underwood & Co. (Flanders Machine Works), 1024 Hamilton St., Philadelphia, Pa. While adapted to this special work, it is also applicable to general portable milling.

A Multiple Hand Punch, for piercing a number of holes at once, is made by the Lansing Machine Co., Lansing, Mich. This tool will easily pierce 24 holes in No. 16 gage sheet steel. The surface of the die is so shaped that only four of the punches are working at once.

A Motor-Driven Speed Lathe, made by the American Wood Working Machinery Co., Rochester, N. Y., has a General Electric motor mounted directly on the spindle as a part of the head-stock. The carriage is provided with a rack feed on the bed, and has a cross slide and compound rest.

The "G. M." Screw-Cutting Engine Lathe has been placed on the market by the G. M. Lathe Co., Lennox Bldg., Cleveland, Ohio. It is intended to fill the demand for a low-priced lathe for automobile garages, jobbing machine shops, etc. It is driven by a five-step cone pulley, and swings 16¼ inches over the shears.

A Power Hack-saw Machine built by Henry G. Thompson & Son Co., New Haven, Conn., introduces the feature of a positive lift and a quick return on the back stroke. The machine is intended for use on 10-, 11-, or 12-inch blades, and will operate on stock up to 5 inches in diameter. An automatic stop is provided.

A Cam-Cutting Machine has been brought out by the Garvin Machine Co., Spring and Varick Sts., New York City. It has a large capacity, being able to cut cams up to 36 inches in diameter of face, edge, disk, or cylinder types. It resembles in its construction a profiling machine, provided with special appliances for holding the work and the master cam.

A Heavy Drilling Vise is made by the Titus Machine Works of Marion, Ohio. It is similar to that built by the same firm and described in the department of "New Machinery and Tools" in the July, 1907, issue of Machinery, but is made much heavier, so that it is useful for milling machine and planer work as well as for the drill press.

An Emery Wheel Stand with a Skeleton Frame, built of castings and steel rods, is made by George E. Soper, Kankakee, Ill. The spindle is arranged to be belted directly with the line shaft, the spindle being started or stopped by raising or lowering the head on which it is mounted in a manner somewhat similar to that followed in some designs of buffing wheel stands.

A line of Shaft Turning, Straightening and Polishing Machinery of the continuous type has recently been brought out by the Brightman Mfg. Co., Shelby, Ohio. Material as short as 8 feet in length can be machined. The apparatus consists of two machines, the first of which turns the stationary shafting, while in the second it is finished by being passed between straightening and polishing rolls.

The Magnetic Chuck, built by O. S. Walker & Co., Worcester, Mass., has recently been adapted to holding very small work. This has been done by cutting the serrated pole faces of the magnet with finer teeth, thus giving a greater number of magnetic gaps in the length of the face. Special templets may be employed for centering the work over the gap in the pole faces.

An Electric Operation Recorder is made by the Bristol Co. of Waterbury, Conn., for recording the occurrence and duration of different operations such as the starting and stopping of machines, opening and closing of valves, the passing of trains, etc. Each instrument may be furnished with as many as twelve recording pens. The paper dial used gives a complete record for twenty-four hours.

The "Stuyvesant" Turret Lathe is the name given to a new product of the J. G. Blount Co., Everett, Mass. This lathe is intended for the general run of chucking and turret lathe work in the machine shop. The ways are of the flat type; another noticeable feature of the design is the fact that the cone is reversed from the usual position, having a small step in the front.

A Double-Spindle Drilling Machine, built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., employs a cross-rail with two complete spindle-heads adjustable on it. This cross-rail is mounted on two housings which, in turn, support a work table 20 inches wide by 6 feet 5 inches long. There are four belt speeds. The back gears double this number for each spindle.

The Carr Tool Holder, built by Carr Bros. of Syracuse, N. Y., and described in the new tools department of the November, 1907, issue of Machinery, has recently been improved by the provision of arrangement for adjusting the height of the tool post without losing any of the rigidity that characterizes the older form. It has also been adapted to the use of turning and boring tools, as well as side tools.

An Automatic Nut Tapping Machine of the type in which the tap floats freely, and is centered and held from revolving by the stream of nuts passing over its shank, has been designed by Mr. W. M. McKenzie, 39 Park Place, New Rochelle, N. Y. With this style of nut machine the process of tapping is a continuous one, it not being necessary to remove the tap to empty the nuts from the shank.

A Direct Process for Copying Blueprints is being introduced in the United States by Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa. This, which is known as the "Duplico" process, consists in brushing a solution over the blueprint, washing it, dipping it in a second solution, again washing, and, after drying, making it translucent by a third solution. This gives a negative from which prints can be made on any kind of sensitized paper.

A Hot Pressed Nut Machine, built by the Acme Machinery Co., Cleveland, Ohio, has been specially designed for the most severe working conditions and for the utmost durability and freedom from repairs. The bed is a single steel casting. The gearing is of steel, as are all the working parts, the bearing surfaces being of hardened tool steel and phosphor bronze, with cast iron lining strips, plates and bushings. Radical improvements in the mechanism have been introduced also.

A Tool-Holder for Turning Locomotive Tires has been brought out by the G. R. Lang Co., Meadville, Pa. The blade is of the straight, forming tool variety, and is held in a dovetail seat in the holder, which grasps it firmly on the sides. Notches cut in the back of the blade engage the clamping bolt in such a way as to give a positive backing for the thrust of the cut. The holder is of course useful for holding tools of other shapes, besides those employed in railroad shops.

A Thermo-Electric Pyrometer, made by the Wilson-Maeulen Co., 1 East 42d St., New York, has been equipped by its builders with an electrical alarm attachment which rings the bell when the temperature indicated passes the prescribed maximum and minimum limits. It can be quickly adjusted for any desired limits. Another device brought out by the makers provides for shifting the connections automatically to give an indication from different furnaces successively, at intervals of a few minutes apart.

A Grinding Attachment, known as the "Marvel," built by Armstrong Blum Mfg. Co., 113 N. Francisco Ave., Chicago, Ill., is arranged to be attached to the lathe or planer without

requiring any change in the over-head works. The drum for driving the grinding wheel on the carriage of the lathe or the slide of the planer, is carried by removable supports attached to the machine itself. In the case of the lathe, this drum counter-shaft is driven from the large step of the cone pulley.

A New Line of Tool Holders has been brought out by the Clifford Tool Co., Concord, N. H. The holders are made entirely of tool steel, so that they are not injured by the severest clamping strains to which they may be subjected. They are made in both straight and off-set styles. A valuable feature of their construction is the fact that the blades can be used until they have been ground very short, thus making the holders very economical in the use of costly high-speed steel.

A Combination Wheel and Disk Grinder, built by the Garvin Machine Co., Spring and Varick Sts., New York, is made along novel lines. The frame is of the milling machine type. The work table is oscillated by a worm-driven crank in the countershaft. The rear end of the spindle carries an emery-wheel for general purpose grinding. The emery disks furnished are provided with a gummed solution spread on them, which merely has to be moistened before application to the plate, no press being necessary.

A Horizontal Bulldozer is made by Logemann Bros., Milwaukee, Wis., which may be converted into a horizontal crank riveter. When so arranged, it is provided with a hydraulic holder-on, operated by an accumulator provided with the machine, which holds the work against the die with a certain definite pressure, but still allows the holder to recede when the stock is thick, or the rivet large; it allows it to advance in the case of opposite conditions. The builders also make a plain bulldozer of the same general construction, but without the gap required by the riveting machine.

An Automatic Double Slide Press, built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., involves the novel construction of employing what is practically a series of eight subpresses, through which the strip of stock is passed by a roll and ratchet feed. As the press is double acting, the variety of operations it is possible to perform is almost limitless. At 180 strokes per minute, the regular working rate, it completes that number of parts per minute, performing in the same time 1,440 operations, all of which are completed without any re-handling.

Portable Oxy-Acetylene Outfit. This outfit consists of an acetylene generator and carbon generator, mounted on a truck so that it can be taken from place to place as required by the work to be done. The acetylene is produced by lump carbide, and the oxygen by the heating of a mixture of black oxide of manganese and chlorate of potash, the heating being done by Bunsen burners fed from the acetylene tank. This apparatus has been designed to meet all fire insurance requirements, and provides for the doing of autogenous welding in a very simple and satisfactory way. The builder of the apparatus is F. C. Sanford Mfg. Co., Bridgeport, Conn.

Machine for Bending Rods or Bars. This machine, which is made by the Wallace Supply Co. of Chicago, Ill., was particularly designed for bending rods for reinforced concrete work. It is applicable, however, to all operations of this sort within its range, which is for work up to 1 inch in diameter or $\frac{1}{2}$ x 4 inches, in soft stock, cold. This great power is obtained, while still making rapid handling possible on smaller work, by providing two means of operating the bending dies. For small work, the bending is done directly by hand. For heavier work, a gear and pinion connection is operated by a ratchet lever, thus giving increased power.

A New 8-Inch Bench Lathe has been brought out by the Waltham Machine Works, Waltham, Mass. It involves a number of improvements in its construction, differing from the usual design of this type of lathe. One of the most noticeable of these differences is the placing of the large end of the cone pulley at the front end of the bearing, and the provision of unusually large chuck and spindle capacity. The removal of the pulley screw is all that is required to withdraw the spindle out through the front bearing. Convenient forms of slide rests are provided, together with chasing, screw cutting, grinding, milling, and other attachments.

A Hand Threading Machine, made by the Threading Machine Co., Sandusky, Ohio, has the novel feature of a positive lead screw for the chasers. The apparatus also includes a conical ring which automatically closes the chasers with the proper taper for the standard Briggs thread. An automatic throw-out is also provided which removes the chasers from contact with the pipe when the thread has been cut to the proper distance. The smaller sizes of this tool are operated by handles in a way similar to the ordinary threading die stock. The larger sizes are mounted on tripods or benches, and are geared to work by hand cranks.

A Large Portable Boring Machine, built by the Beaman & Smith Co. of Providence, R. I., is notable for its compactness and neatness of design, and for the way in which all the controlling handles have been brought within easy reach of the operator's platform. It consists of a traveling column mounted on a base-plate, and carrying a 10 H.P. variable speed motor for driving the spindle. The spindle has a power feed longitudinally, a vertical feed for the saddle on the column, and a horizontal feed for the column on the bed. Quick traverse is also provided for these movements. The column travel is 6 feet, and the vertical movement of the saddle, 4 feet 6 inches. The boring spindle is 5 inches in diameter and has eighteen speed changes.

An Enclosed Pinion Type Drill Chuck has been put on the market by the T. R. Almond Mfg. Co., Ashburnham, Mass. This is the well-known Almond type of chuck, altered to permit the use of a pinion and square end key for tightening. The body of the chuck is recessed to receive the pinion, which meshes with teeth cut in the front of the geared nut. As the pressure on the nut is at the back, the same wearing surface is preserved as in the former chuck of this make. A cap covers the pinion and provides a support for the outer end while the inner end has a bearing in the body of the chuck. Both pinion and nut are made of a special grade of tool steel, tempered. The knurled sleeve can be used for quick adjustment, as formerly, while the key is used for final tightening.

* * *

The growing scarcity of lumber in the United States makes the use of concrete for building and general construction work imperative wherever it can be employed, but a great drawback to the use of concrete in monolithic construction—the most desirable form—is the necessary use of a large amount of lumber for the forms to support the concrete during the setting period. An ingenious plan for avoiding a large part of the lumber expense and at the same time securing a superior concrete structure was employed at Camp Perry, Ohio, last summer, for the construction of a two-story mess hall. The sides of the building were molded in reinforced concrete flat on the ground. The reinforcement was steel rods interlaced into the structure in approved form so as to strengthen it around the windows and other openings. When the concrete had hardened the sides were raised to a perpendicular position and the corners were united by twisting the ends of the reinforcement rods together, and were filled out by pouring liquid cement around them. Obviously a much better concrete structure is obtained when molded flat, the material being more readily rammed into position. The labor is much reduced both as regards ramming and elevating into position. A drawback to the extensive use of this plan of erecting concrete structures is that it cannot be readily employed where buildings are close together, there being insufficient room for the side walls in horizontal position unless the buildings are separated by a distance equal to the height of the walls.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The twenty-ninth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 W. Thirty-ninth St., New York, December 1 to 4. Six professional sessions will be held, two of them simultaneously with other sessions. The opening session will take place at 8:45 P. M. December 1, when the president will address the society on the Conservation Idea as Applied to the American Society of Mechanical Engineers. After the reading of the president's address, a social gathering will follow. During the three following days professional sessions will be held, at which a great number of papers will be presented, these papers being briefly reviewed below. On the evening of December 2, Lieutenant Frank P. Lahm, of the Signal Corps of the United States Army, will deliver an illustrated lecture on aeronautics. On the evening of December 3 there will be a reception in the Engineering Societies Building, when the president and president-elect will receive members and guests in the auditorium.

REVIEW OF THE PAPERS.

The Engineer and the People, by Mr. M. L. Cooke.

This paper contains a general discussion on the duties of the engineer, as a member of his profession, toward the public. Throughout the paper various ways in which the engineer can fulfill these duties are pointed out, and special attention is given to the lines along which engineers could be particularly active in the public interest. The paper lays down a general plan for a larger measure of cooperation between engineering societies and the general public.

Aeronautics, by Major G. O. Squier.

This paper is the first presentation of the subject of aeronautics before a national engineering society in America. The author is connected with the Signal Service of the United States Army, and has, consequently, had an opportunity to observe at close range the construction, equipment and principles of operation of heavier-than-air machines, and dirigible balloons. The paper contains much valuable information, due to the fact that the material upon aviation on file in the War Department has been placed at the disposal of the author for the preparation of his paper.

A Method of Obtaining Ratios of Specific Heats of Vapors, by Mr. A. R. Dodge.

A method of obtaining ratios of specific heats which does not involve the use of available steam tables conceded to be inaccurate for such investigations, is given in this paper. The method is based upon the expansion of fluid initially superheated in a throttling calorimeter, and tables are included giving data for calculations.

The Total Heat of Saturated Steam, by Dr. H. N. Davis.

This paper contains the results of another investigation along the same lines as that outlined in the paper by Mr. A. R. Dodge, referred to above. The author reviews various experiments made, and compares the formulas by means of which the total heat of saturated steam can be determined. A new formula which differs somewhat from the classic Regnault's formula, is given, together with diagrams showing the deviation between the results obtained by the two formulas.

Fuel Economy Tests, by Mr. C. R. Weymouth.

Results of tests made at the 15,000 K. W. power plant of the Pacific Light and Power Company, Redondo, Cal., are here presented. The power plant has steam engine prime movers, crude oil being used for fuel. The results of the tests indicate a remarkable economy for all conditions, and of special interest is the almost uniform fuel economy for the plant, for all fractional loads from about one-half load up to the maximum capacity.

Unnecessary Losses in Firing Fuel Oil and an Automatic System for Eliminating Them, by Mr. C. R. Weymouth.

The author presents as a solution to the problem of automatic firing of steam boilers in plants using liquid fuel, an automatic system of regulation. The development and details of this system are explained, as well as results obtained by its practical application.

Efficiency Tests of Milling Machines and Milling Cutters, by Mr. A. L. De Leeuw.

Machine tool designers and machine tool builders, as well as mechanics in general, will be particularly interested in this paper, which has direct bearing on the performance of one of the most important machines in the modern machine shop Besides giving interesting data regarding tests performed on milling machines and cutters, the paper gives a general outline of the logical principles followed by the machine designer in developing what might be called a scientificially designed machine. An abstract of this paper will be found elsewhere in this issue, engineering edition.

Metal-cutting Tools without Clearance, by Mr. J. Hartness.

The objects of the tool described in this paper are: the reduction of the stresses existing at the cutting point; the provision for support of the cutting point by a bearing of the face of the tool against the surface of the metal just cut, with a view of eliminating lateral vibration; and the balancing of the side pressure upon the cutter. The cutter is supported in a holder which allows it to swivel about an axis coincident with the cutting edge, thus permitting the tool to follow the cut. A cutter with an acute point is used, which produces a continuous chip, and a chip breaker is a part of the design.

Development of a High-speed Milling Cutter with Inserted Blades, by Messrs. Wilfred Lewis and W. H. Taylor.

This paper contains a review of prevailing methods of making inserted blade milling cutters, and then outlines the reasoning which led up to the design of the milling cutter described. The paper is amply illustrated, showing the details of the design; and results of experiments carried out for testing the efficiency of the cutter in actual work, are presented. One of the most prominent features of the new milling cutter is that the blade is bent to form a helix, thus permitting a definite slope and lip angle throughout the entire length of the blade, a condition which is not possible with the ordinary inserted blade milling cutter having straight blades inserted at an angle with the axis of the cutter body.

Interchangeable Involute Gear Tooth Systems, by Mr. Ralph E. Flanders.

This paper discusses the effect of changing the addendum and pressure angle of interchangeable involute gearing, from the standpoints of interference, number of teeth in continuous action, strength, efficiency, durability, smoothness of action, etc. The comparisons of various typical involute systems in regard to these points seem to the author to justify the adoption of a new or alternative standard of smaller addendum and greater pressure angle, for use in large, heavy work, and for smaller high-speed gearing as well, if experience shows that it can be used on that work without losing smoothness of action.

Spur Gearing on Heavy Railway Motor Equipments, by Mr. N. Litchfield.

This paper deals with the breakage of gearing in heavy electric railway service. A resumé is given of the methods employed to overcome the breakage, and the strains in the teeth as calculated by the Lewis formula are shown. Attention is called to the fact that this formula is not entirely applicable on account of the difficulty in maintaining alignment of gear and pinion.

Articulated Compound Locomotives, by Mr. C. J. Mellin.

The articulated compound locomotive as met with in present American locomotive practice for heavy freight service, is described, and the object and advantages of this design are briefly referred to. By means of this construction the tractive power can be doubled over that of the ordinary engine for a given weight of rail, and, at the same time, a substantial saving in fuel is obtained.

Liquid Tachometers, by Mr. A. Trowbridge.

This paper contains an illustrated description of the operation, construction and methods of testing liquid tachometers. The principle on which the liquid tachometer acts is that the pressure developed by the centrifugal force of the liquid when the instrument is running at a certain speed, is a definite quantity. Among the many applications for which liquid tachometers have been adapted the first has been for labora-

tory service in testing dynamos and engines and other machines with revolving members. Another use for these instruments has been as a speed indicator for automobile and locomotive service

Training Workmen in Habits of Industry and Cooperation, by Mr. H. L. Gantt.

This paper deals with the old and new methods of training workmen, and maintains that if the training is based on scientific investigation, the efficiency of the workmen can be greatly increased, and employers can, as a consequence, afford to compensate those who show increased efficiency far in excess of the compensation usually paid for similar work.

Salt Manufacture, by Mr. G. E. Willcox.

This paper contains a description of the mechanical methods and engineering features of large salt plants, and reviews from the mechanical engineer's point of view, a few of the more recent developments in this manufacture. Reference is made solely to plants operated by what is known as the steam grainer system, as distinguished from the vacuum pan system and the solar or open-air system. The paper is illustrated with line diagrams and half-tone engravings and contains much of general interest.

Industrial Photography, by Mr. S. Ashton Hand.

The importance of photography in the machine industry should not be underestimated, because photography is one of the most important aids of the selling department of a machine-manufacturing plant, the photographs themselves, or, in the majority of cases, half-tones made from the photographs, being an important part of all advertising mediums. In the present paper the author describes in detail the apparatus employed and the principles considered in making photographs of industrial objects. It deals with the preparation of the subject to be photographed, the lighting and position, the focusing, the exposure, and the copying and enlarging of negatives.

Reminiscences of a Gas Engine Designer, by Mr. L. H. Nash.

In this paper the author reviews some of the steps of progress in the development of the gas engine, which have come within his personal observation. He describes different types of engines, including the two-cycle engine, and several devices of general interest invented by himself. One of these is a sewing machine motor which failed of commercial success because of the lack of mechanical appreciation of the feminine operator of this machine.

Some Possibilities of the Gasoline Turbine, by Mr. F. C. Wagner.

In considering the possibilities of a gas turbine, it is commonly assumed that the gas should be burned with something near the theoretical quantity of air required for complete combustion, the same as is done in the expansion gas engine of the ordinary type. The temperatures produced by the combustion of the gas, however, are so high that the strength of the metal wheel is seriously diminished. It is the purpose of the present paper to compare different methods for reducing the temperature of the gases, and especially to consider how such a reduction affects the efficiency of the turbine and air compressor. The paper contains considerable data which will interest gas and gasoline engine designers.

Physical Properties of Carbonic Acid and Conditions of its Economic Storage for Transportation, by Prof. Reid T. Stewart.

A number of tables and charts accompanying this paper show, in condensed form, the results of recent investigations made regarding the physical properties of carbonic acid. The value of these investigations is that they furnish the data necessary in investigating the strength and safety of existing carbonic acid cylinders, and in the designing of new cylinders on a safe and economic basis. The methods employed in carrying out the scientific investigations are reviewed, and the latter part of the paper refers directly to the design of carbonic acid cylinders, giving formulas relating to their calculation and proportioning.

The Slipping Point of Rolled Boiler Tube Joints, by Prof. O. P. Hood and Prof. G. L. Christensen.

The object of this paper is to supply data regarding the behavior of joints made by the familiar method of rolling boiler tubes into containing holes. Diagrams are presented showing the loads required to pull tubes from their seats, and results of tests with cold drawn boiler tubes rolled into various forms of tube openings, are given. The method of applying the load and measuring the slip is also illustrated and described.

Tests of Friction Clutches for Power Transmission, by Prof. R. G. Dukes.

This paper gives the results of tests on friction clutch couplings for determining their maximum capacity. Five examples of the best-known types of clutches were purchased in the open market, and all were tested under similar conditions. Each clutch was subjected to a series of cone pressures, gradually increasing in amount, the maximum load which the clutches would pick up and carry being determined for each cone pressure.

An Averaging Instrument for Polar Diagrams, by Mr. W. F. Durand.

This paper has been prepared with the intention of describing an instrument for obtaining averages for diagrams, plotted in polar coordinate. While this paper is chiefly of theoretical interest, engineers interested in dial-recording gage instruments which trace diagrams in polar coordinates, but with a curvilinear path of the tracing arm, will undoubtedly find the instrument described, of interest.

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The matter of supplying machines with lubricating fluid may be decided either in favor of a distributing system of pipes supplied from a common reservoir by one pump, or by making each machine a unit in itself, having its own reservoir and pump. Both systems have certain advantages and disadvantages. If a central distributing system is installed, it is the same as "putting all your eggs in one basket"; if anything goes wrong with the piping or pump, a whole department is held up until the trouble is remedied. Again, there is the difficulty of carrying the supply and return pipes through the shop to every machine, without causing obstructions and a generally hideous mess. If the shop construction is such that the supply for one floor can be distributed underneath the floor and up to each machine through the floor beneath it, there is little objection to the distribution plan, but this plan is not always feasible. Serious troubles frequently arise from clogging of the pipes by deposits adhering until a pipe is completely filled. These difficulties are avoided by the unit system in which each machine has its own supply system. The individual system means a reservoir and pump for each machine, and instead of one pump occasionally giving trouble you may have a hundred in the course of a year. The individual reservoirs may add to the floor space required, and keeping up the supply means carrying in fresh lubricant in pails. These features are somewhat objectionable, but balancing one system against the other, Mr. McGregor, of the Union Twist Drill Co., Athol, Mass., found from personal experience that the individual system is incomparably better, and it was adopted for the twist drill fluting machines in the drill department of his company. The installation is satisfactory in all respects. The general appearance of a department fitted thus is superior to that of one having the common distributing system. The secret of success is getting pumps that are reliable, and providing strainers that strain.

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The paper "High Powered Rifle and Its Ammunition" presented by Mr. Franklin Phillips at the monthly meeting of the American Society of Mechanical Engineers, November 10, was attended by a good audience of interested members. The paper was illustrated with numerous lantern slides, and many technical points in regard to the construction and use of military rifles were brought out. Captain Phillips is an expert rifle shot and spoke with much enthusiasm on the need of teaching the art of rifle shooting to young men. Captain Casey of the U. S. Army followed with a few remarks in regard to the development of the Spitzer bullet, and spoke of the change from 150-grain bullets to 180-grain bullets, made necessary by the irregularities due to windage with the lighter bullet. He was followed by Captain Waldron of the Ross Rifle Co., Mon-

treal, Canada. Captain Waldron illustrated on the screen a new cartridge developed for the Ross rifle, which gives the extraordinary initial velocity of 3,000 to 3,100 feet per second. A piece of steel plate ⅝ inch thick, 40 carbon steel, was exhibited which had been penetrated at a distance of 40 to 50 yards. Some one remarked, after the meeting, that with such guns "Mother's Bible" would not be of much service in protecting her son from the bullets of the enemy.

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In the description of the handy center indicating tool by W. W. Cowles in the November issue it is stated that the ball in which the point is mounted is hardened. This is not necessary and, in fact, the ball is preferably left in the annealed condition necessary for drilling the hole. It was also intimated that the spindle of the machine must be stopped in order to use the tool. This is unnecessary as the indicator can be used without stopping the machine by simply guiding the pointer to the prick-punch mark with the finger and then withdrawing the work. The pointer will then run "out" if the center mark is not dead in line with the spindle.

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PERSONAL.

William E. Keily has resigned his position as managing editor of the *Western Electrician*, and will act as a general writer on technical and commercial subjects.

Walter B. Snow, publicity engineer, Boston, Mass., has been appointed by Governor Guild, a member of the Massachusetts Commission for the Blind.

Hugh A. Brown has resigned his position in the Chicago office of the Crocker-Wheeler Co. to become sales manager for the Rockaway Coaster Co., Cincinnati, Ohio.

James A. Pratt who for the past two years has held a position as instructor in machine work at Pratt Institute, Brooklyn, N. Y., has been appointed to a similar position at Williamson Free School of Trades, Delaware County, Pa.

J. R. Gordon has been appointed manager of power apparatus sales for the Western Electric Co. in its Southern territory. Mr. Gordon is well known throughout the country as a pioneer in the electrical field, having been associated with those who organized and operated the first Edison plants. His headquarters will be in Atlanta, Ga.

F. W. A. Joly, president of the Association of German Manufacturers of Fire-brick (Wirtschaftliche Vereinigung Deutscher Chamotte Fabrikanten), is on a visit to America to study American conditions with a view of drawing therefrom applications for the fire-brick industry in Germany. The association of which he is president has established standards of quality and shape, reducing the number of shapes materially; it has studied the requirements of customers with reference to tensile strength, refractory qualities and uniformity of product. American fire-brick makers may obtain valuable suggestions from the experiences of German makers. Mr. Joly is making the Hotel Astor, New York, his headquarters.

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OBITUARY.

Prof. William Edward Ayrton, a noted electrical engineer and inventor, died in London, November 8, aged sixty-one.

Cyrus C. Currier, of Cyrus Currier & Sons, Newark, N. J., died October 30 at his home in South Orange, N. J., aged sixty-one.

General John E. Mulford, founder and for thirty-one years president of the Prentiss Vise Co., died at his home in Montour Falls, New York, October 18, aged seventy-nine years.

Herbert D. Hale, architect of the Engineering Societies Building, New York, died at his home in New York, November 10, aged forty-two years.

Frank B. Kleinhans, chief draftsman of the United Engineering Co., Pittsburg, Pa., died in Easton, Pa., aged 34. Mr. Kleinhans was the author of the book "Boiler Construction," and a contributor to MACHINERY and other trade journals.

Alfred Marsh, a geologist and chemist, and inventor of the gas meter in common use, died November 17 at Kalamazoo, Mich., aged ninety years. Mr. Marsh was born in England and for many years was employed by the Manhattan Gas Co., New York.

William Eddy Ripley, one of the oldest and most esteemed employes of the Brown & Sharpe Mfg. Co., Providence, R. I., died November 10 at his home in that city, aged sixty-five years. Mr. Ripley was connected with the Brown & Sharpe Co. for almost all his active business life, having entered the employ of the company in 1861. Up to 1902 he was timekeeper in charge of the cost-keeping department, and since has filled the responsible position of confidential secretary. Mr. Ripley was a member of the local societies, clubs and lodges, and is survived by a widow and a son and daughter.

Samuel D. V. Burr died at his home in Plainfield, N. J., October 28, aged fifty-three. He was born in New York and moved to Plainfield when a boy, where he graduated from the Plainfield High School in 1870. Later he graduated from Rutgers College, and became a writer on engineering and scientific subjects. Mr. Burr was on the staff of the *Scientific American* for six years, the *Engineering News* for three years, and the *Iron Age* for sixteen years. He was the author of "Bicycle Repairs," "Tunneling Under the Hudson," "Rapid Transit in New York and Other Great Cities." He is survived by his wife, son and daughter.

George A. Fairfield, secretary of the Hartford Board of Trade and one of the best known business men of the city, died suddenly November 9, aged seventy-four. He was apprenticed at seventeen in the machine shop of Lucius and Ira Dimmock, Northampton, Mass., makers of silk machinery. Following his apprenticeship, he worked for several concerns, and at the breaking out of the Crimean War, was with Robins & Lawrence, Windsor, Vt., who had contracts for making guns for Great Britain. When this work was completed he went with the American Machine Works at Springfield, Mass., where he designed most of the labor-saving machinery in the U. S. Government Armory in that city. In 1857 he was employed by Colt's Patent Fire-arms Mfg. Co. of Hartford, where he worked on a contract with the Russian Government to furnish it with machinery for manufacturing fire-arms. Mr. Fairfield opened the first purely mechanical drawing school in Hartford in 1858. In 1865 he entered the employ of the Weed Sewing Machine Co. and built it up into a great enterprise. Later he was associated with Colonel Albert Pope in the manufacture of bicycles and was influential in bringing the great industry to Hartford. Mr. Christopher M. Spencer interested Mr. Fairfield in the manufacture of the Spencer repeating rifle, and it was for some time manufactured in the Weed Sewing Machine factory. Mr. Fairfield was director in a number of the important industrial and commercial concerns in Hartford.

Elmer G. Eberhardt of Newark, N. J., vice-president of the Newark Gear Cutting Machine Co., died November 21, 1908, of tuberculosis, after an illness of less than a year. He was born in Newark, 1881, and attended the public schools there. He was graduated from the Newark High School in 1896 at the age of fifteen years, and from there entered Stevens Institute at Hoboken, N. J. He was soon at the head of his class, but decided, in his second year, to take up the practical work of machine tool designing and construction, and therefore discontinued his course to engage in work with his father, Henry E. Eberhardt. After several years of this work, during which he made a number of improvements and inventions, especially relating to automatic gear-cutting machines and crank shapers, he decided to finish his technical education. He accordingly entered Sibley College of Cornell University in the middle of the school year of 1900-1901, and graduated in 1904 with the degree of mechanical engineer.

While at Cornell he acquired the nickname of the "General" because of his acknowledged leadership in the classes of mathematics, mechanics, and engineering. He was elected president of the Cornell Institute of Electrical Engineers and

Elmer G. Eberhardt.

vice-president of the Cornell Society of Mechanical Engineers. At the close of his course he was awarded the honorary key of the Sigma Xi for high scholarship in the engineering studies. Besides his studies, he was actively interested in athletics.

Upon graduation, Mr. Eberhardt entered into the machine tool manufacturing business, forming with his father and three brothers, the Eberhardt Brothers Machine Company, which is now the Newark Gear Cutting Machine Company. He was made the vice-president, and from the beginning of the business, until his illness necessitated his leaving the work which he loved, he was active in the designing and construction of the gear-cutting machines and crank-shapers made by the firm. He took out a number of patents upon inventions covering many branches of the machine field.

Mr. Eberhardt had been a contributor to MACHINERY ever since its beginning, and he many times expressed himself as much interested in the problems which appeared from time to time in its columns. He had a wide reputation as a consulting engineer upon matters especially relating to gears and gear-cutting, and engaged in original investigations along this line. He was an associate member of the American Institute of Electrical Engineers and of the American Society of Mechanical Engineers.

Mr. Eberhardt is survived by his parents, one sister and four brothers, three of whom are engaged in the business. He was beloved by all who knew him, and especially in the factory was he liked, by the apprentices and others who looked up to him as a teacher with experience.

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COMING EVENTS.

December 1-4.—Annual convention of the American Society of Mechanical Engineers, Engineering Societies Building, 29 West 39th St., New York City. C. W. Rice, 29 West 39th St., New York, secretary.

December 7-10.—Annual convention of the National Commercial Gas Association, First Regiment Armory, Michigan Ave. and 16th St., Chicago, Ill. Coincident with the meeting, and throughout the week, the association will hold its annual exhibition of gas appliances. John C. D. Clark, 157 Michigan Ave., Chicago, chairman of the committee of arrangements.

December 9.—Mr. M. A. Loeb, secretary and treasurer of the Rock Island Battery Co., Rock Island, Ill., has issued a call to the manufacturers and dealers of gas and gasoline engines, and dealers and manufacturers of accessories thereto, to attend a preliminary meeting at the Auditorium Hotel, Chicago, December 9, 1908, 10 A. M., with a view of discussing and formulating plans for the formation of an association. Officers are to be elected and a committee appointed for the purpose of arranging for a national convention to be held at some time and place decided upon by the executive committee.

December 11.—Meeting of the American Institute of Electrical Engineers at 33 West 39th St., New York City, 8 P. M. R. W. Pope, secretary.

December 31-January 7.—Ninth annual show of the American Motor Car Manufacturers' Association at Grand Central Palace, New York City.

January 16-23.—Ninth annual show of the Association of Licensed Automobile Manufacturers at Madison Square Garden, New York.

NEW BOOKS AND PAMPHLETS.

THE LUMBER CUT OF THE UNITED STATES, 1907. 53 pages, 6 x 9 inches. Published by the Department of Commerce and Labor, Washington, D. C.

Charities and the Commons is a weekly journal of philanthropy and social advance issued by the Charity Organization Society of the City of New York, publication office 105 East 22d St., which will be found of value to all interested in social welfare work. The price is $2.00 per year, single copies 25 cents.

THE TEMPERATURE-ENTROPY DIAGRAM. By Charles W. Berry. 299 pages, 5 x 7¼ inches. 109 figures. Published by John Wiley & Sons, New York. Price $2.00.

This is the second edition of a volume first brought out in 1905, and intended especially for the use of students of thermodynamics. The present edition is considerably enlarged, it being more than doubled in size. A more extended application of the principles of the $T\phi$-analysis to advanced problems of thermo-dynamics has been made, the chapter on the Flow of Fluids has been entirely re-written, and various other phases of the subject in hand have been more thoroughly discussed.

THE MECHANICAL WORLD ELECTRICAL POCKET BOOK FOR 1909. 208 pages, 4 x 6 inches. Published by Emmott & Co., Ltd., Manchester, England. Price 6d. net.

This convenient and useful handbook contains considerable matter of value to electricians and others interested in the electrical industries, dynamos, and motors. Some of the different sections are headed: Electrical Units, Electrolysis, Magnets, Electric Bells, Power Transmission, Dynamos and Motors, Alternate Current Systems, Rotary Converters, Care of Dynamos and Motors, Line Wires and Conductors. Many useful tables are included, and blank pages for diary and memoranda conclude the book.

AUDEL'S GAS ENGINE MANUAL. 469 pages, 5¼ x 8¼ inches. Published by Theo. Audel & Co., New York. Price $2.00.

This book is a practical treatise relating to the theory and operation of gas, gasoline, and oil engines, and includes chapters on producer gas plants, marine motors, and automobile engines. It contains a great deal of useful information relating to the care of combustion engines. Some of the most interesting chapters are: Theoretical Working Principles; Indicator Diagrams of Engine Cycles; Fuels and Explosive Mixtures; Gas Producer Systems; Compression, Ignition and Combustion; Governing and Governors; Ignition and Igniters; Installation and Operation; Oil Engines; Testing; Nature and Uses of Lubricants.

PATENTS AS A FACTOR IN MANUFACTURING. By E. J. Prindle. 134 pages, 5 x 7½ inches. Published by The Engineering Magazine, New York. Price $2.00.

The purpose of this volume, according to the author, is not to make the inventor and manufacturer his own patent lawyer, but it is intended to convey general ideas regarding the nature of patents, the protection they may afford, the relation of employers and employees to patents and the general rules by which the courts will proceed in upholding a patent and in thwarting attempted infringement. It is intended especially to lay down fundamental principles, in order to enable the inventor or manufacturer to take the early steps which are usually taken before the advice of counsel is secured.

THE MECHANICAL ENGINEERING OF STEAM POWER PLANTS. By F. R. Hutton. 825 pages, 6 x 9 inches. 700 figures. Published by John Wiley & Sons, New York. Price $5.00.

This is the third, re-written, edition of Professor Hutton's well-known work on steam power plants. The new treatments in the present edition which are specially noteworthy are those of the analysis of the power plant, and the distinction between the simple and the complex phases of this problem; the treatment of the steam pipe as an element of co-ordinate importance with the boiler and engine; the chapters on auxiliaries; the chapter on steam turbines; and on the engine mechanism. These new sections add considerably to the value of the book, and will prove interesting to power-plant engineers and others concerned with the subject, in its engineering aspect.

MACHINE SHOP CALCULATIONS. By Fred H. Colvin. 174 pages, 4½ x 7 inches. Published by the Hill Publishing Co., New York. Price $1.00.

In the preface of this book the author states that while the treatment of the subject may be considered too elementary by some, he has tried to make every point so clear that anyone can comprehend it, and to show how the methods apply to every-day shop work. The different chapters in the book are headed as follows: Common Fractions; Decimal Fractions; Cancellation; Ratio or Proportion; Percentage; Speed of Pulleys; Speed of Gearing; Gearing a Lathe to Cut Any Thread; Screw Thread Calculations; Drilling for Taps; Taper Work; Speed of Lathes, Planers and Shapers; Square and Cube Root; Measuring Surfaces; Contents or Volume of Solid Bodies; Measuring Angles; Making and Using Formulas; The Vernier and Micrometer; Regular Polygons and Their Properties; The Uses of Shop Trigonometry; Trigonometry Tables.

RAILROAD ENGINEERING. By W. L. Webb. 296 pages, 6½ x 9½ inches. 161 figures, 23 tables. Published by the American School of Correspondence, Chicago, Ill. Price $3.00.

This book is divided into three sections, each dealing with a different phase of railroad engineering. The first section is devoted to railroad surveys, dealing with surveying methods and instruments and railroad location. The second, and by far the largest, section is devoted to construction, operation, and maintenance, and the third to the economics of railroad management; this latter part, of course, deals with this subject from the engineer's point of view. The volume is especially adapted for purposes of self-instruction and home study, and care has been taken to keep the treatment of each subject within the range of the student's understanding, so that the work appeals not only to the technically trained expert, but also to the self-taught practical man who wishes to keep abreast of modern progress. Of course elementary mathematical foundation is required in order to be able to follow the developments of the formulas and the methods explained.

CATALOGUES AND CIRCULARS.

PATTERSON TOOL & SUPPLY CO., Dayton, Ohio. Leaflets of the Owen milling machines built in three sizes.

PRATT & WHITNEY CO., Hartford, Conn. Miniature catalogue of Pratt & Whitney turret lathes, which are built in five sizes.

WEBER GAS ENGINE CO., Kansas City, Mo. Catalogue of Weber gas engines and gas producers.

SKINNER CHUCK CO., 94 N. Stanley St., New Britain, Conn. Circular of the 1904 pattern independent Skinner lathe chuck.

S. OBERMAYER CO. Cincinnati, Ohio. Catalogue No. 40 containing 369 pages devoted to foundry supplies and information for the foundryman.

NATIONAL SEPARATOR & MACHINE CO., Boston, Mass. Circulars descriptive of cylinder turret drill presses, and combined oil separator and filter.

REEVES ENGINEERING CO., Mt. Vernon, Ohio. Catalogue of Reeves vertical internal combustion engines for gas, gasoline and distillate fuels.

AMERICAN SPIRAL PIPE WORKS, P. O. Box 485, Chicago, Ill. Catalogue of spiral riveted pipe, forged steel pipe flanges, hydraulic and exhaust steam supplies.

VICTOR R. BROWNING & CO., Cleveland, Ohio. Bulletins Nos. 2 and 3, illustrating overhead electric traveling cranes and Armington electric hoists, which are made in several styles.

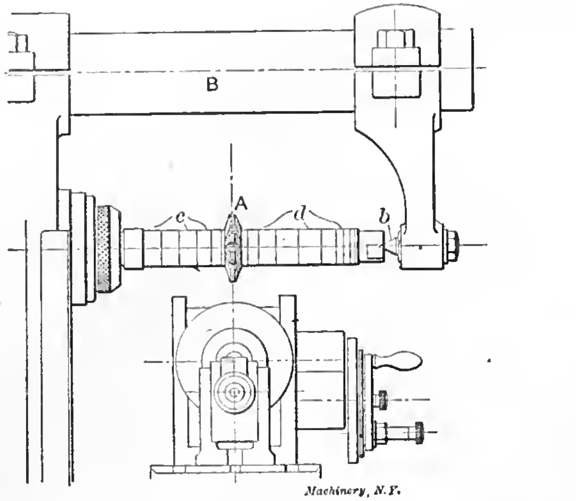
BRASS FOUNDERS SUPPLY CO., Newark, N. J. Catalogue No. 14 of flasks and other equipment and supplies for modern brass, bronze aluminum and iron and steel foundries.

Supplement to MACHINERY, January, 1909.

Operations for the Article in this number entitled "Machine Shop Practice—Gashing and Hobbing a Worm-Wheel."

SHOP OPERATION SHEET NO. 85.

John Edgar. MACHINERY, January, 1909.



Preparing the Milling Machine to Gash a Worm-wheel Blank.

Note.—This work is to be done on a universal milling machine.

1. Place the dividing head and tail-stock in place on the machine table. Since the gear connection is not needed for this work, the head may be placed in any convenient position along the table—preferably near the center.

2. Place a cutter arbor in the spindle, and select a gear cutter *A* of the proper number and pitch, corresponding to the number and pitch of the teeth to be cut in the blank.

3. The cutter should be placed on the arbor after a sufficient number of collars *c*, to bring the cutter approximately over the center of the table, have been put on. Insert the key which drives the cutter, and, after the collars *d* have been placed on the arbor, bind the cutter securely in place with the arbor nut.

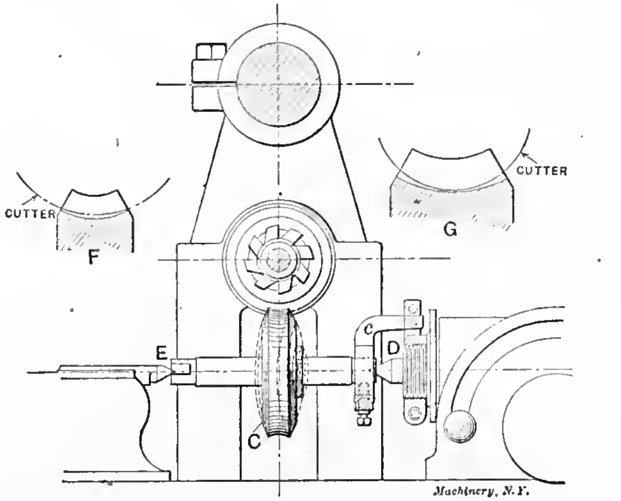
4. Adjust the arbor support center *b* to the center of the arbor, and clamp the overhanging arm *B*.

5. Move the carriage in or out, as the case may require, until the center of the dividing head spindle is directly under the center of the cutter. If a standard gear cutter is used, the center in the head may be set to coincide with a center line on the cutter which is placed there by the makers to facilitate setting the cutter central with the work spindle. If a plain cutter is used (which will be without the center line), a convenient method of setting it is to place an arbor on the head and tail centers; then with the blade of a centering square projecting upward, adjust the carriage until the side of the cutter has a full contact with the central edge of the blade. A second adjustment of the carriage, equal to one-half the thickness of the cutter, will locate the latter central with the dividing head.

6. Clamp the carriage to the knee slide.

SHOP OPERATION SHEET NO. 86.

John Edgar. MACHINERY, January, 1909.



Gashing a Worm-wheel Blank.

Note.—It is assumed that the table is set laterally as previously described.

1. After pressing the previously turned blank *C* on an arbor, place the arbor, with a dog *c* for driving attached, between the head and tail centers *D* and *E*, and clamp the dog.

2. Shift the table until the center of the blank is directly under the center of the arbor, as shown in the illustration. If care is used, the setting may be gaged by observing the light between the cutter and the curved throat of the blank.

3. Swivel the table until the cutter and the axis of the blank are at the proper angle with each other, and clamp the table. This angle should be indicated on the drawing. The way of determining it, however, is explained in the Machine Shop Practice article in this issue of Machinery.

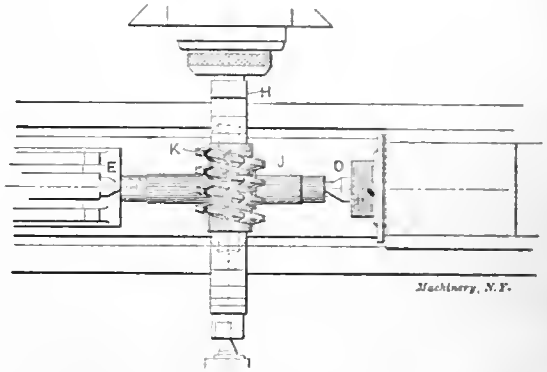
4. The cutter is next sunk into the blank to the proper depth. Unless the diameter of the cutter is equal to that of the hob, care must be taken not to gash too deep. When the diameter of the cutter is greater than that of the hob, we have the condition shown at *F*; the depth to which the gashing cutter should be set is limited by the depth of the cut at the side of the blank. Should the diameter of the cutter be smaller than that of the hob, the condition shown at *G* is encountered; here the depth to which the cutter should be set is shown to be on the center line.

5. Bring the cutter into contact with the throat of the blank and then set the dial on the elevating screw to zero. Start the machine, and raise the blank an amount equal to the desired depth of cut which should be slightly less than the whole depth of the tooth.

6. Drop the knee so that the blank clears the cutter and index for the next tooth. Continue gashing and indexing until the required number of gashes have been cut.

SHOP OPERATION SHEET NO. 87.

John Edgar. MACHINERY, January, 1909.



Hobbing a Worm-wheel.

Note.—The blank is assumed to have been previously turned to the correct diameter, within narrow limits, and gashed.

1. Insert a true-running arbor *H* in the machine spindle, after thoroughly cleaning both the spindle hole and arbor shank. After pressing the blank on a true arbor *J*, place the latter between the centers *D* and *E*, without a driving dog attached.

2. Steady the outer end of the arbor by fixing the center of the arbor support into it.

3. Adjust the table longitudinally until the center of the blank is directly under the center of the arbor *H*. The blank may be set quite accurately by bringing it into contact with the arbor and adjusting the work until the arbor rests centrally in the throat of the blank.

4. With the arbor still in contact with the periphery of the blank, at its throat, set the dial of the elevating screw at zero. Measure the diameter of the arbor with a micrometer, and divide this dimension by 2, obtaining the radius. Measure the diameter of the hob *K*, and also ascertain its radius. Subtract the radius of the arbor from the radius of the hob, lower the knee of the machine an amount equal to this result, and again set the dial at zero. The knee may now be lowered a small amount in order that the blank may clear the hob when the latter is being placed on the arbor.

5. Tighten the hob on its arbor, and then raise the knee until the hob is in mesh with the gashes in the blank. It will be observed that the whole tooth depth has not been reached when the hob bottoms in the gashes. The machine is now set in motion and as the hob revolves, the blank rotates with it. The hob is now fed into the blank, by raising the knee, until the dial indicates the correct depth. If the hob is properly made, and the wheel blank accurately sized, the teeth will be cut to the correct depth when the inner diameter of the hob grazes the blank at its throat diameter. The hob and blank should now rotate several times to eliminate any spring and to produce smooth teeth. This rotation should not, however, continue too long as the tendency is to produce thin teeth.

I.—ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL.

Maximum Fiber Stress	No. W. & M. Wire Gauge	Diameter of Wire	Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil.																		
			Pitch Diameter of Spring.																		
			1/16"	3/32"	1/8"	5/32"	3/16"	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"	1 5/8"
125,000	25	.020"	6.25	4.21	3.21	2.50	2.06	1.545	1.24	1.042	.895										
			.0079	.0164	.0298	.0453	.0644	.1150	.1792	.2565	.3545										
	24	.023"	9.5	6.3	4.75	3.71	3.15	2.38	1.845	1.521	1.325										
			.0063	.0141	.0262	.0382	.0563	.1011	.1528	.2173	.2991										
	23	.025"	12.28	8.15	6.08	4.9	4.025	3.05	2.5	2.065	1.74	1.52									
			.0058	.0126	.023	.0363	.0516	.0929	.1481	.2111	.2812	.3671									
	22	.028"	17.3	11.5	8.63	6.85	5.76	4.32	3.46	2.83	2.39	2.18									
			.0052	.0117	.0206	.0325	.0469	.0832	.1304	.1840	.2463	.3425									
	1/32"	.031"		15.63	12.7	9.35	7.82	5.87	4.67	3.91	3.36	2.94	2.33								
				.0106	.0205	.0293	.043	.0757	.1171	.1691	.2303	.3022	.467								
150,000	21	.032"		20.8	15.51	12.4	10.32	7.7	6.14	5.085	4.44	3.78	3.13								
				.0124	.0221	.0342	.0496	.0814	.1350	.1937	.2681	.3433	.553								
	20	.035"			20.1	16.2	13.45	10.08	8.1	6.66	5.75	4.96	4.05	3.39							
					.0199	.0313	.0448	.0799	.1251	.1773	.2435	.3139	.5158	.7259							
	19	.041"			32.6	26.2	21.65	16.2	13.04	10.85	9.27	8.1	6.52	5.35	4.57						
					.0172	.0268	.0381	.0682	.1069	.1535	.2079	.2731	.4296	.608	.8237						
	18	.047"				39.12	32.6	24.55	19.6	16.44	13.95	12.3	9.8	8.1	6.92	6.14					
						.0233	.0336	.0587	.0934	.1352	.1817	.2412	.3738	.5358	.7249	.962					
	17	.054"				59.4	49.6	37.25	29.7	24.66	21.2	18.55	14.75	12.4	10.58	9.255	8.23				
						.02	.0291	.0519	.0814	.1154	.1572	.2067	.3198	.4665	.6305	.8254	1.043				
	1/16"	.062"					74.9	56.1	44.9	37.3	32.	28.	22.4	18.63	16.1	13.95	12.5	11.22			
							.0265	.0473	.0738	.1053	.1437	.1889	.2939	.4244	.5887	.753	.9592	1.183			
	16	.063"					78.24	58.7	46.9	39.2	33.9	29.4	23.5	19.6	16.8	14.7	13.2	11.9	10.75		
							.0248	.0443	.0689	.0993	.1324	.1775	.2689	.400	.5421	.7103	.9065	1.122	1.355		
	15	.072"					117.3	80.75	70.65	58.7	50.20	43.6	35.2	29.	25.	21.9	19.5	17.5	16.05		
							.0218	.0357	.0608	.0872	.1183	.1542	.2426	.3468	.4735	.6208	.7857	.9686	1.180		
	14	.080"						121.	96.6	80.5	69.15	60.4	48.28	40.1	34.6	30.1	26.75	24.2	22.1	20.2	
								.0354	.055	.079	.1077	.1417	.2197	.3169	.433	.5638	.7096	.8855	1.0715	1.277	
140,000	13	.092"						171.	135.3	113.5	97.6	85.5	68.9	57.3	48.8	42.6	37.8	34.5	31.3	28.6	
								.0288	.0439	.0635	.0865	.1140	.1796	.2577	.3475	.4522	.5728	.7186	.8654	1.030	
	3/32"	.093"						178.	142.	118.2	99.5	89.	71.2	59.1	50.9	44.3	39.6	35.7	32.3	29.3	27.3
								.0283	.0438	.0631	.0842	.1132	.1763	.2532	.3460	.4510	.5708	.710	.8529	1.017	1.193
	12	.105"							204.	170.	146.	127.5	102.	85.4	73.	63.4	56.6	51.1	46.3	42.6	38.9
									.0378	.0561	.0762	.1003	.1559	.2237	.3060	.389	.5010	.627	.758	.903	1.104
	11	.120"							303.	253.	217.5	190.	152.5	126.8	108.7	95.2	84.2	76.2	69.2	63.5	58.5
									.0338	.0488	.0664	.0871	.1363	.1965	.2667	.3489	.4397	.5242	.6596	.7872	.9208

Contributed by Henry L. Hanson.

II.—ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL.

Max. Fiber Stress	No. W. & M. Wire Gauge	Diameter of Wire	Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil.																							
			Pitch Diameter of Spring.																							
			3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 3/8"	1 1/2"	1 5/8"	1 3/4"	1 7/8"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"	3 1/2"	3 3/4"	4"	4 1/4"
140,000	1/8"	.125"	286.	245.	214.	171.5	143.	121.9	107.3	95.	85.2	78.	71.5	65.8	60.8	57.2										
			.047	.064	.0834	.1302	.1881	.2542	.3345	.4215	.5195	.6345	.7463	.8768	1.0166	1.236										
	10	.135"	359.	309.	270.	217.	171.	154.	135.	120.	108.5	98.7	90.2	82.7	77.2	71.8	67.5									
			.043	.0589	.0774	.1210	.1655	.2359	.3185	.3911	.4894	.5841	.6979	.8572	.9568	1.081	1.240									
	9	.148"		408.	356.	285.	237.5	207.	178.	158.	142.4	130.	118.5	109.5	102.	95.	89.									
				.0537	.1058	.1100	.1589	.2127	.2825	.3563	.4410	.5376	.6345	.7440	.9194	.9936	1.130									
	5/32"	.156"		480.	418.	333.	270.	239.	208.	185.3	167.	152.2	139.	128.	119.4	111.6	104.6	92.7								
				.0513	.0672	.1042	.1464	.2055	.2674	.3386	.4196	.5066	.6036	.7056	.8266	.9428	1.076	1.357								
	8	.162"			468.	376.	311.5	276.5	234.	207.	187.5	170.8	156.	143.6	134.	125.5	117.	103.6								
					0647	.1012	.1460	.2043	.2588	.3255	.4061	.4906	.5826	.6810	.7946	.9132	1.035	1.305								
	7	.177"			608.	487.	406.	347.	305.	270.	243.4	223.5	205.	187.6	174.2	163.4	152.5	135.5	122.							
					.0589	.092	.1398	.1799	.2366	.2979	.3721	.4501	.5372	.6132	.7242	.8354	.9467	1.198	1.480							
125,000	3/16"	.1875"			642.	522.	426.	367.	320.	288.	256.	233.	213.	197.	183.	170.	160.	142.5	128.3							
					.050	.0792	.1119	.1527	.1991	.2533	.3116	.3760	.4450	.525	.620	.700	.800	1.020	1.230							
	6	.192"			696.	556.	465.	396.	348.	309.	278.	254.	232.	214.	199.	186.	174.	154.5	139.3	126.3						
					.049	.077	.110	.149	.192	.247	.305	.365	.440	.515	.600	.695	.785	.990	1.220	1.480						
	5	.207"				694.	579.	495.	432.	385.	340.	315.2	288.	266.	247.	232.	216.	192.5	175.	158.	144.5	133.9				
						.071	.1010	.138	.1800	.239	.283	.343	.405	.470	.550	.633	.730	.910	1.130	1.370	1.650	1.920				
	7/32"	.218"				812.	678.	580.	509.	452.	408.	369.	339.	310.	291.	270.	255.	225.	204.	185.	169.5	155.9				
						.0695	.097	.132	.171	.215	.268	.322	.379	.445	.530	.595	.680	.860	1.060	1.290	1.540	1.780				
	4	.225"				895.	746.	640.	560.	498.	447.	407.	372.	345.	320.	299.	280.	248.	224.	203.	187.	172.2				
						.065	.092	.122	.165	.210	.256	.313	.365	.430	.505	.575	.663	.840	1.060	1.270	1.480	1.740				
	3	.244"				1120.	950.	811.	711.	632.	570.	527.	475.	438.	405.	381.	356.	316.	284.	259.	237.5	220.				
						.0595	.088	.116	.154	.194	.242	.295	.350	.415	.472	.550	.620	.775	.970	1.160	1.360	1.600				
	1/4"	.250"					1027.	880.	760.	685.	617.	560.	513.	476.	440.	410.	385.	342.	308.	281.	266.	236.				
							.084	.110	.147	.188	.232	.284	.338	.395	.460	.525	.598	.760	.945	1.130	1.360	1.570				
	2	.263"					1195.	1125.	895.	795.	717.	632.	598.	551.	501.	478.	448.	400.	359.	326.	298.	278.7	256.	238.		
							.079	.106	.142	.180	.223	.264	.325	.375	.435	.500	.580	.725	.910	1.080	1.290	1.540	1.760	1.950		
	9/32	.281"					1450.	1240.	1087.	969.	869.	794.	724.	665.	620.	580.	543.	482.	435.	395.	362.	335.	310.	290.4		
							.074	.100	.134	.167	.205	.253	.295	.356	.410	.473	.532	.660	.825	1.010	1.200	1.400	1.630	1.890		
	1	.283"						1264.	1110.	985.	886.	805.	740.	682.	634.	592.	564.	492.	439.	402.	370.	341.7	317.	296.6		
								099	.133	.166	.203	.252	.294	.348	.405	.465	.530	.650	.820	.950	1.190	1.390	1.620	1.860		
	1/0	.307"						1630.	1420.	1260.	1135.	1035.	945.	872.	810.	758.	710.	630.	568.	516.	473.	436.	406.	378.6	355.	334.
								.093	.121	.152	.186	.228	.272	.322	.372	.427	.490	.610	.760	.910	1.080	1.260	1.490	1.680	1.940	2.180
	5/16"	.312"							1575.	1376.	1220.	1100.	1000.	915.	845.	775.	732.	687.	610.	550.	500.	460.	421.7	392.	366.3	343.
									.084	.110	.138	.172	.208	.247	.290	.336	.386	.442	.550	.690	.830	1.000	1.150	1.330	1.540	1.780

Contributed by Henry L. Hanson.

III.—ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL.

Max. Fiber Stress	No. W. & M. Wire Gauge	Diameter of Wire	Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil.																								
			Pitch Diameter of Spring.																								
			1"	1⅛"	1¼"	1⅜"	1½"	1⅝"	1¾"	1⅞"	2"	2¼"	2½"	2¾"	3"	3¼"	3½"	3¾"	4"	4¼"	4½"	4¾"	5"	5¼"	5½"	5¾"	6"
115,000	2/0	.331"	1636.	1455.	1310.	1187.	1090.	1000.	932.	870.	818.	725.	653.	594.	545.	501.1	468.	436.5	410.	385.							
			.105	.130	.162	.195	.234	.273	.315	.365	.415	.520	.655	.790	.925	1.090	1.280	1.470	1.680	1.870							
	11/32"	.343"	1820.	1620.	1452.	1325.	1214.	1120.	1040.	970.	910.	808.	728.	661.	608.	560.	520.	486.	454.	428.							
			.100	.128	.155	.190	.218	.268	.308	.353	.400	.505	.625	.750	.910	1.060	1.220	1.380	1.600	1.780							
	3/0	.362"	2140.	1910.	1714.	1560.	1430.	1318.	1220	1142.	1070.	950.	858.	778.	714.	658.	612.	571.	535.	504							
			.095	.119	.147	.180	.210	.250	.290	.333	.382	.480	.595	.720	.850	.990	1.170	1.333	1.510	1.720							
	3/8"	.375"		2110.	1940.	1730.	1580.	1458.	1354.	1265.	1185.	1058.	950.	860.	790.	732.	678.	635.	592.	560.	528.	501.					
				.113	.144	.172	.205	.240	.280	.320	.360	.460	.570	.680	.820	.965	1.100	1.280	1.450	1.640	1.840	2.05					
	4/0	.393"		2430.	2180.	1984.	1820.	1680.	1560.	1458.	1365.	1212.	1092.	990.	910.	842.	780.	730.	682.	645.	607.	577.					
				.109	.136	.165	.198	.230	.265	.308	.348	.440	.545	.650	.780	.920	1.050	1.220	1.390	1.560	1.770	1.980					
	13/32"	.406"			2400.	2170.	2000.	1840.	1710.	1600.	1500.	1330.	1200.	1090.	1000.	929.	855.	805.	750.	711.	666.	636.					
					.131	.159	.188	.220	.255	.295	.335	.420	.520	.625	.755	.890	1.000	1.120	1.330	1.530	1.670	1.840					
	5/0	.430"			2875.	2610.	2400.	2210.	2050.	1918.	1798.	1598.	1440.	1508.	1200.	1105.	1028.	964.	900.	840.	800.	755.					
					.128	.147	.182	.210	.242	.282	.323	.400	.500	.610	.725	.840	.980	1.160	1.280	1.420	1.600	1.820					
	7/16"	.437"			3000.	2730.	2500.	2310.	2140.	2000.	1880.	1665.	1500.	1365.	1250.	1159.	1074.	1004.	940.	886.	835.	793.	750.	717.			
					.123	.146	.178	.207	.241	.277	.318	.392	.492	.591	.704	.825	.958	1.000	1.250	1.400	1.580	1.760	1.950	2.150			
110,000	6/0	.460"				3065.	2800.	2580.	2400.	2230.	2100.	1865.	1680.	1530.	1400.	1293.	1200.	1118.	1058.	968.	932.	885.	840.	800.			
						.135	.162	.190	.220	.250	.287	.360	.445	.535	.645	.750	.885	.990	1.140	1.310	1.460	1.600	1.800	1.970			
	15/32"	.468"				3225.	2940.	2725.	2530.	2375.	2210.	1970.	1770.	1610.	1472.	1362.	1265.	1181.	1110.	1032.	985.	929.	885.	845.			
						.133	.158	.186	.215	.247	.280	.357	.440	.530	.658	.740	.860	.970	1.130	1.260	1.420	1.580	1.740	1.940			
	7/0	.490"				3675.	3370.	3115.	2890.	2710	2535	2245.	2025.	1840.	1690.	1563.	1445.	1355.	1268.	1195.	1125.	1069.	1015.	967.	920.	883.	
						.126	.152	.176	.205	.238	.268	.338	.415	.505	.605	.705	.830	.940	1.070	1.200	1.360	1.500	1.680	1.840	2.040	2.220	
	1/2"	.500"					3610.	3320.	3090.	2890.	2710.	2410.	2160.	1970.	1810.	1661.	1550.	1439.	1352.	1263.	1205.	1136.	1082.	1026.	985.	939.	
							.149	.172	.203	.228	.265	.330	.410	.505	.595	.695	.810	.920	1.040	1.180	1.340	1.480	1.660	1.820	2.000	2.200	
	9/16"	.562"						4700.	4390.	4090.	3830.	3420.	3080.	2790.	2565.	2359.	2190.	2055.	1913.	1804.	1710.	1610.	1535.	1458.	1395.	1350.	1280.
								.154	.179	.208	.232	.295	.365	.442	.530	.615	.750	.820	.925	1.060	1.180	1.305	1.460	1.600	1.767	1.910	2.100
	5/8"	.625"							6100.	5600.	5260.	4660.	4210.	3825.	3505.	3242.	3000.	2812.	2630.	2480.	2340.	2216.	2110.	2000.	1913.	1830.	1750.
									.163	.184	.200	.261	.328	.394	.472	.552	.642	.737	.844	.948	1.060	1.180	1.317	1.500	1.600	1.730	1.880
100,000	11/16"	.687"									6375.	5650.	5090.	4630.	4250.	3934.	3625.	3409.	3195.	2932.	2825.	2669.	2560.	2425.	2330.	2214.	2125.
											.174	.218	.272	.327	.390	.460	.530	.610	.695	.790	.875	.970	1.090	1.200	1.330	1.450	1.560
	3/4"	.750"										7400.	6640.	6030.	5540.	5096.	4745.	4418.	4150.	3897.	3690.	3486.	3325.	3150.	3025.	2880.	2770.
												.203	.250	.303	.362	.420	.490	.558	.630	.720	.820	.905	1.000	1.110	1.220	1.320	1.440
	13/16"	.812"											8420.	7660.	7000.	6496.	6010.	5631	5260.	4940.	4675.	4425.	4200.	4000.	3825.	3655.	3500.
													.228	.278	.330	.388	.445	.515	.585	.665	.740	.825	.915	1.080	1.100	1.230	1.320
	7/8"	.875"											10530.	9550.	8700.	8111.	7500.	7015.	6560.	6190.	5740.	5530.	5250.	5000.	4770.	4575.	4370.
													.210	.255	.305	.360	.418	.480	.540	.620	.682	.765	.855	.950	1.030	1.130	1.220

Contributed by Henry L. Hanson.

IV.—ALLOWABLE PRESSURE AND CORRESPONDING COMPRESSION OF HELICAL SPRINGS OF ROUND STEEL.

Maximum Fiber Stress	Diameter of Wire	Greatest Allowable Pressure in Lbs. and Corresponding Compression in Inches Per Coil.													
		Pitch Diameter of Spring.													
		2¾"	3"	3¼"	3½"	3¾"	4"	4¼"	4½"	4¾"	5"	5¼"	5½"	5¾"	6"
90,000	15/16"	10600.	9700.	8976.	8400.	7780.	7160.	6840.	6470.	6119.	5810.	5536.	5290.	5050.	4850.
		.2200	.2580	.3030	.3530	.4050	.4500	.5250	.5800	.6450	.7150	.7850	.8700	.9450	1.030
	1"		11780.	10874.	10100.	9424.	8800.	8316.	7850.	7440.	7050.	6732.	6330.	6150.	5870.
			.2450	.2720	.3300	.3760	.4250	.4900	.5400	.6000	.6700	.7400	.8000	.8900	.9600
	1⅛"				14400.	13085.	12600.	11670.	11230.	10400.	10100.	9450.	9200.	8600.	8400.
					.2900	.3250	.3800	.4250.	.4850	.5280	.6000	.6450	.7250	.7800	.8350
	1¼"				19700.	18400.	17200.	16240.	15300.	14500.	13700.	13100.	12540.	12000.	11500.
					.2620	.3030	.3480	.3840	.4350	.4800	.5350	.5900	.6450	.7150	.7800
80,000	1⅜"					21800.	20400.	19000.	18100.	17000.	16150.	15380.	14850.	14000.	13600.
						.2450	.2750	.3100	.3500	.3850	.4350	.4700	.5250	.5700	.6250
	1½"					27150.	26500.	25440.	23500.	22300.	21400.	20300.	19300.	18200.	17700.
						.2150	.2550	.2950	.3200	.3550	.4050	.4350	.4800	.5200	.5750

These tables are based on {
Maximum Fiber Stress 80,000 to 150,000 Lbs. Per Square Inch,
Torsional Modulus of Elasticity 10,500,000.

For no vibration multiply actual load by 1.5
For moderate vibration multiply actual load by 2 } *and select resultant pressure in table.*
For incessant vibration multiply actual load by 3

In calculating deflection consider 2 coils as ineffective.

For helical springs of square steel multiply load by 1.2 and deflection by 0.59.

Contributed by Henry L. Hanson.

MACHINERY

January, 1909.

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—1.*

R. B. BROWN.

THE introduction and development of the electric motor, which has revolutionized so many of the methods of manufacture and transportation, has, perhaps, influenced the design of no other single auxiliary apparatus in the productive industries more than that of cranes and hoists. The present series of articles, therefore, has been written with the intention of placing on record the present practice in the design of overhead cranes, electrically operated, and of presenting such data as will aid the designer of such apparatus to properly calculate and proportion the various details, and supervise their construction.

Overhead Travelers.

The overhead traveler in its various forms is probably in greater demand than any other type of electric crane on the market, a fact which has induced many firms to specialize in this particular branch of crane building. As a result of the continued and growing demand for these cranes, many attempts have been made, with more or less success, to standardize, as far as possible, the various details of construction.

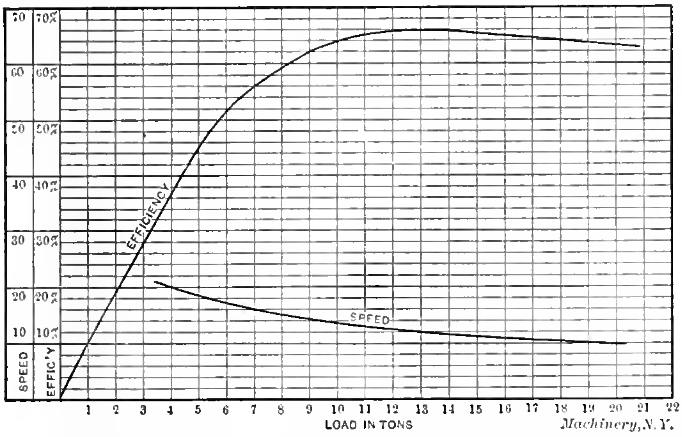


Fig. 1. Lifting Diagram for 20-ton Crane; Full Load Speed 10 feet per minute.

Electric travelers represent a type of crane which under ordinary conditions is in almost continual service, and, as with other constant working machines, it is essential that rapidity of operation, together with economy in current consumption, be preeminent factors to the purchaser and manufacturer alike. The requirements of the former should be based on the results of general experience gained during the past few years, while these results depend entirely on the skill of the designer, and the workmanship.

The three types of ordinary travelers in use are the one-motor, three-motor, and four-motor cranes. The three-motor, and for medium and heavy cranes, the four-motor types, have been found to be by far the most efficient, and are, practically speaking, the only types now used for modern workshops, warehouses, and similar localities. Until quite recently, the single motor type was considered preferable, on account of its cheapness, for engine rooms and similar places where a crane is only required occasionally. The present price of motors and their connections, and the fact that single motor cranes require more gearing than the three-motor type, is in favor of the universal adoption of the latter, more especially since several makers manufacture the crabs of this type in quantities and keep them in stock, and can therefore give a quicker delivery.

One of the principal obstacles that has been placed in the way of standardizing electric cranes, is the widely varying opinions of engineers on the question of speeds. Except for travelers which are required for work of a special nature, there is no reason why all cranes of this type should not be worked at practically the same speeds. In order to consider the conditions affecting the speed of each motion, they must be dealt with separately.

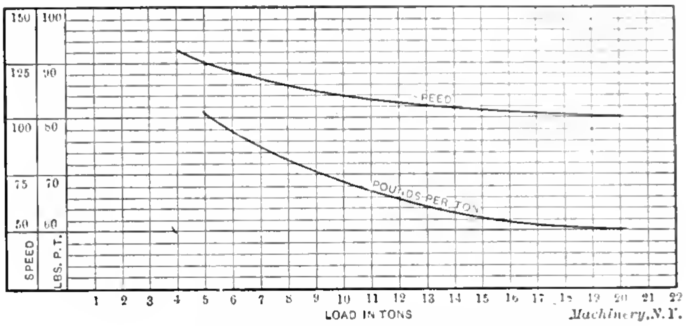


Fig. 2. Travereing Diegrem for 20-ton Crane; Full Load Speed 100 feet per minute.

When inquiring for a crane of any type, it is usual to state the speed at which the maximum load has to be lifted; and in selecting this speed the fact should not be overlooked that, excepting the case of small powered cranes and those required for special service, the normal load is seldom more than about 20 per cent of the full capacity of the crane. It is better, therefore, to consider what is the highest and safest speed at which this normal load can be worked, and then select a full load speed which will give the same foot-tonnage of work done. By the use of crane-rated series wound motors, a variation above the rated speed of about 50 per cent, increasing in proportion to the load, can be obtained, and this fact makes the use of change gears on the main lift unnecessary. If, however, a crane is to be used in a shop where a great deal of small material has to be constantly handled, but where a full load only occurs occasionally, as for instance, in a fitting shop, it is more economical to have an auxiliary barrel fitted onto cranes of from ten to twenty tons capacity, and worked by the main lift motor. When a light lift is required, it should be one-fifth of the full capacity of the crane, and the speed specified should be such as will give the same foot-tonnage as the main lift. Auxiliary barrels are generally placed on the main barrel pinion shaft, and so arranged that either the main pinion or the auxiliary barrel may be driven from this shaft by means of a clutch.

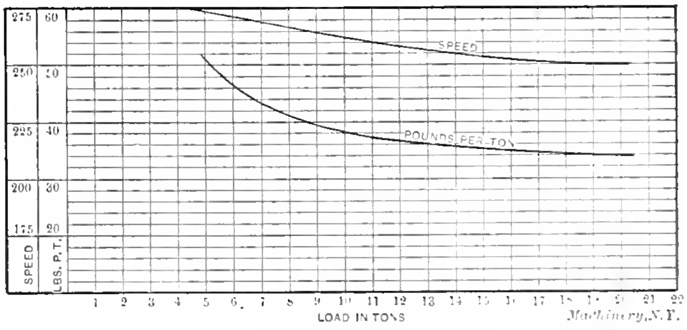


Fig. 3. Traveling Diegram for 20-ton Crene; Full Load Speed 250 feet per minute.

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*For previous articles on cranes, crane design, and efficiency of crane mechanism, see History of Crane Design, June, 1908; Design of Light Structural Jib Cranes, by W. H. Butz, December, 1907; Power Required for Cranes and Hoists, by Ulrich Peters, November, 1907; Formulas for Force Required to Move Crane Trolleys, by John S. Myers, October, 1907; Calculations for Shaft Gear and Bearings of Crane Motors, by George J. Leire, July, 1905; Notes on Band Brake Design, by C. F. Blake, March, 1905, and January, 1901.

For cranes of twenty-five tons and upwards, that are to be in constant use, the best practice now demands an independent motor for the auxiliary barrel, the capacity of which is generally five or six tons, and the speed from twenty to thirty feet per minute.

The conditions concerning the acceleration of speed under lighter loads apply in a similar manner to traversing and traveling, and it is never worth while having a change of gear applied to these motions. The traveling speeds are a somewhat variable quantity, and cases often occur where small-powered cranes have to travel at a very high speed, as, for example, where cranes are used over pig casting beds or stock yards; when engaged in such work they may travel at a speed of 500 feet per minute, or more. For ordinary shop and similar practice the various speeds given in Table I are deduced from the modern requirements and represent an average of the speeds which have been standardized by leading makers.

In connection with the speeds in Table I., it will be necessary to explain how the horse-power required in each case has been arrived at. The horse-power of the lifting motor depends purely on the work done on the load, and the power absorbed in the resulting friction of the gearing, journals, and pulleys. This quantity varies to some extent with the number of reductions and the type of gearing. The efficiency of a crane is generally lowest at the test, improving somewhat as the journals and teeth get bedded down. The efficiency of the first or motor reduction with well-made machine cut spur gears running in an oil bath, has been found by trial to reach as much as 97 per cent, and may be taken at 95 per cent under ordinary practical conditions.

TABLE I. SPEEDS OF ELECTRIC OVERHEAD CRANES.

	Lifting.		Traversing.			Traveling.						
						Weight of Crane.				B. H. P. Required.		
Power of Crane, tons.	Speed, feet per min.	B. H. P.	Weight of Crab, tons.	Speed, feet per min.	B. H. P.	30' 0" Span, tons	50' 0" Span, tons.	70' 0" Span, tons.	Speed, feet per min.	30' 0" Span.	50' 0" Span.	70' 0" Span.
3	33	10	2	120	2	7	10	14	300	5	6	7
5	20	10	2½	120	2	10	13	16	300	7	8	9
7½	20	15	3	120	3	11	14	17	300	8	9	10
10	15	15	4	100	4	12	15	18	250	9	10	11
15	12	18	4½	100	5	14	16	21	250	12	13	14
20	10	20	5	100	6	16	17	23	250	14	15	16
25	10	25	5½	80	6	19	21	26	200	14	15	16
30	10	30	6	80	8	21	25	31	200	15	18	20
40	7½	30	8	80	10	25	34	43	200	20	23	25
50	6	30	12	60	10	32	39	48	150	20	23	25
60	5	30	16	60	12	....	44	58	150	....	26	28
75	5	38	20	60	12	....	50	70	150	....	32	36
100	5	50	28	60	16	....	70	80	150	...	40	42
120	5	60	32	60	20	...	80	95	150	....	45	50
150	5	75	38	40	20	....	90	105	150	....	55	60

The average efficiency of one reduction of cut spur gears, running dry, is 92 or 93 per cent, and of cast spur gears running dry, 90 per cent. The loss due to journal friction is generally about 2 per cent for each axle when properly lubricated. The only other loss in efficiency of any importance is in the snatch block, if there is one fitted to the crane. This quantity is always reduced by using large pulleys and, preferably, small hardened pins, the pulleys being bushed with gun-metal, under which condition the efficiency works out to about 97 per cent.

From the above results a very fair idea of the over-all mechanical efficiency of a crane can be determined, if the number of reductions and the other particulars are known. It will be found that small high speed cranes have a higher efficiency than the larger ones, owing to there being less gearing; thus, in the case of a crab lifting three tons on a single rope and having two reductions of machine cut gearing, the first of which runs in oil, the overall efficiency will be about

$$\frac{95 \times 92 \times 98 \times 98}{100} = 84 \text{ per cent.}$$

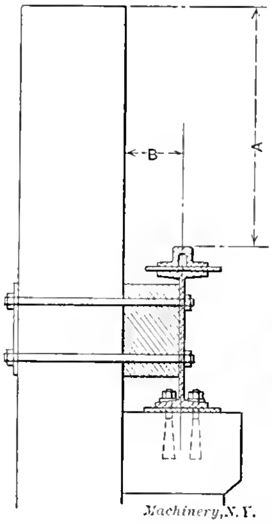
For a contrary example take a 50-ton crab having four reductions, the first three of which are machine cut, the motor reduction running in oil. Then the overall efficiency will be about

$$\frac{95 \times 93 \times 93 \times 90 \times 98^4 \times 97}{100} = 66 \text{ per cent.}$$

A very common rule in practice is to allow ten foot-tons of work done at the hook per brake horse-power, this factor being equivalent to a mechanical efficiency of about 66 per cent. This constant is practically correct for medium and large cranes, but for small sizes it allows for a slightly larger motor than is really necessary, which is perhaps a good fault, since small cranes are generally in constant use. The above calculations are not, generally speaking, necessary in practice, but have been made in order to show how and where the power due to friction is principally absorbed, and it will be seen that the results agree very closely with the diagrams shown in Fig. 1, which are made from trials taken from overhead cranes, representing the best class of design and workmanship. It is usual and more instructive to speak of the gross efficiency of a crane, that is the combined electrical efficiency of motor and wiring, and the mechanical efficiency of the gearing, or in other words, the ratio between current consumed at the switchboard and work done at the hook. This is the efficiency as shown by the diagrams.

The electrical efficiency of a lifting motor may generally be taken at 80 per cent, covering motor and wiring, so that in the case of the 3-ton crane exemplified above, the gross efficiency would be about $\frac{84 \times 80}{100} = 67$ per cent. Similarly, the 50-ton crab would give a gross efficiency of $\frac{66 \times 80}{100} = 53$ per cent. Both of these quantities agree with actual results.

The horse-power, or current required for each motion, as given in Table I. is the calculated power based on the above described coefficients; for practical purposes, however, the nearest manufactured size of motor would be used. The power required for traversing and traveling must be sufficient to overcome the rolling and axle friction, and the friction of the intermediate driving gear. The horse-power of these motors is generally based upon a certain tractive resistance, usually expressed in so many pounds per ton of rolling load. This is a very variable quantity, even the results of tests showing a remarkable latitude. Although it is best to work with data obtained from experiments, it will be well to show the calculations which most nearly agree with actual results.



Machinery,N.Y.

TABLE II. CLEARANCE SPACE REQUIRED FOR OVERHEAD CRANES.

Size of Crane.	A		B
Tons.	Ft.	Ins.	Inches.
3	5	0	7
5	5	6	7
7½	5	6	7
10	5	9	7½
15	6	0	7½
20	6	0	8
25	6	6	8
30	7	0	9
40	8	0	9
50	8	6	10
60	9	0	10
75	9	6	10
100	10	0	12
120	12	0	12
150	12	0	12

The axle friction μ depends to some extent on the lubricating arrangements, but in the calculations it is assumed that these conditions are well provided for, both in traversing and traveling. The power required is figured from the formula

$$P = (\mu r) \frac{W}{R}$$

where W = load in pounds,
R = radius of wheel in inches,
r = radius of axle in inches,
μ = coefficient of friction = 0.10.

The rolling friction of metal wheels on steel rails is considered to be equal to $0.002 \frac{W}{R}$. This quantity may, therefore, be combined with the above quantity and the result obtained direct, thus

$$(\mu r + 0.002) \frac{W}{R}.$$

Take for example a 30-ton crab weighing six tons, having runners 18 inches in diameter, and axles 4½ inches in diameter. The combined axle and rolling friction will be

$$(0.1 \times 2.25 + 0.002) \times \frac{36 \times 2{,}240}{9} = 2{,}034 \text{ pounds.}$$

The efficiency of the driving gear can be found in the same manner as described for the lifting gear, when the number of reductions are known. In the present example there would be three reductions of machine cut gears, all running dry, the total efficiency of which would be about

$$\frac{92 \times 92 \times 92 \times 98 \times 98}{100} = 75 \text{ per cent.}$$

Taking the full load speed at 60 feet per minute, it will be found that the brake horse-power required will be

$$\frac{2{,}034 \times 60 \times 100}{33{,}000 \times 75} = 5 \text{ B. H. P.}$$

The axle friction of the traveling gear will always be found to be considerably less than that of the traversing motion, due to the fact that the crab axle diameter is often larger than the main axle, while the runners are usually only half as large, and the resistance varies in proportion to the ratio of these quantities, as will be seen from the above formula. When assuming the efficiency of the driving gear for the traveling motion, some special allowance should be made for the loss of power due to the cross shaft. This shaft is carried by several bearings, and it is probably the deflection of the girders, and the consequent slight bending of the shaft, that causes the drive to be rather inefficient.

No direct results concerning this shaft are available, but its efficiency will probably be about 90 per cent for cranes of moderate span. Allowing for two reductions of machine cut gears running dry, the efficiency of this drive will, therefore, be about $\frac{92 \times 92 \times 90}{100} = 76$ per cent. Suppose for example, that a 30-ton crane traveler weighs 25 tons, and runs upon wheels 30 inches in diameter having 4-inch axles; then the combined rolling and axle friction will be, as in the case of the crab.

$$(0.1 \times 2 + 0.002) \times \frac{55 \times 2{,}240}{15} = 1{,}659 \text{ pounds.}$$

Taking the traveling speed at 150 feet per minute, and neglecting acceleration which may, for ordinary speeds, be assumed as taken care of by the coefficient of friction and the overload of the motor permissible, the brake horse-power required will be

$$\frac{1{,}659 \times 150 \times 100}{33{,}000 \times 76} = 10 \text{ B. H. P.}$$

The resistance to traction, as nominally referred to, which this power covers will be

$$\frac{10 \times 33{,}000}{150 \times 55} = 40 \text{ pounds per ton.}$$

Similarly the 5 B. H. P. motor for traversing allows for 76 pounds per ton. For practical purposes 40 to 50 and 60 to 70 pounds per ton have been allowed for the best class of travelers having large diameter wheels and machine cut gears. Some tests have shown that a higher factor than 70 pounds per ton is required for traversing, such results possibly being due to the fact that the lubrication was inefficient; the travelling wheels also are often too small. The diagrams in Figs. 2 and 3 show actual results obtained in the traversing and traveling motions of cranes.

Before concluding this installment on preliminary considerations, it is advisable to call the architect's attention to the importance of allowing an adequate working space for travelers when designing shops, etc. Due to overlooking this fact, the first cost is often considerably increased, while the crane is generally of inefficient design and unsightly appearance. The dimensions given in Table II have been taken from actual practice, and will be a guide to those designing new buildings. The headroom given in this table is the least possible with an ordinary type of crab, some designs requiring rather more space. Table II shows a simple form of attachment for track girders, which has been found to answer very well for cranes up to 30 tons, and possesses the merits of being easily adjusted and inexpensive.

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PRODUCING BLACK NICKEL COATINGS ON METAL SURFACES.

The following solution for depositing a black nickel coating on metal surfaces is given by the *Brass World*. The solution consists of the following constituents: water, one gallon; double nickel salts, 8 ounces; ammonium sulphocyanate, 2 ounces; zinc sulphate, 1 ounce. If the zinc sulphate is not in the form of white crystals, but is white and dry, then only one-half ounce should be used. The double nickel salts are dissolved in the water, and then the ammonium sulphocyanate is added. After this has been done, the zinc sulphate is introduced. The solution is used at its ordinary temperature, but in winter should not be allowed to get colder than 60 degrees F., and works best at about 80 degrees F. Ordinary nickel anodes are employed, with a surface several times that of the work to be plated. The work is cleaned carefully, preparatory to the plating. The black nickel deposit may be put directly on steel, brass, copper, German silver, or bronze, but it is preferable to first flash the work in a hot copper solution, then in a white nickel solution, and finally deposit the black nickel. For cheap work, the copper and white nickel deposits may be dispensed with, but the black nickel is less apt to peel off if put on the white nickel. The black nickel is deposited with a weak current. Best results are obtained with a current from ½ to ¾ of a volt.

The deposition should be allowed to stand for an hour or more if a heavy deposit is desired. When the article comes from the black nickel solution, it will be found that it is of a gray or brown shade. While this disappears to a considerable extent when lacquered, the color is not a dead black. By using a dip consisting of one gallon of water, twelve ounces of iron perchloride, and one ounce of muriatic acid, a dead black color is produced. All nickel deposits should be lacquered after dipping.

The following causes of difficulties should be guarded against: If the black nickel deposit has spear-shaped markings on it and is partly white, too high a voltage has been used. If the deposit flakes off after standing for some time, too strong a current has been used, or the work has not been clean. If the deposit is too heavy, it is also apt to flake off. If the deposit is still brown or gray after it comes from the dip, the dip is old, or the article has not remained in the dip long enough. If, although the voltage is right (less than one volt), the deposit is streaked, the bath has become acid; add carbonate of nickel (plastic) to neutralize the acid. Use plenty of anode surface and old nickel anodes if possible. If the edges of the deposit are removed in the dip, the dip is too hot, or the black nickel was not deposited a sufficiently long time. If the surface is iridescent after lacquering, the lacquer is too thin.

* * *

Statistics dealing with the iron industry of the world show that, during 1907, the United States produced about 43 per cent of the total pig-iron and 45 per cent of the total amount of steel produced in the world. Germany takes second place with, respectively, 22 and 24 per cent. Great Britain comes in the third place with 17 and 12 per cent, respectively.

INDUSTRIAL PHOTOGRAPHY.*

The first aim of the photographer of machines and industrial subjects, in general, intended for half-tone reproduction in catalogues and trade journals, should be to produce prints that will require the least retouching when used for making half-tones, and this for two reasons: First, the retouching of prints for half-tone work is quite expensive; and second, the print that requires the least retouching gives much the best results in the finished half-tone. The photographs from which the half tones in this article have been reproduced were not retouched at all.

Nearly all industrial establishments are equipped with a photographic outfit of some kind, and in some instances an experienced photographer is in charge; but in the majority of cases one of the draftsmen must take care of all the photographic work of the establishment, and it is in the hope of aiding some of the latter that the author prepared the paper abstracted.

Apparatus.

The camera should be a strong and serviceable one having a long bellows with very little cone. In fact, one with a perfectly straight bellows is best, as it allows greater adjustment of the lens board without danger of the bellows folds cutting off any of the object. The vertical and side swings should be ample. The camera need not be larger than 6½ by 8½ inches, and should not be larger than 8 by 10 inches, as anything over this size is cumbersome to handle, and requires a very expensive lens and a great deal of skill to operate. If large prints are wanted, bromide enlargements can be made up to any reasonable size, and if for any reason large direct or contact prints are wanted, a slightly enlarged positive can be made from the negative, and a negative as large as wanted can be made from the positive. This procedure has its advantages, as it is often possible to correct in a great measure any errors in exposure or development, and many errors in lighting and position.

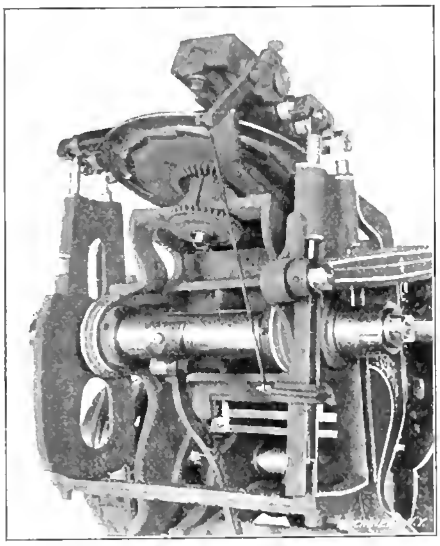
Fig. 1. Details Brought Out, and Deep Shadows Avoided by Preparation of Machine Parts before Photographing—No Retouching made on Photograph.

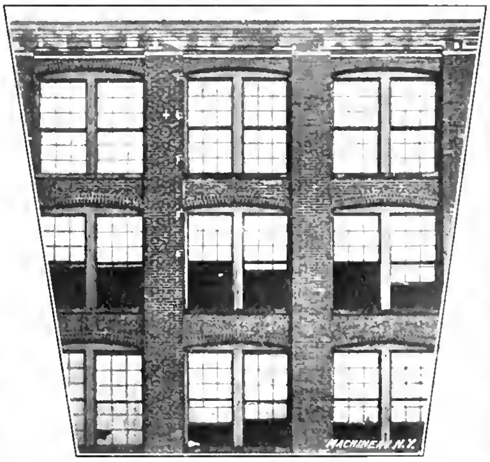

Fig. 2. Distorted View in Fig. 3 corrected in Reproduction.

Fig. 3. Distorted View caused by Pointing Camera upwards.

The tripod should be solid and stiff with the fewest possible joints. The lens should be the best obtainable, and too great emphasis cannot be placed on its being of long focus. Never under any circumstances should its focus be shorter than the diagonal of the largest plate with which it is to be used. It should be capable of rendering sharp definition from corner to corner of the plate when using a comparatively large diaphragm. The plates should not be the most rapid made, as the emulsion with which these are coated is not generally rich enough in silver to give printing density for anything but portrait work, and also because the timing of the exposure must be very exact. Plates of medium speed are the best and should be of the kind known as "double coated" or "non-halation."

If interior views are to be made where windows and other openings to the light have to be faced, then the plates should be coated on the back with a compound known as "backing." This "backing" should be washed off with a damp sponge before development.

Proparation of the Subject.

If a machine is to be photographed, it should be painted with a finishing coat of drab paint, which may be designated as "mouse color," and the paint should be so mixed as to dry absolutely "flat," that is, without any gloss whatever. If parts underneath the machine or in shadow are wanted to be shown, they should be painted a lighter shade than the more prominent parts, and the deeper they are in shadow the lighter they should be painted, in extreme cases even blending the color gradually into a white. All brightly polished parts should be daubed or rubbed over with a handful of soft putty to dull the brightness. Unless these precautions are taken, the parts in shadow will show very dark in the photograph, and if very close together will be seen only as one shapeless mass, and the bright spots will show chalky white with very black lines and little or no detail. If letters or figures cast on any part of the machine are wanted to be shown, daub them with white paint from the end of a finger. Rubbing with chalk will give them a very rough appearance.

It must be borne in mind that all high lights and shadows are greatly intensified in photography, and that a sensitive plate that will register all the gradation of tone as seen by the human eye has yet to be made. Fig. 1 is an illustration of a machine that was properly prepared for being photographed. If possible it is best to photograph a machine before it has been run, otherwise oil from the bearings will seep out on the paint and leave dark and glossy spots which will look bad in the photograph. If the machine is to be run before being photographed, then it should not have its finishing coat until after the run or test is over. Before the finishing coat is put on, all the bearings should be thoroughly flushed with gasoline and the whole exterior cleaned with the same stuff to remove all oil.

Lighting and Position.

Machinery should never be photographed out-of-doors or under a skylight, as there is too strong a top light, which causes deep shadows. The light should preferably come from the north, and should fall on the machine at a downward angle of about 20 degrees from the horizontal. Cross lights from other windows should be avoided by pulling down the shades or tacking up heavy paper. Cross lights make a confusion of shadows and obliterate certain lines, giving the machine anything but a natural appearance. If necessary to photograph the machine by other than northern lighting, then make the exposure when the sun is overhead. If the exposure must be made when the sun is shining through the windows at any considerable slant, tack cheese cloth over the windows to diffuse the light.

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*Abstract of paper by Mr. S. Ashton Hand, read before the American Society of Mechanical Engineers, December, 1908.

A machine should never be photographed directly from the front, which will make it appear too flat. For depth, the camera should be placed enough out of center to show a little of one side of the machine and high enough to show a little of the top. A background of heavy drilling, either white or very light in color, should be hung not less than 6 feet back of the machine. It should be of ample size—large enough so that the camera can be moved where wanted and still show the background behind every part of the machine. If there are folds or wrinkles in the background, have a man at each side take hold of the edges and shake the curtain slowly and gently during the whole time of the exposure. This will prevent the folds or wrinkles from showing in the photograph.

Fig. 4. Camera and Negative Holder arranged so as to correct Distortion shown in Fig. 3.

Shop floors are dark in color, and if a machine is photographed directly on the floor it is often puzzling to know where the lower part of the machine ends and the floor begins. Therefore a floor cloth of the same color and width as the background should be used. It should be deep enough to extend from 4 to 6 feet in front of the machine and under it and to the background. Instead of a floor cloth, sheets or strips of light colored paper can be used, but be sure there is no pronounced red or yellow, as such colors are non-actinic and will show black in the photograph.

Focusing.

Never focus on the center of the ground glass, as this will give you the point of sharpest focus of the lens, and what is wanted is the average focus; therefore focus at a position midway between the center and the edges of the ground glass. Get the nearest parts of the machine in focus. Small diaphragms will sharpen up the distant parts. Sometimes a better effect can be obtained by pointing the camera slightly downward, but if at any time the camera is used in any other than a level position, the ground glass should be brought to a vertical position, otherwise the result will be distorted lines. Fig. 3 shows a distorted view of a part of the side of a building, made by pointing the camera upward. If the photograph of a machine shows such distortion, and for any reason it cannot be photographed again, a negative can be reproduced eliminating the distortion, by placing the negative in a frame tilted at such an angle that the narrowest lines are nearest the lens, and making a positive in the camera, tilting the ground glass at an equal angle, but in the opposite direction. A negative can be made from this positive, as shown in Fig. 2, which was actually made from a negative reproduced in the above manner from that used for Fig. 3. Notice how much the top of the negative had to be enlarged to bring the lines parallel. Fig. 4 shows a camera and negative holder in the proper position for this operation.

Fig. 5. Photograph taken without Special Precautions against Strong Light in the Background.

If the machine to be photographed is a long one, requiring a raking view, use the horizontal swing to bring that part of the ground glass on which the image of the farthest part of the macine appears, farthest away from the lens. This will even up the focus and make it possible to use a larger diaphragm, shortening the time of exposure, and also extend the vanishing point to a greater distance, giving it a more normal perspective. If there are perceptible vibrations to the floor on which the photographing is done, get three pieces of harness felt ½ inch thick, and two or three inches square. Place one of these on the floor under each leg of the tripod, and they will absorb all ordinary vibrations and keep the camera steady.

Fig. 6. Same Interior as in Fig. 5, but taken with Strong Light in Foreground.

Exposure.

Exposures should always be ample, as an under-exposed plate can never be made to show that which the light has not impressed upon it (although it can be greatly helped by skillful development), but a moderately over-exposed plate can easily be treated in development, or even afterwards, so as to yield a first-class print. If in doubt as to the correct time of expcsure, make a guess as near as possible. Suppose your guess to be four minutes, then put a loaded plate holder in the camera and draw the slide so as to expose two inches of the plate and make an exposure of two minutes; cap the lens, draw the slide out two inches more, and make another exposure of two minutes. Repeat this, drawing the slide two inches at a time, until the whole plate has been exposed. If the plate is 8 by 10 inches, there will be five parts, having respective exposures of 10, 8, 6, 4, and 2 minutes each. Develop this plate, and it will be easy to tell which part has had the proper exposure, and from the position of this part the time can readily be found.

Interiors.

In photographing interiors, avoid pointing the camera towards windows if possible, but if this cannot be avoided, then cover the windows with heavy drilling or thick wrapping paper, fastening it well around the edges, so that no bright margins of light are visible. After the exposure has been made, the window coverings can be removed and an additional exposure of a fraction of a second can be given. This will give the windows a natural appearance and will often show objects on the outside. Interiors can be photographed without these precautions, but skillful work will be required to make good negatives.

Figs. 5 and 6 were made on a very bright day when snow was on the ground, and the light coming in the windows was intensely white. As the negatives were wanted in a hurry, no precautions were taken to soften or keep out the light at the windows. The far end of Fig. 5 was a southern exposure, and the sun heat was streaming in at the windows. Fig. 6 is a view in the same room taken from the south end, where the light was so intense that the milling machine in the foreground appears light in color, although it was painted a dark steel color.

Copying.

In copying drawings or other subjects in black and white, it is necessary to use a very slow plate, give the shortest possible exposure, and use a concentrated and well-restrained developer. If a copy is to be made from a blue print, it will be necessary to bleach the print in a weak solution of ammonia and water, and after a thorough washing, to immerse it in a weak solution of tannic acid. The part that was formerly blue will now be a rich purplish brown.

Enlarging Negatives.

A negative can be reproduced in a larger size by first making a positive in the copying camera, and then making a large negative from the positive by the use of the same instrument. If a negative is enlarged to many times its original size, a granular effect will be noticed. This is caused by magnification of the emulsion structure which is made up of countless thousands of hills and valleys. This granular effect can be eliminated by slightly over-exposing and greatly over-developing the original negative, and then reducing it to the proper density. The positive should have the same treatment.

Reduction does three things: (*a.*) It reduces or clears the shadows faster than the high lights. Therefore over-exposure is resorted to in order to increase the density of the shadows in proportion to the high lights, so that they shall bear proper relation to each other after reduction. (*b.*) It thins the density of the negative or positive. Therefore over-developing is resorted to in order to have resulting density after reduction. (*c.*) It cuts down the hills to the level of the valleys, so that very little if any granular effect is noticeable when the emulsion is magnified.

In reproducing negatives either in the original or a larger size, there is a splendid chance for what may be termed "jockeying." A brilliant negative may be made from a very flat one, and *vice versa;* errors in perspective can be corrected by the method illustrated in Fig. 4; and unequal lighting can be corrected by judicious shading during exposure, etc.

X-Ray or Ghost Photographs.

When an illustration is wanted to show clearly some hidden interior part of a machine in relation to and more distinctly than other parts, the usual procedure is to have a wash drawing made in India ink, from which the half-tone is produced. This method is always expensive, and the results are often very unsatisfactory.

In a power-driven machine for cutting paper, the power is transmitted through worm gearing and a positive clutch, all of which is enclosed in an oil-tight case, as shown in Fig. 8. An illustration showing the worm and worm-wheel in mesh was wanted.

The case and its contents were removed from the machine and mounted on a box. The upper part of the case was taken off, leaving the worm-wheel and the clutch collar exposed to view. The worm and shaft were removed from the upper part of the case and placed in their proper position in relation to the worm-wheel, as shown in Fig. 7. A dark background was placed in the rear and an exposure was made. After the exposure the cap was put on the lens, the worm and shaft taken away, and the upper part of the case put in position as in Fig. 8. A light background was substituted for the dark one, and another exposure made on the same plate, the result of which is shown in Fig. 9.

Development.

Of the art of development much has been written, and more has been said, but the fact remains that the only adequate teacher is experience. After many years of experience, the author of the paper abstracted hesitates to attempt to tell in writing how to handle a sensitive plate in development. A few hints, however, concerning the behavior of certain mixtures of developer, may be of service.

Too weak a developer makes a flat thin negative.

Too concentrated a developer makes a negative with too much contrast.

Under-developing makes a negative lacking in printing density.

Over-developing makes a thick dense negative requiring a very long time to print.

An under-exposure should be developed with a diluted developer.

An over-exposure should be developed with a concentrated developer well restrained with bromide of potash.

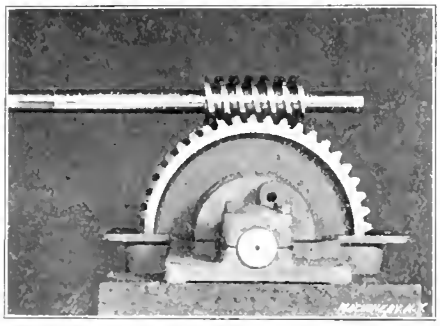

Fig. 7. Photograph of Worm and Gear with Upper Part of Case Removed.

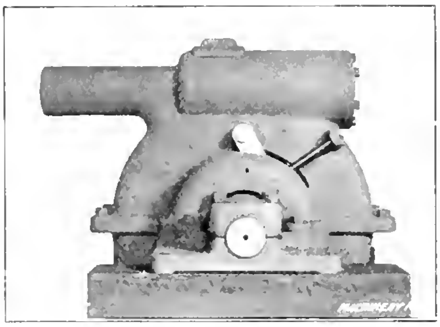

Fig. 8. Exterior of Case to be Photographed on Same Plate as Worm and Gear in Fig. 7.

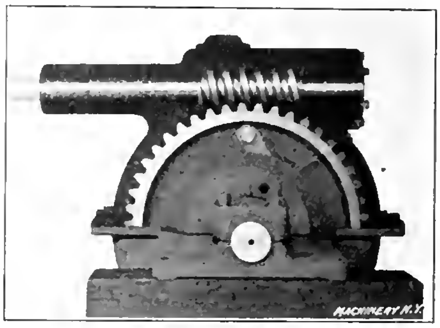

Fig. 9. Result of Exposures of Figs. 7 and 8 on Same Plate.

Developers, like artists' colors, should be mixed with brains.

Better choose a moderately slow developer, learn how to use it, and don't let any one persuade you to change it.

The actual printing can, as a rule, be done better by a professional photographer than by an amateur, and as a rule it will be found cheaper to have the prints thus made.

* * *

An ingenious method of regulating the speed of mechanism so as to be absolutely synchronous and to have a known velocity, has been used, which is very simple and worth noting because of the principle. Say that we are given the case of operating a mechanism for autographically recording the pressures of succeeding explosions in a closed receptacle using an apparatus similar to a steam engine indicator, and that it is essential that the speed of the recording apparatus be the same for each test. The method used by Mr. Frederick Grover in his well-known gas explosion tests was to mount a stop watch (that is, one having the second hand in the center) in the mechanism train so as to rotate in a direction opposite to the movement of the second hand and at the same speed. The hand then stood still in space when the mechanism was correctly timed. Any deviation forward or backward showed that the mechanism was running too fast or too slow. A suitable speed-varying device enabled the observer to speed up or slow down the train and thus keep the second hand standing perfectly still. The device is a perfect check on numbers of rotations per minute and the regularity of action.

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According to an English patent specification, celluloid may be made non-inflammable by the addition of chloride of aluminum and nitrate of aluminum.

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS—5.

SPECIFICATIONS, ESTIMATES AND CONTRACTS IN ENGINEERING PRACTICE.

WILLIAM P. SARGENT.*

According to Schopenhauer, words and signs simply serve the purpose of fixing conceptions in the mind. The words and signs of engineering are the drawings and specifications, and the contractor will execute his work according to how well these convey to him the conceptions and requirements of the planning engineer. In the specifications, the exact character of the work should be fully and explicitly stated, and the wording should be definite, so as to convey the precise meaning.

Specifications are made up of general clauses covering the general conditions, responsibility of the two parties, etc., and specific clauses covering the details of design and construction, From an analysis of a number of specifications the following points are selected as indicating a consensus of opinion concerning many of the essential features of specifications.

General Clauses in Specifications.

1.—A concise and comprehensive statement descriptive of the work to be done in accordance with the drawings and specifications.

Example.—The work to be done under this contract comprises the furnishing and erection, on foundations provided by the owners, of two (2) water tube boilers, ready for smoke, steam, and water connections, in strict accordance with these specifications and drawings, Nos. 1 and 2, dated October 10, 1908.

2.—A complete list of the drawings, with the drawing dates, accompanying and forming a part of the specifications.

3.—The drawings and specifications together are to govern the work, and everything called for either on the drawings or in the specifications, or in both, is to be furnished or executed.

4.—Definition of the words "engineer," "owners" and "contractor," as used in the specifications.

5.—The engineer shall explain any obscurity in drawings or specifications, shall decide as to the purpose and intent of drawings and specifications, or of the kind and quality of work or material required thereby, and his decision shall be conclusive.

6.—The contractor shall keep a foreman constantly on the site, the charge of the work being his sole duty.

7.—The engineer shall give lines and levels.

8.—For dimensions governed by conditions already existing the contractor must be governed by measurements taken by himself, scale or figured dimensions notwithstanding, but no deviation shall be made without authorization of the engineer.

9.—The contractor is responsible for the full understanding of the existing condition of the site, and all work or material necessary to change the site to the condition provided for in the specifications, is included in the contract.

10.—Materials and workmanship to be subject to inspection and approval of the engineer who shall have authority to reject any material or work not in conformity with the specifications.

11.—Owners reserve the right to make alterations while work is in progress; additions to, or deductions from, the amount of the contract on account of alterations to be made according to a schedule approved by the engineer.

12.—Owners reserve the right to put other parties at work while the contract is being executed, with the understanding that there shall be no interference with the progress of work under this contract.

13.—Rubbish must be cleared away during the progress of the work at any time the engineer may direct and at the completion of the contract.

14.—All material in the buildings torn down shall be the property of the contractor and any old material may be used in the new work if approved by the engineer.

15.—Contractor must comply with municipal or state ordinances, and shall do all work necessary to so comply whether called for specifically herein, and shall not make any extra charge on this account.

16.—Contractor must pay for all permits or other municipal charges.

17.—Contractor shall carry builders' insurance to cover the amounts paid from time to time by the owners and assign the policies to the owners.

18.—Contractor shall indemnify and save harmless the owners from all suits or actions of any kind for, or on account of, use of patented articles or rights, and any damages or injuries received or sustained by any party or parties by or from the contractor or his agents or servants in the performance of the work.

Many of the above clauses in the specifications examined differ widely in the intent and are often worded so as to tend to envelop and conceal the meaning rather than to explain it. There is often repetition after repetition of seemingly identical thoughts.

The third clause seems to often cause difficulties, and every engineer or architect has more or less trouble in so wording it that he does not occasionally meet with a contractor who either innocently or wilfully misconstrues the clause in a manner to relieve himself from some work intended.

The fourth, fifth, sixth, and seventh clauses are seldom misunderstood but should be worded very clearly.

The eighth clause is found with a wide variation in intent and wording. Often it is used to throw the responsibility for the architects' or engineers' work onto the contractor. This is palpably unfair. Where would one find, for instance, a designer or draftsman who would send drawings into the shop and expect the machinist to assume the responsibility for the accuracy of the dimensions? Generally a contractor will ignore any clause which makes him responsible for the dimensions, trusting that the specifications will not be strictly held to. Of course there are cases where measurements can not be obtained, except during some period of the work or wrecking, or where existing structures have been used as basing lines, or are not as they seem, and it is perfectly fair to have the contractor verify such dimensions in question, as he is the best fitted to do so. It is better to specifically state such dimensions than to write a general clause that is unfair or that will be tacitly ignored; but it is proper to have the contractor call attention to any real or apparent error, thus affording a chance for investigation and rectification before any loss is entailed.

Clauses Found at Times in Specifications and at Times in Contracts.

There are a number of clauses affecting the following points, that are not always found in the specifications but if not, they will be in the contract: time of completion, violation of contract, payments, ownership of work and materials, liquidated damages, bond.

As to the time of completion, it is well that it be stated in the specifications if possible, as the fact that the work should be finished at a definite date appeals to the sporting instinct of the foremen and workmen when they know that it is "up to them." Generally, however, the contractor names the date of completion, and it gets into the contract, but not into the specifications.

Clauses dealing with the monetary part of the transaction seem more properly to belong to the contract. This leaves the specifications entirely an instrument for guidance in accomplishing the material results desired. Very few contractors would care to have the terms of payment or matters of a like nature open to their foremen or workmen as would be the case if such clauses were included in the specifications.

In a paper read by a contractor before an engineering society, some of the shortcomings of specifications were discussed from a contractor's point of view. One statement was: "A contractor should not be held responsible for the stability of a structure, provided the work is constructed as required by the specifications." Another contractor stated that there is positively nothing which raises a bid price like asking a contractor to assume uncertainties.

Specifications are not very interesting reading unless one has some actual work to be performed, but as the general

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figures of cost given previously would not hold good without limitation, the writer will epitomize the specific clauses covering the details of design and construction. Utility, permanency, and low cost are the desiderata governing the same, and buildings erected on these lines should be equal in quality and appearance to the one illustrated in Fig. 30 (see December issue).

Excavation.—Depths and widths: per drawing. Specified depth insufficient: notify engineer. Bottoms: level, undisturbed. Material excavated: placed on premises or carted away at engineer's option. Shoring: if necessary; to remain if withdrawing endangers adjacent structures.

Back-filling.—As soon as practicable. Puddled and tamped.

Grading.—Inside buildings: wet and tamp, per drawings. Immediately around buildings: per drawings.

Cement, Mortar, Concrete.—Cement: Portland, to comply with and subject to tests; per specifications recommended by The A. S. C. E.; cement submitted to engineer at least twelve days before using.

Sand.—Clean, sharp, and coarse.

Stone.—Clean, hard, durable—to pass 2-inch ring in any direction.

Gravel—Clean, hard, free from other matter except sand; proportion of sand such that all voids will be filled.

Cinders.—Clean anthracite.

Lime.—Thoroughly burned, freshly slaked, clean.

Cement mortar.—1 part cement, 2 parts sand.

Lime mortar.—1 part lime, 4 parts sand.

Gaged mortar.—1 part cement mortar, 1 part lime mortar.

Concrete.—1 part cement, 2 parts sand, 5 parts broken stone; 1 part cement, 7 parts gravel; 1 part cement, 5 parts cinders, 2 parts sharp fine gravel.

Structural Steel.—Medium steel: 60,000 to 70,000 pounds tensile strength; elastic limit not less than one-half the tensile strength, manganese less than 1.0 per cent. Contractor to furnish all members shown on drawings and all other metal work necessary to the stability of structure; bolts must fit; shop connections riveted; abutted surfaces machined; field connections bolted, except column splices and column connections. Contractor to make his own working drawings, must verify drawings furnished him, and be responsible for accuracy of his drawings in all details; drawings subject to approval of engineer. Painting: one shop coat, two coats on all surfaces inaccessible after erection; finish field work so that all exposed surfaces shall have two coats; paint approved by engineer. Inspection: work and material subject to inspection by inspector appointed and paid by owners; final inspection and acceptance at building.

Brickwork.—Brick: straight, hard, sound; face brick selected of uniform color. Every seventh course headers; joints not to exceed ½ inch; laid to line, shoved joints; masons to set anchors, etc.; openings next to steel work slushed with mortar; walls left clean and neat, using acid solution if directed by engineer.

Woodwork.—Kinds and grades specified according to local conditions and practice. Soundness and freedom from structural defects of more importance than appearance.

Roofing and Sheet-metal Work.—Slag or gravel roof according to "Barret's Specification" with a guarantee for ten years; flashed up against parapet walls to 12 inches above low point of gutter; counterflashing built into walls, of Taylor's IX Old Style tin; down-spouts with copper intake and copper wire strainer 8 inches high.

Sky-lights.—Wired glass at least ¼ inch thick, in copper bars; design approved by engineer.

Glazing.—Windows factory ribbed in upper sash. Lower sash and doors D. S. A. quality clear glass.

Painting.—All metal work to have two coats, and all woodwork to have three coats when finished; each coat different color.

Hardware.—Plain, extra-heavy. Sliding doors on approved hangers and tracks.

Plumbing.—According to local ordinances.

Estimating on Shop Construction Work.

That the best way to learn to do a thing is by doing it holds true with estimating. The only aid that the writer can offer is of a general nature, as the variable conditions of locality and trade activity affect prices greatly. Unless an engineer has been engaged in contracting, his estimate will generally be lower than a contractor's bid, but his estimates of quantities should not vary materially from those of the contractor.

The following example will show variations in bids from experienced contractors on a factory building, designed by the architects to cost $160,000. The extreme range of sixteen bids was from $172,000 to $230,000. The three lowest bids were within $1,000; the next three were about $3,000 higher but within a range of $1,000. This was close bidding. When estimating on construction work the engineer should try to put himself in the contractor's place and figure as though responsible for obtaining the contract for the work in competition with others, and at the same time securing a reasonable profit.

"Unit cost," in the following paragraphs, means the basing cost to the contractor, excluding expense items. "Total cost" includes the expense items. "Price" is the amount (including profit) received by the contractor. These prices, obviously, are the costs from the view-point of the owner.

The total cost of material should be estimated as comprising: *a.* The cost F. O. B., shipping, freight, unloading, hauling, storing. *b.* 5 per cent for contingencies. *c.* 1½ per cent for interest on funds up to the time of payments (partial) by the owner. *d.* 1/5 per cent for bond (of contract). *e.* 2/5 per cent for builders' insurance. These percentages will vary from those stated for specific instances. To this total cost add a percentage for profit.

The total cost of labor comprises: *a.* Wages of skilled and common labor, or pay-roll; *b.* 5 per cent for superintendence. *c.* 4 per cent for general expenses. *d.* 1 per cent for insurance of workmen and public. *e.* 10 per cent for contingencies. *f.* 1½ per cent for interest on money. *g.* 1/5 per cent for bond. *h.* 1/5 per cent for builders' insurance. To this total cost add a percentage for profit.

To make up the total cost of a project to the owners, 5 per cent of the grand summation should be added to cover the cost of engineering.

Basing Costs and Prices for Estimating.

The unit prices given below are based either on cost records or on the most reliable authorities in print, and it is believed that estimates incorporating them will be close to fair contract prices if care is taken to add the proper expense and profit percentages that rule in any particular section. The contract prices quoted are not in all cases the lowest, but are selected as being bid by the contractor that would render the best service for the price paid.

First Section—Buildings.

Excavation.—Cost of labor, in cents per cubic yard in place, based on 15 cents per hour; loosened with pick and thrown on bank: *a.* Loam and gravel, 5 feet deep, 15 cents. *b.* 6 to 10 feet deep, 30 cents. *c.* in loam and clay, 5 feet deep, 20 cents. *d.* 6 to 10 feet, 45 cents. Backfilling: *e.* Loose earth, 5 cents. *f.* Tough earth, 7 cents. Tamping: *g.* 6 cents. Carting: *h.* At rate of 30 cents per mile. In winter, add 50 per cent to *a, b, c, d, e, f, g.* Contract prices: Ohio, 1906-07 (*a*) summer, 25c.; winter, 50c.; Connecticut, 1906 (*c*) 65c.; carting, ½-mile haul, 10 cents; excavation, 15 feet deep in clay, and carting (hoisting engine already on ground), $1.00 per cubic yard; driving tunnel in clay, depth 30 feet, excavation, shoring, and carting, $3 per cubic yard. See "Gillete's Cost Data" for additional costs on excavation and allied subjects.

Concrete.—Cement should be purchased in the winter months to get the lowest price. A fair average cost of cement at the mixer, allowing for waste and lost sacks, is $1.50. Broken stone, $1.25. Sand, $1.00. Gravel, $0.75 per cubic yard. Cost of materials per cubic yard of concrete in place: 1—2—5 mixture broken stone, $3.75; 1 to 7 gravel concrete, $2.25.—Labor: For foundation work, mixing and placing by hand, 60 cents per yard; mixing by machine and placing by hand, 45 cents per yard.—Forms: Labor and material, 40 cents per yard.—Contract prices: Without forms, Ohio, 1907, gravel, $4 per yard; with forms, $5 per yard. Connecticut, 1906, broken stone, 1—2—5, without forms, $6; with forms, $6.50. These prices are for building foundations. Machine foundations including setting of bolts, pockets, etc.: Ohio, gravel concrete, $4.75; forms 7½ cents per square foot additional. Connecticut, broken stone concrete including forms, $7.—Concrete for ground floors including the setting of sleepers: Ohio, gravel concrete, 18 cents per cubic foot. Connecticut, stone concrete, 22 cents per cubic foot.—Roof slab: Connecticut, cinder concrete, 4 inches thick, 10-foot span, 21 cents per square foot. Ohio, 10-foot span, stone, 25 cents per square foot.—Gallery floors: 250-pound live load, 5-foot spans, cinder concrete, 26 cents per square foot. For 600-pound load, 5-foot span, 35 cents per square foot.—Reinforced concrete tunnels driven in clay 30 feet below surface, 4 x 10 feet inside, $35 per lineal foot: concrete with forms, $14 per cubic yard additional. Tunnel: 6 x 8 feet inside with industrial track, turn-table, 12-inch and 15-inch cast-iron pipes in floor, tapped sockets in walls for pipe hangers, $41 per lineal foot complete. Length about 330 feet, part driven and part open cut.

Cut Stone.—For sills, Ohio, 1907, tool planed, $1.25 per cubic foot. Connecticut, 1906, $2 per cubic foot; rock faced, $1.65 per cubic foot. Labor: setting, 25 cents per cubic foot.

Brickwork.—Cleaning old brick, $1 per 1,000. Unloading, 30 cents per 1,000. Cost of brickwork is governed by local prices and wages. Generally one helper is required to each mason. With cement at $1.50, sand $1, lime 63 cents per barrel, lime mortar will cost $1.25 per 1,000 kiln count, gaged mortar will cost $2.47 per 1,000. One to three cement mortar, $2.80 per 1,000. One to two cement mortar, $3.70.—Average price of brick at the yards in 1906: Illinois, $4.79; Michigan, $5.70; Ohio, $5.90; New York, $6; New England, $7 per 1,000.—Contract prices: Wall measure (22½ per cubic foot), Ohio, 1906, $11; 1907, $11.50. Connecticut, 1906, $13.30; Illinois, 1908, $10 per 1,000. Kiln count, or actual brick required will run about 17 per cubic foot of wall.

Terra-cotta.—Tile coping for 9-inch wall, 14 cents per lineal foot; corners, 36 cents. For 13-inch wall, 20 cents per foot; corners, 55 cents. Labor setting, 6 cents per foot.

Windows.—Plank frames, S. S. glass primed at mill, 15 cents per square foot of wall opening; box frames, D.S.A. glass, primed, 20 cents per square fcot; add 1½ cents for hardware; 4 cents for painting two coats; 10 cents for setting per square foot. For factory-ribbed glass add 2½ cents per square foot. Metal frames and sash with ribbed wire-glass, $1.60; with polished plate glass, $2.35 per square foot.—Metal window shutters, 50 cents per square foot. Window guards, No. 15 galvanized wire, ½ inch diamond mesh, in place, less than 15 square feet to one guard, 20 cents per square foot; 25 to 35 square feet, 17½ cents; 40 to 60 square feet, 15 cents per square foot.

Doors.—Wooden sliding doors, in place: 35 cents per square foot; steel rolling doors, 70 cents per square foot.

Skylights.—Copper bars, ¼ inch ribbed glass, 60 cents per square foot in place; if wire glass, add 10 cents per square foot.

Roofing.—Tar and gravel or tar and slag, $4.00 per square (100 square feet). Copper strainers with intakes, $1.50, in place. Down spouts, 5-inch galvanized, 25 cents per lineal foot, in place; 6-inch, 30 cents. Flashing, galvanized No. 24, 14 inch, 7 cents per lineal foot; in place, 14 cents; 20-inch, 13 cents and 20 cents. Counterflashing, material, 10 cents; in place, 25 cents.

Floors.—Cost complete, 6 inches gravel concrete, 4x4-inch cedar sleepers, 2-inch centers, tar and sand, 2x6-inch T. & G. Y. P. planking, ⅞x4-inch square edged No. 1 Maple top floor, 18 cents per square foot. Contract price, Ohio, 22¼ cents per square foot.—Cement floors: 6 inches cinders, 3 inches concrete, 1 inch cement top, 10 cents per square foot. Contract price, Connecticut, 1906, for 5 inches concrete, 1 inch cement top, 20 cents; 6 inches concrete, ½ inch cement binder, 1 inch asphalt, 24 cents.

Structural Steel.—Pittsburg, Nov., 1908: Beams and channels, 15 inch and under, $1.60; over 15 inch, $1.70; angles 6 inch and under, $1.60; plates, $1.60. Following prices should cover the cost to owner of the material erected and painted at any point where freight rate is not more than 15 cents a hundred. Trusses, 1,500 pounds and under, $65.00 per ton; 3,000 pounds and over, $60.00 per ton. Single I-beam columns, $55.00. Plate and angle columns, $65.00 to $70.00. Lattice columns, $72.00 to $78.00. Plate girders, $58.00 to $60.00. Beams, $50.00 to $52.00.

Carpenter Labor.—This is the most difficult class of construction work as regards estimating, as the "personal equation" enters largely and records of labor cost vary under seemingly like conditions. The following figures should be checked according to local conditions before using, as the quantities run up into big figures. All figures are for board measure, and in estimating allowance should be made for waste if standard lengths cannot be used (multiples of 2 feet), and for the difference between actual dimensions and "strip count" or nominal size. For instance 2x6-inch tongued and grooved material is cnly 5¼ inch face, and 1⅝-inch thick. Therefore it will require 11.7 per cent more lumber, board measure, than if the material were up to size. 1x4-inch maple is only 13/16x3¼-inch when matched. Hence the economy of square edge material, as but ¼ inch to 5/16 inch is required to dress the width. Unloading, from car to wagon or car to pile, 900 feet per hour per man. Purlins: Squaring to length, boring, raising and bolting to trusses, 61 feet per man per hour. Roof sheathing: Raising to roof level, 160 to 200 feet per hour per man. Laying: 55 to 60 feet per hour. Flooring: Gallery; under planking, raising 200 feet per man; laying, 60 feet; maple top flooring, 26 feet per man per hour. Ground floor: planking, 100 to 120 feet per man; maple top floor, 30 feet per man per hour. Nails: For roof sheathing allow 60 cents per 1,000 feet; floor planking, $1.25; maple top floor, ⅞ inch, 55 cents; 1⅛ inch, 75 cents. Fences: Ordinary board, 60 cents per lineal foot; swinging or sliding wagon gates, $50.

Sewers.—Tile salt glazed pipe F.O.B. site per lineal foot.

	6 in	8 in.	10 in.	12 in.	15 in.	20 in.	30 in.
Pipe	$0.09	$0.15	$0.225	$0.29	$0.42	$0.75	$2.83
Curves ...	0.33	0.60	0.92	1.16	1.58	2.50	
Branches..	0.41	0.68	0.98	1.28	1.88	3.38	
Reducers..	0.40	0.60	0.87	1.13	1.70	3.00	
Lidded Tile		0.20	0.31	0.40	0.52	0.77	

For lidded branches add 33 per cent to cost of standard branches.

TABLE XII. PERCENTAGE TABLE OF COSTS OF SHOP BUILDINGS.

	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6	
	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.	Per Cent.	Cents per Square Foot Floor Space.
Structural Steel	100.0	66.8	100.0	89.2	100.0	85.0	100.0	70.8	100.0	71.0	100.0	43.1
Crane Runways	7.7	5.1									41.1	17.7
Foundations—												
Excavation	1.8	1.2	....	....	....	....	1.3	0.9	0.6	0.4	2.7	1.2
Concrete	10.1	6.8	....	....	....	....	8.4	6.0	7.6	5.4	26.8	11.6
Piling	....	....	....	....	....	....	....	....	....	....	....	....
Concrete and Cement Floors	33.6	22 4	....	....	....	....	12.1	8.6	9.0	6.4	....	....
Mason Work—												
Cut Stone	8.3	5.6	2 2	2.0	2.9	2.5	1.9	1.4	0.9	0.7	2.2	0.9
Coping	0.6	0.4	20.4	18.0	26.0	22.0	1.0	0.7	17.8	12.7	52.2	21.6
Brickwork	27.7	18.5					25.8	18.3				
Mill Work and Glass	12.8	8.5	12.0	10.7	11.7	9.9	9.6	6.8	11.6	8.3	43.9	19.0
Lumber	26.5	17.7	20.0	17.8	12.5	10.6	15.0	11.0	11.0	7.9	32.3	14.0
Carpenter Labor	7.0	4.7	10.6	10.5	7.8	6.6	9.6	6.8	3.6	2.6	9.1	3.9
Gravel Roof	1.9	1.3	2.8	2.5	3.3	2.8	5.0	3.5	5.0	3.7	9.3	4.0
Sky-lights	0.7	0.5	19.0	17.0	20.8	17.7	7.4	5.3	6.6	4.7	....	....
Sheet Metal Work	7.0	4.7	2.2	2.0	2.9	2.4	4.0	2.8	4.3	3.0	1.8	0.8
Hardware	4.4	2.9	....	....	....	....	....	....	0.6	0.4	....	....
Painting	8.1	5.40	4.6	4.1	3.7	3.1	3.7	2.6	1.1	0.8	5.4	2.3
Plumbing	8.3	5.5	....	....	....	....	11.3	8.0	....	....	9.4	4.1
Sewers											5.2	2.2
Wiring and Lighting	....	....	....	....	....	....	2.0	1.4	2.8	2.0	4.9	2.1
Heating (does not include power plant apparatus)	....	....	....	....	....	....	11.0	8.0	22.5	16.0	19.1	8.2
Piping—Air, Water, Oil, Steam	....	....	6.2	5.5	....	....	8.0	5.6	....	....	46.2	20.0
Blast-pipe and Blower	....	....	....	....	....	....	....	....	....	....	6.0	2.6
Machine Foundations	....	....	....	....	....	....	....	....	....	....	4.1	1.8
Hammer Foundations	....	....	....	....	....	....	....	....	....	....	9.6	4.1
Shafting Hangers, Belts, Motor	....	....	....	....	....	....	....	....	....	....	13.6	5.9
Furnaces and Foundations	....	....	....	....	....	....	....	....	....	....	24.0	10.4

Labor Excavating, laying and backfilling standard pipe, 125 per cent of cost of material; for lidded pipe, 150 per cent. Electrical tile ducts, 3¼ cents per duct foot or 13 cents per lineal foot of 4 duct conduit. Add 125 per cent for labor.

Percentage tables of cost of buildings are often given in books on estimating, but they are based on the complete cost of the building and some items are given in one table and not in others. This makes such tables almost useless. Table XII. is compiled from the best of these, but is based on the cost of the structural steel which cost does not vary so much as many of the other items. The prices of steel work of different classes previously given includes all expense and profit. Therefore, in making up the total sum for use as a basis for using the table, make allowance only for contingences of 5 to 10 per cent according to the thoroughness with which the quantities are estimated. It should be noted that the cost of skylights is about 15 times as much as gravel roof per square foot. When using the table, the per cent and cost should be increased to the basis of 4 cents per square foot for the roofing when there are no skylights and galleries.

TABLE XIII. POWER PLANT—EFFICIENCY AND COST.

Based on units of 500 Horse-power.

(MACHINERY, February, 1905; Sibley Journal; Author's personal records.)

	Type of Engine.	Result.	Steam, Pounds, per I. H. P.	Coal, Pounds, per I. H. P.	Coal, Pounds, per K.W. Hour.	Proportional Value, Per Cent.	Fuel, Interest, Depreciation per year, Dollars F=$2.00, I=5%, D=10%.	Labor per H.P. Per Year, Dollars, 9-hour Day.	Boiler H.P. per Engine H.P.	Cost per Engine H.P., Dollars.										Total Cost of Plant, 1000 Engine Horse-power.
										Engine.	Generator, Switch Board, Station Wiring.	Boilers.	Pumps, Condensers, Heaters.	Piping, Foundations.	Stack and Breeching.	Stokers Erected.	Water Softener.	Power House Crane, Coal Handling Apparatus.	Total per Engine H.P.	
Non-condensing.	Simple Slide Valve.	Average	34.3	4.63	6.9	53.1	42.16	6.50	1.135	8.00	22.00	13.60	2.00	6.00	a*–4.44	3.80	3.20	27.50	90.54	90,000
		Best	31.6	4.61	....	....	....	....	....	....	....			....	b –2.33	....	....	....	....	....
	Simple Corliss Valve.	Average	28.3	3.45	5.65	64.5	....	....	0.933	12.00	22.00	11.20	2.00	6.50	a –3.69	3.15	2.80	27.50	90.84	90,000
		Best	26.9	3.01	....	....	....	....	....	....	....	....	....	....	b –1.92	....	....	....	....	....
	Comp. Slide Valve.	Average	30.7	4.17	6.12	60.2	....	....	1.00	11.00	22.00	12.00	2.00	7.00	a –3.91	3.35	2.80	27.50	90.56	90,000
		Best	....	....	....	....	....	....	....	....	....	....	....	....	b –2 05	....	....	....	....	....
Condensing.	Comp. Slide Valve.	Average	22.7	3.25	4.57	80.5	....	....	0.75	11.00	22.00	9.00	4.00	7.50	a –2.93	2.50	0.25	26.00	84.68	85,000
		Best	16.7	2.40	3.60	....	....	....	....	....	....	....	....	....	b –1.54	....	....	....	....	....
	Turbine	Average	....	....	....	....	....	....	0.67	26.75		8.00	6.25	7.90	a –2.62	2.25	0.25	20.00	74.02	74,000
		Best	....	....	....	....	....	....	....	....	....	....	....	....	b –1.38	....	....	....	....	....
	Comp. Corliss Valve.	Average	18.2	2.36	3.64	100	23.20	4.80	0.602	16.00	22.00	7.00	4.00	8.00	a –2.35	2.00	0.25	25.50	87.10	87,000
		Best	14.5	1.80	2.7	....	....	....	....	....	....	....	....	....	b –1.24	....	....	....	....	....

* a = brick stack. b = steel stack.
Fuel, labor, interest, depreciation:
Cost per engine H P. per year, large machine tool shop, $37.00 } running 6000 hours per year.
Cost per K.W. hour of current consumed, 1.4 cent }

TABLE XIV. RECENT BIDS ON VARIOUS SIZES OF ENGINES, GENERATORS AND TURBO-GENERATORS, PER HORSE-POWER.

Nominal Engine Capacity. .... Nominal Generator Capacity...	300 H P. 200 K W	450 H.P. 300 K W.	750 H P. 500 K.W.	Two 750 H.P. 500 K.W.	Foundation.	Condenser.	Piping.	Switch Board.	Total per H.P. for 1500 H.P.
Engine..................	$21.20	18.80	14.45	14.45	2.50	4.50	3.39	3.69	$36.38
Generator.	14.78	10.85	7.85	7.85					
Turbo-generator..........	....	....	23.30	23.30	1.25	4.50	3.39	3.45	35.89

When using this table for "snap" estimates, add to the total sum, which represents the cost of the buildings alone, the cost of all items necessary to bring the buildings and equipment to an operative basis. The moving of the equipment from the old shops, and the repairing of old machines, should not be forgotten. The hints given in the previous installments of this series will aid in making a complete estimate. It is doubtful if there has ever been an estimate made on the cost of shop improvements that has not been exceeded by the actual costs, as invariably the tendency is towards adding equipment, or making some things better than intended.

Description of Shops in Table XII.

Shop No. 1. Machine shop, four story, high-class, 100,000 square feet floor space; steel frame; concrete floors. Live loads: second floor, 250 pounds per square foot; third and fourth floors, 200 pounds each. Roof: 2 x 6-inch plank, slag and tar, load 50 pounds per square foot. Ground floor: concrete with sleepers and 1⅛-inch maple top floor; upper floors 1⅛-inch maple. Windows, 65 per cent of wall surface. Two stair towers; two elevator shafts; one closet tower outside of main floor space

Shop No. 2. Machine shop, 150 x 400 feet, with 37 feet gallery, 40 feet to eaves. Heavy work.

Shop No. 3. Machine shop, 150 x 300 feet, 40 feet to eaves, no gallery; heavy wood floors.

Shop No. 4. Foundry, 31,000 square feet floor space. Sand floor, 30 x 220 feet; main floor, molding sand, 115 x 220 feet; wash room, 31 x 75 feet, cement floor.

Shop No. 5. Foundry, 130,000 square feet. Sand floor, 30 x 450 feet. Brick curtain walls. Office. Wash room, 32 x 120 feet. Yard crane runway included.

Shop No. 6. Forge shop, 13,000 square feet, 25 feet to eaves. Dirt floor. Trolley hoist runway inside of building and over storage yard outside.

Second Section—Power Plant Equipment.

Boilers.—Horizontal water tube, highest grade; units of 260 or 300 boiler horse-power, F.O.B. site, $10.00 per horse-power. Foundations, $1.00 per horse-power. Boiler setting with No. 1 fire-brick in first two passes, $2.25 per horse-power. Boiler room piping, $2.50 per horse-power. Breeching, $0.75. Stokers, $3.80; setting, $0.15, but deduct $0.60 for grates and fronts not used. Stacks: Steel stacks, guyed, one stack to each unit, $1.80 per horse-power. Self-supporting, one stack to 2 units, $2.50 per horse-power erected. Radial brick stacks, one for complete plant, 150 feet high with fire-brick core 50 feet high, $3.90 per horse-power. Balanced draft, $5.00 per horse-power (reduces the cost of the stack 50 per cent). Feed water heaters, $0.50 per horse-power. Water softening apparatus for 1,000 horse-power, $2.80 per horse-power (non-condensing plants or where jet condensers are used). Vertical water tube boilers, with stack on foundations, ready for steam and water connections, $13.00 per horse-power. Engine room equipment is given in Table XIII. Coal-handling apparatus: Track hopper and bucket conveyor to pockets, capacity 20 tons per hour, erected, $7,650.00. Coal pockets, roofed, with chutes and measuring gages to stokers, capacity 300 tons, erected, $6,050.

Third Section—Miscellaneous.

Conveyors.—Belt, 18-inch erected on steel supports, $11.50 per lineal foot of conveyor; 24-inch, $15.00 per lineal foot. If on wooden supports, $1.00 less for each size. Vertical bucket conveyors, $20.00 per foot of lift. Track hoppers, unloading from drop bottom cars, $250.00 erected.

Locomotive Cranes.—15 ton capacity and with power and speed sufficient for use in switching, with cab enclosed, and

double drum arranged for handling two line grab bucket, complete with ballast ready for use, $6,500.00.

Grab buckets.—Single line, 25 cubic feet capacity, $1,100.00; 45 cubic feet, $1,300.00. Two line buckets, $350 and $500.

Cranes.—Traveling, erected, 15 ton, 50 feet span, $3,700, with auxiliary hoist, $550 additional; 10 ton, 50 feet span, $3,500; 5 ton, 50 feet span, $3,000; 25 feet span, $2,000; 3 ton, 25 feet span, $1,500; 3 ton trolley hoist, $1,250.

Elevators.—Belt driven freight elevators, erected, 3 ton, 40 feet per minute, $900; direct driven electric, 3 ton, 75 feet per minute, $2,500; 30 feet per minute, $1,700; hydraulic, 25 feet lift, 75 feet per minute, $2,000; 50 feet per minute, $1,200.

Contracting and Purchasing.

In every case the engineer must ask for bids. The various building contractors should be considered on the following points: Commercial integrity and general reputation; capabilities for handling contract in connection with other contracts on hand; organization and speed of execution of large contracts of the class of construction required; quality of workmanship; freedom from labor troubles. It will be found that the number of desirable bidders, when critically examined, is not large in any particular locality, still a list can be made, not neglecting those who can handle small contracts well, and rated according to the size of contract that each can handle.

General contractors will generally use the lowest bids from sub-contractors in making up their bid. The engineer should require that a list of sub-bidders should be furnished and approved by him, as often the best contractors on parts of the work will not put in bids to the general contractor, but will bid direct. It is well to encourage the smaller bidders in this practice, as the engineer can study their efficiency and reliability. The advantage to the engineer lies in obtaining accurate data of cost of various parts of the work and being able to guard against combinations and unbalanced bids.

Classes of Contracts.

Competitive bidding and a lump sum contract (at the present time) is probably the most satisfactory to the owner, and will enable the total cost to be known in advance of the commencement of work. The cost-plus-a-percentage-plan is greatly in the contractor's favor, as the greater the cost the greater the contractor's profit and there is no incentive to rush the work. The cost-plus-a-fixed-sum-plan is the best if operations must be commenced before thorough plans and specifications can be prepared.

It eliminates the element of risk to the contractor, but throws a great deal of work and worry onto the owners that would be assumed by the contractor under a lump sum contract. As to speed, that depends entirely on the organization of the contractor's forces and his desire to make a reputation for rapid execution of contracts. His pecuniary interest is no greater if the work progresses rapidly than if it lags. With a lump sum, the rapidity of construction almost always tends to larger profit to the contractor without any addition to the amount that the owner has reconciled himself to pay.

Form of Contract.

Without going into the legal points of engineering contracts, the more important particulars are: Definiteness of statement regarding the work included in the contract and that the drawings and specifications are a part of the contract and equally binding with the clauses of the contract proper; the terms of partial and complete payments and the conditions of acceptance of the work prior to such payments; provision for completing the work in the event of the contractor failing in the performance of the work or otherwise violating the terms of the contract; liquidated damages for non-completion of contract in the prescribed time; provision for the extension of the time in which the contract is to be completed according to changes and causes beyond the contractor's control. The "uniform contract" recommended by the American Institute of Architects is in the main satisfactory to both owner and contractor.

Regarding mechanics' and other liens, the engineer should investigate the State laws and protect his principals from a double payment in the event of the contractor failing and leaving material and work unpaid for.

Purchasing Equipment.

The conditions governing the purchasing of equipment are of a different nature from those pertaining to the building trades, but where specifications are drawn by the engineer for equipment, the same care should be exercised in stating definitely what is wanted

Generally the only specifications that need be drawn by the engineer are: that the apparatus shall perform a given amount of work in a given time; that this amount shall be guaranteed under actual working conditions; that in the installation the maker shall instruct in the operation; that the apparatus shall be erected and operated and tested to fulfil the guarantee; that repairs during a year caused by defects and workmanship shall be charged to the maker; that the efficiency or cost of operation shall be stated as a part of the guarantee.

* * *

GUARD FOR EMERY WHEELS.

The half-tone below illustrates a simple but effective guard for emery wheels, brought out by the Vereinigten Schmirgel- und Maschinenfabriken, Hanover-Hainholz, Germany, and illustrated in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, Nov. 25, 1908. A particular feature of this guard, outside of its adjustability to different sizes of emery wheels, is also the elastic construction which provides for absolute safety in case the wheel should burst. In case of ordinary cast iron guards, it often happens that the emery wheel, bursting when running at high speed, breaks the guard also and scatters pieces of the guard around the room. The severity of injuries is, of course, lessened by the resistance of the guard, but damage is not entirely eliminated. In the guard shown in the illustration herewith, however, the parts of the wheels strike against a corrugated band, composed of several laminations of sheet steel. On account of the corrugated construction, the guard possesses an elasticity which aids in preventing breakage of the steel laminations in case of accident. Experiments have been undertaken by the manufacturers to ascertain the ability of the guard to withstand the bursting of wheels, and these experiments have been highly successful.

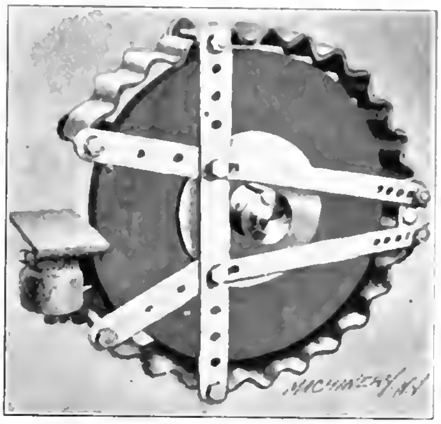

Fig. 1. Elastic Emery Wheel Guard which is able to withstand Severe Shocks.

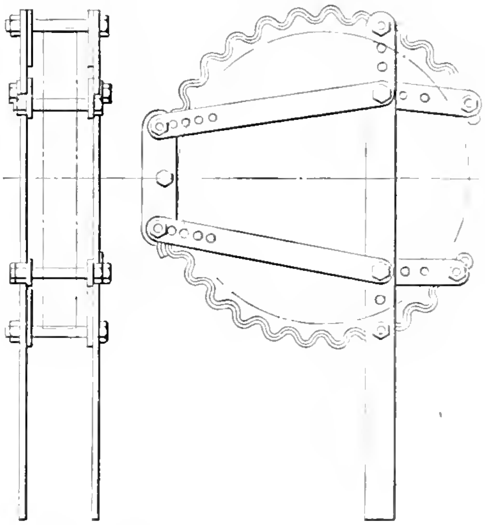

Fig. 2. Elevations of the Corrugated Guard.

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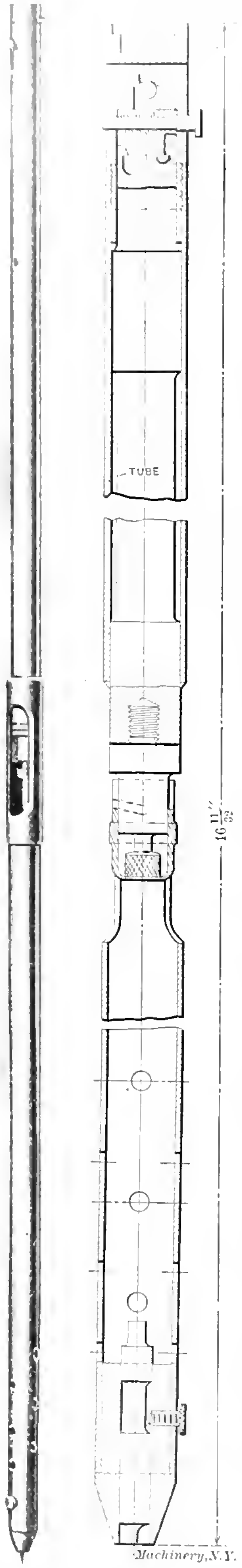
The largest concrete arch bridge in the world was recently completed in Switzerland. It comprises a central arch of 259¼ feet and six 33-foot arches in the approaches.

BALLENTINE HARDNESS TESTING DEVICE.*

In the September issue of MACHINERY, the Brinell method of testing the hardness of metals was described in an extended article. The principle involved in testing the hardness of metals by this method is based on the fact that the hardness of metals may be compared by recording the resistance of the metal to indentation. If indentations are made in various substances by the same force transmitted through the same medium, the relative hardness of different materials can be measured by determining the dimensions of the indentations. This is, in principle, the system employed by the Brinell apparatus.



Figs 1 and 2. General View and Section of Ballentine's Hardness Testing Device.

The fact should not be overlooked, however, that the measuring of the dimensions of such indentation is more or less difficult to accomplish accurately, and the method requires special instruments for obtaining the indentation, and for measuring the amount of depression in the metal tested. In order to overcome this difficulty, a means known as the Ballentine method and apparatus for quickly and accurately determining the resistance to indentation of a material has been devised and constructed.

The method employed by Mr. Ballentine consists in allowing a hammer of specified weight to fall through a specified height on an anvil to which is connected a pin which rests on the specimen to be tested. An indentation in the material is obtained, but the resistance encountered, instead of the dimensions of the indentation, is measured. This resistance is measured by the blow of the hammer being transmitted to the test pin through a soft metal recording disk located at the lower end of the hammer. This disk affords a constant resistance to deformation, and will be indented to a depth varying in proportion to the resistance the pin encounters in indenting the material tested. The recording disk is usually made from lead.

The accompanying half-tone and line engraving show the general appearance and a sectional view of the apparatus, which consists of a guide tube encasing the drop hammer which at the lower end is provided with a small anvil to which is clamped a lead disk. At the upper end the hammer is held at the top of the tube by a spring latch. At the lower end of the tube a test pin holder is located, in which are inserted the test pins for testing the various materials. The upper end of the test pin holder is provided with an anvil of the same diameter as the one on the lower end of the hammer. A small spirit level is inserted in the top of the tube for leveling the apparatus, and two small slots are cut in the guide tube for inserting and removing the recording disks. The apparatus can be used to test all materials which can be ordinarily machined by steel cutting tools, but cannot be used for hardened steel and similar materials which are too hard to be indented in this manner. Two test pins are provided, one for soft materials such as lead and babbitt metals, and another for harder materials such as iron and steel. The pin for hard material is very short and small in diameter while the pin for soft material is longer and larger in diameter.

The testing can be made either on small test specimens or directly on large parts in process of manufacture, the great advantage of this hardness tester being that it is entirely self-contained and well adapted for either laboratory or general shop use. To make a test it is only necessary to smooth off a surface on the specimen to be tested, and clamp it firmly to some rigid body.

Fig. 3. Lead Recording Disk, Before and After Test.

In Fig. 3 is shown a lead recording disk before and after the test. These disks are made within 0.0015 inch of nominal size from a material as nearly of uniform density and hardness as obtainable. The disk is measured with a micrometer before being placed on the drop hammer. When the test has been made, the thickness of the metal between the two recording anvils is again measured, and the difference between the two dimensions will indicate the resistance to indentation or the hardness of the material tested. If, for instance, the disk measured 0.300 before the test, and 0.156 after the test, the difference, 0.144 inch, indicates the hardness of the material, and this hardness would be known as No. 144. The device is manufactured by Tinius Olsen & Co., 500 N. 12th St., Philadelphia, Pa.

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REMARKABLE RESULT OF COMBINING ALLEGED MACHINE EFFICIENCIES.

The following ingenious invention of a combustion motor for automobiles is described in *Svensk Motortidning.* A promising young inventor was grappling with the problem of bringing out an economical 20-horse-power combustion engine, and in doing so he studied a great many trade catalogues of accessories for engines of this kind. His investigations led him to the conclusion that by judicious selection of integral parts of the machine he would be able to bring out an engine which would come very close to becoming a perpetual motion machine. He obtained guarantees from various firms manufacturing the smaller details as to the amount each would save in fuel, and constructed an engine provided with a special carbureter, saving 30 per cent, and provided with bearings of special metal saving 12 per cent of the fuel. A governing apparatus saving 18 per cent was applied to the engine, and besides a muffler saving 10 per cent, an automatic lubrication system saving 15 per cent, a patented valve arrangement saving 11 per cent, and finally a system of ignition guaranteed to save 5 per cent; adding up his percentages of saving the inventor found that he had saved exactly 101 per cent of the fuel required. Allowing the superfluous one per cent for frictional and undetermined losses, he thus found that by the combination of the above inventions he had obtained an engine which would work without any fuel whatever, and he naturally made application for a patent on the combination of these wonderful apparatus. The principle is so simple that it is almost irritating that one did not think of it oneself. The invention reminds us of the planer salesman who, among other things claimed for his planer, said that while it took a great deal of power to start it, when once started, it ran so easily that it actually at times would drive the engine.

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* For previous articles on testing apparatus see: "The Brinell Method of Testing the Hardness of Metals," September, 1908, and "A New Mechanical Test of Hardness" (Shore's scleroscope), by J. F. Springer, October, 1908. [illegible] of testing metal hardness are Prof. Turner's diamond test and [illegible] Keep's drill tests.

HOW MANY GASHES SHOULD A HOB HAVE?

RALPH E. FLANDERS *

The question of how many gashes to cut in a worm hob, particularly if the hob is multiple-threaded, has always been a puzzling one for most mechanics, including in that number the writer of this article. Until recently he had supposed that the only requirement that had to be met in this matter was that discovered by Mr. Beale, of the Brown & Sharpe Mfg. Co., at the time the writer was employed by that firm. This requirement is that the number of gashes must have no common factor with the number of threads in the worm. That is to say, if the worm is quadruple threaded, the number of gashes should be 9 or 7 rather than 8. If the work is sextuple threaded, the number of gashes should be 7 or 11 rather than 8, 9 or 10. This is one requirement, but there seem to be other factors that enter into the decision as well. These were brought to the attention of the writer by Mr. N. B. Chace, superintendent of the Cincinnati Shaper Co., in his attempt to get a hob that would cut smooth, regular teeth for the worm-wheel of the spindle drive in a machine he was building.

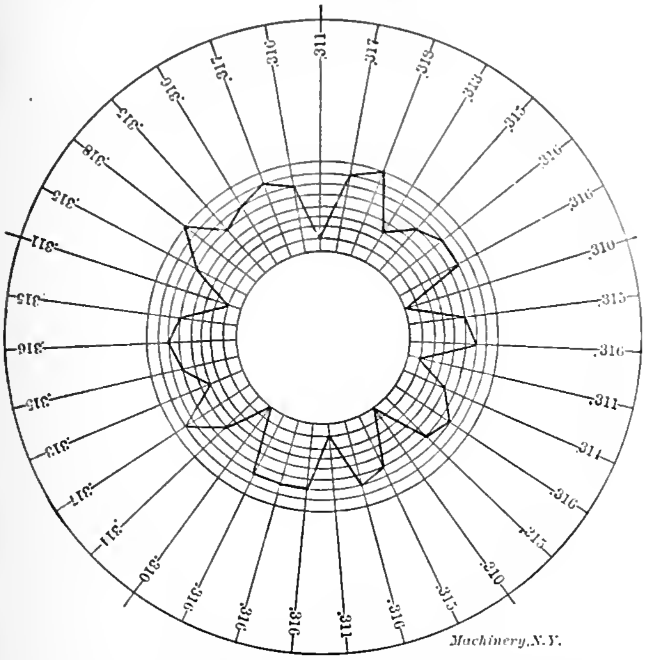

Fig. 1. Thick and Thin Teeth, produced by Incomplete Generating Action on the Part of the Hob.

The worm-wheel of this drive had 35 teeth. The worm had 7 threads and a lead of 5 inches. The number of flutes or gashes in the hob was 9. These gashes were milled spirally so that they were at right angles to the thread. The hob was made by a well-known firm which makes a specialty of such work; it was proved by subsequent tests to be accurately and finely made, and altogether a very creditable piece of work. Do what he could, however, Mr. Chace was unable to hob worm-wheels that would be satisfactory. When tried in place in the machine and run with the worm, each one appeared to have five low spots, something as if the pitch line were a pentagon instead of a circle. The wheels were taken out and the thickness of the teeth in the center of the throat at the pitch line measured as accurately as possible. The results of one of these tests, made at the time of the writer's visit, is shown in Fig. 1, where it will be seen that there is a regular recurrence of thin teeth in each fifth of the circumference of the wheel with less marked series of fine intermediate thin teeth. The diagram in the center of the figure shows graphically (by the exaggerated radial distance from the center), the variation in the measurements obtained. The first thought would naturally be that the hob had warped out of true in hardening, in which case the ratio between the worm and the wheel of 5 to 1 would give the error indicated; but careful measurements failed to detect any error of this kind, either in the periphery of the hob or on the sides of the cutting edges.

The Imperfect Generating Action of the Hob.

To find what was really the trouble with the hob (or rather, with the work of the hob, for the hob was found to be all right), it will be necessary to study its action in cutting a worm-wheel. The diagram in Fig. 2 will serve to illustrate some of the important points connected with this action. In the upper part of the diagram at the right is shown an end view of a single threaded hob having six gashes. To the left of this is shown the pitch cylinder of the hob with a helix traced upon it, representing the center of the thread. Lines parallel with the axis of the work are drawn on this pitch cylinder, representing the intersection of the faces of the teeth with the cylinder. The intersections of the helix with these lines at *a*, *b*, *c*, *d*—*q*, represent the positions on the pitch cylinder of the center of each of the teeth of the hob. Below this representation of the pitch cylinder is shown a development of its circumference through an axial length equal to the linear pitch of the worm, represented in this case by the distance *c i*. On this development, the tooth helix between *c* and *i* becomes a straight line, as shown, and the center of the tooth faces *c*, *d*, *e*, *f*, *g*, *h* and *i* are developed, as before, by the intersection of this tooth line with equally spaced horizontal lines representing the six gashes in the circumference. Below this development of the circumference of the hob is shown a series of outlines of the cutting edges of the hob, each one of which has its center directly below the corresponding center c_1 d_1, etc., in the development. These outlines evidently represent the successive positions of the teeth of the hob as they pass the plane of the throat of the worm-wheel in hobbing its teeth. There are seven of these positions, but as one of them belongs to the next section of the hob, from *i* to *o*, the diagram shows six positions of the hob teeth in the linear pitch of the hob.

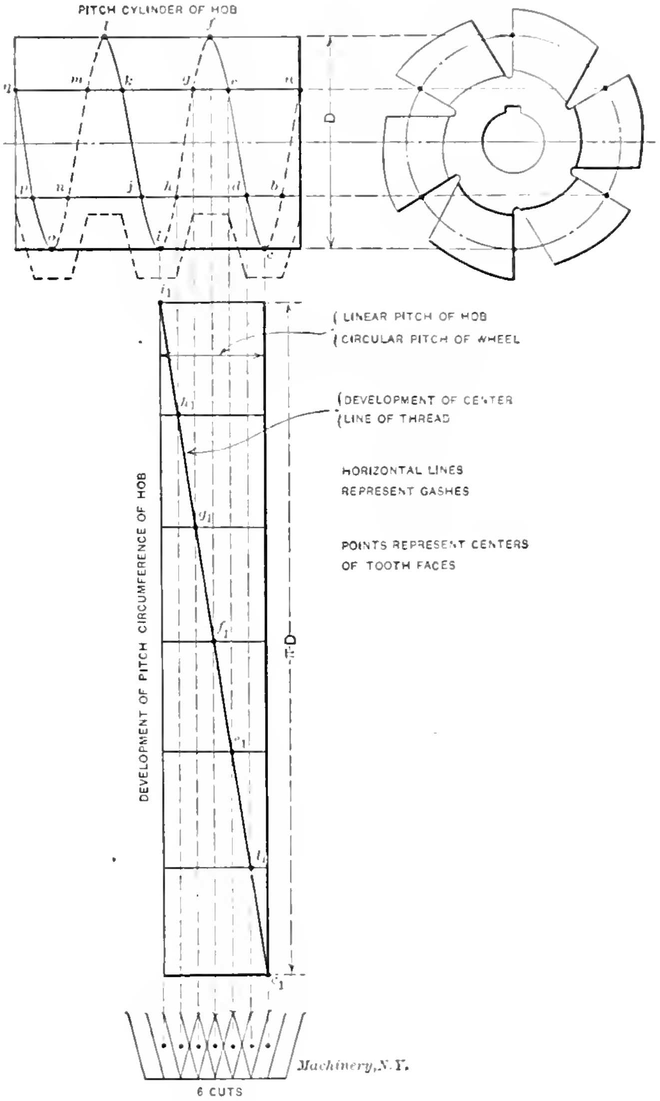

Fig. 2. Finding the Number of Cuts per Linear Pitch.

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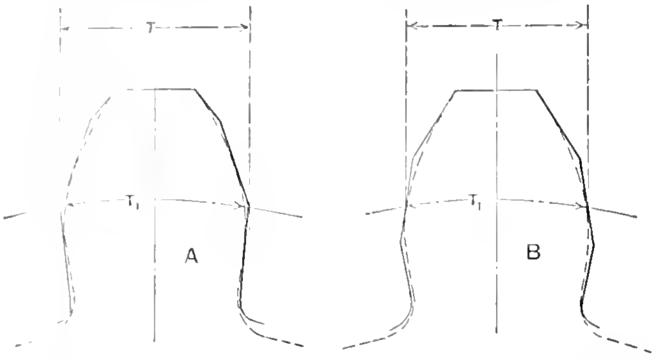
* Associate Editor of MACHINERY.

This means, of course that the hob does not accurately generate a tooth of the wheel, since it acts on it only in the six successive positions shown, instead of continuously throughout the whole distance of the circular pitch. In order to get smooth accurate teeth, the number of cuts in the linear pitch must be made as many as possible; the more there are, the more nearly perfect would the generating action be; the less there are, the rougher will be the tooth. Now, as will be shown later, there is but *one* cut per linear pitch in the example mentioned in the second paragraph of this article. Under these circumstances, the teeth of the worm, instead of being smoothly generated to a curve, are only slabbed out by a series of flat cuts, as indicated in Fig. 3. The reason for the five thin teeth in the circumference is now evident. At every fifth of a revolution those teeth of the hob which formed the outline near the pitch line of the gear gave it a shape similar to that shown at the right of the engraving. In the thick teeth, the conditions shown at the left are found, where the outline of the tooth at the pitch line is formed by cuts so placed as to make corners at this point instead of flats as at the right. This means that the teeth measured on the pitch line are thick at one point and thin at the other, giving high spots, as found by running the wheel with the worm, and as indicated also by the measurement shown in Fig. 1. The reason for the intermediate thin spots between the even fifths is not clear from the preceding explanation, but they are doubtless due to the particular arrangement of the flats on the tooth outline which happens in this particular wheel.



Machinery,N.Y.

Fig. 3. Example of Thick and Thin Teeth from Incomplete Generation.

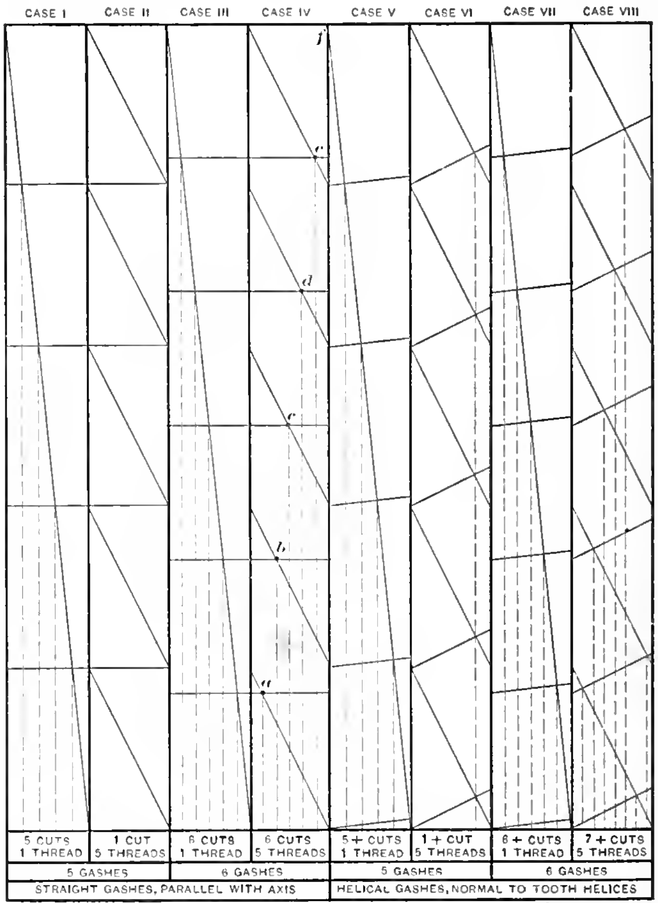
Diagrams for Finding the Number of Cuts per Linear Pitch.

It is evidently a simple matter to draw diagrams for any case showing the development of one linear pitch on the pitch surface of the hob, as in Fig. 2, and find out from that diagram how many cuts the hob gives in that distance. In Fig. 4 eight such diagrams are shown, for eight different cases. The first case is a single threaded hob, having five gashes. This diagram, which is similar to the one in Fig. 2, shows that there are five cuts to the linear pitch. In the second diagram a hob of the same diameter and the same linear pitch having also five gashes, but quintuple instead of single threaded, gives but one cut to the linear pitch. This is evidently a very bad condition and one to be avoided, if possible, and it is evidently brought about from the fact that the number of gashes is the same as the number of threads. In the third and fourth cases the number of gashes has been increased to six, with a single thread in one case and a quintuple thread in the other. In each case there are six cuts to the linear pitch. The fifth and sixth cases are the same as the first and second, except that the lines representing the gashes have been drawn at right angles to the lines representing the tooth helices as would be necessary for hobs which are gashed helically in a direction normal to the tooth helices. These cases will be seen to correspond to Nos. 1 and 2 except that the number of cuts has been increased in proportion to the cosine of the gashing angle, so that we have 5 + cuts for case five, and 1 + cuts for case six. In cases seven and eight are shown the same conditions as in cases three and four, except that the hob is gashed helically. In this case, also, the number of cuts is increased in inverse proportion to the cosine of the gashing angle, giving 6 + and 7 + cuts respectively for the two cases, the hobs having six gashes each.

In Fig. 5 are shown four more cases, considerably more complicated than those in Fig. 4. Here are four hobs, all of the same linear pitch and pitch diameter, and all octuple threaded, with threads of the same lead and helix angle, the only difference in the four being in the number of gashes and the method of cutting them. In Cases IX and XI there are eleven gashes, and in cases X and XII there are twelve. Cases IX and X are gashed parallel with the axis. This, of course, would be utterly impracticable in any hob having threading angles as great as those shown here, so the example is not a practical one, being used only for the sake of illustrating a principle. Cases XI and XII which are gashed helically and normally at right angles to the threads, represent what would be the practical construction of these hobs. Projecting the intersections of the thread lines with the gash lines, down to the bottom of each diagram, we get for Case IX, eleven cuts linear pitch; for Case X, three cuts to a linear pitch; for Case XI, 38 + cuts; and for Case XII 11 + cuts.

The Effect of the Number of Teeth in the Wheel.

But there is still another factor entering into this problem—the number of teeth in the wheel. This is the factor which gave so much trouble to the superintendent in the job mentioned at the beginning of the article. Take, for instance, Case IV in Fig. 4. Suppose that the quintuple threaded, six-gashed hob represented by that diagram, were cutting a 25-tooth wheel, it would not give the six cuts indicated by the diagram. The reason for this will appear by comparing Case IV with Case III. In Case III, where the hob is single threaded, all of the cuts represented by the points of the intersections of the thread and gash lines, are along the same thread. In Case IV, however, each of the five thread lines in the diagram has but one intersection. That means that if the number of teeth in the gear, as in the supposed example, is a multiple of the number of threads in the worm or hob, each of those threads will come back into the same tooth spaces in the wheel at each revolution of the latter, so that for each tooth space there is but one cutting



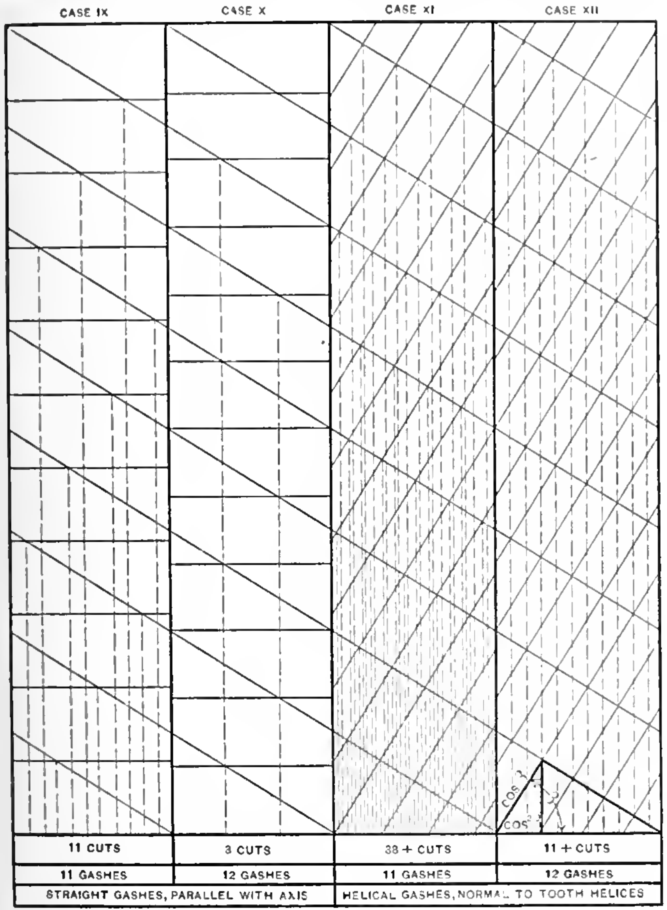
Machinery,N.Y.

Fig. 4. Diagram for Finding the Number of Cuts per Linear Pitch.

position of the hob tooth—that represented, for instance, by point *a* for one of the tooth spaces, point *b* for the next, *c* for the next, and so on. If, on the other hand, there were 26 teeth in the wheel, the first time it went around, point *a* would cut in a certain tooth space; the second time around point *b* would come in the same space, and the third time around point *c* would follow, so that each tooth space would get the benefit of each one of the six cuts, the same as in the single thread worm for case three. It is thus seen that, besides the other points mentioned, the number of teeth in the wheel has an effect on the number of cuts of the worm per linear pitch. In the practical case mentioned in the opening paragraph, there was a 35-tooth worm-wheel and a 7-threaded worm, giving the worst conditions possible.

A General Formula for Determining the Number of Cuts.

From the preceding description it will be seen that there are three points to be taken into consideration in determining the number of cuts per linear pitch (and the consequent generating efficiency of the worm) from the number of gashes in the hob. These factors are: First, the relation of the number of threads of the hob to the number of gashes. Second, the angle of the gashing. Third, the relation of the number of threads of the hob to the number of teeth in the wheel to be cut. [It might be considered that there is a fourth factor, that of the absolute number of teeth in the wheel, since the trouble that comes from a small number of cuts per linear pitch is exaggerated in the case of a wheel having very few teeth. This is not a matter of calculation, however, and would not enter into the calculations anyway, since for any given case for which a hob is being designed, the number of teeth in the wheel is determined approximately at least.]



Machinery,N.Y.

Fig. 5. Diagram for Finding the Number of Cuts per Linear Pitch.

Now, instead of drawing diagrams such as shown in Figs. 2, 4 and 5, it would be better if a simple mathematical expression could be obtained which would give the number of cuts per linear pitch directly. This can easily be done. The effect of the number of gashes with relation to the number of threads is as follows: *The number of cuts per inch varies inversely with the greatest common divisor of the number of threads and the number of gashes in the hob.* The influence of the number of teeth in the wheel is a similar one and may be expressed as follows: *The number of cuts per linear pitch varies inversely with the greatest common divisor of the number of threads in the worm and the number of teeth in the wheel.* The effect of the angle of the gashing may be expressed as follows: *The number of cuts per linear pitch varies inversely with the square of the cosine of the gashing angle, measured from a line parallel with the axis of the hob.* These statements are combined in the following formula:

$$X = \frac{G}{D \times D' \times \cos\beta}$$

in which

G = number of gashes,

β = angle of gashing with axis,

D = G. C. D. of number of threads and number of gashes in hob,

D' = G. C. D. of number of threads in hob and number of teeth in wheel,

X = number of cuts per linear pitch.

G. C. D., of course, stands for "greatest common divisor."

It is easier to see the relationships expressed above, from the foregoing diagrams and description, than it is to explain them. These relationships, though quite simple, are rather elusive. Perhaps, however, the effect of the angle will be understood from the figuring of the triangle at the base of the diagram for Case XII. Note that the formula is true only for the usual cases in which the gashing is either helical and normal to the threading, or straight and parallel to the axis. In the latter case, $\cos^2\beta = 1$, since $\beta = 0$ deg., and the effect of the angle disappears.

Applying the formula to the practical example given in the second paragraph, we have the following values:

$G = 9$,

$\beta = 20$ deg. (assumed, as the angle was not given),

$D = 1$ = G. C. D. of 9 (number of gashes) and 7 (number of threads),

$D' = 7$ = G. C. D. of 7 (number of threads) and 35 (number of teeth in wheel).

Solving for the number of cuts per inch we have:

$$X = \frac{9}{1 \times 7 \times 0.9397^2} = \frac{9}{6.181} = 1.45.$$

If the number of teeth in the wheel had been 36 instead of 35 the number of cuts would have been

$$X = \frac{9}{1 \times 1 \times 0.9397^2} = \frac{9}{0.883} = 10.19$$

which, it will be seen, would immeasurably improve conditions, giving a fine, smooth outline for this number of teeth in the wheel. In the actual wheel, as cut by the hob, the slab-sided effect shown in Fig. 3 was very noticeable, there being about three cuts to each face of the tooth.

Hobbing Methods which give a Complete Generating Action.

It should be noted that while this faulty generating is liable to occur with hobbing by the usual method of sinking the cutter in to depth in a blank, the same difficulty does not occur in the fly-tool process or in a machine using a taper hob fed axially past the work, as described for the Atlas, Eberhardt Bros., Wallwork and Reinecker machines referred to in the article on "Gear-Cutting Machinery" in the June, 1908, issue of MACHINERY. In the case of these machines, working with either taper hobs or fly-cutters, the number of cuts per pitch is, at the least calculation, the number of revolutions per linear pitch of advance of the cutter spindle; it thus runs up into the thousands, where the diagrams shown in Figs. 2, 4 and 5 give only from 1 to 38.

So far as the writer is able to see at present, this treatment of the hob question, suggested by the experiences of the superintendent of the western machine shop, takes care of all the factors which enter into a determination of the number of gashes to use in a hob, so far as this affects the accuracy of the generating action. Expressed briefly, the conclusions are:

Avoid having a common factor between the number of threads and the number of gashes in the hob.

* Avoid having a common factor between the number of threads in the hob, and the number of teeth in the wheel.

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* Owing to special conditions, Mr. Chace was unable to meet this requirement.

HELICAL SPRINGS.

HENRY L. HANSON *

The four tables accompanying this article (see Data Sheet Supplement) give the greatest allowable pressure or load in pounds, and the corresponding compression or deflection in inches per coil of helical springs of various sizes. The same values for helical springs of square steel with like diameters, may be found by multiplying the greatest allowable loads for round stock by 1.2 and the deflections by 0.59.

It is proper to state in the beginning that helical springs are not spiral springs, as they are so often miscalled by the majority of machinists, and even by mechanical engineers. A spiral spring is one in which the coils lie in the same plane, being wound around a center and continually receding from it the same as a watch spring. A helical spring is one that is wound around an arbor, advancing like the thread of a screw. A volute spring, in a sense, might be said to be a combination of the two, being shaped like a cone.

As will be seen from the Tables, the values given therein are for springs made of a good quality spring steel, varying in fiber strength from 80,000 to 150,000 pounds per square inch of section. The maximum fiber strength of the larger sizes of common spring wire or rods has been shown by repeated tests to be somewhat less than the figures given in the tables, but for the smaller sizes of wire the fiber strength obtained by test compares very favorably with the figures given. The greater strength of the small size of spring wire, no doubt, is due to the fact that it is drawn down from large stock, each draft increasing its strength because of the refining effect of the dies on the surface of the metal. In the large sizes, the proportionate increase of strength due to the refined metal is not so much. In fact, large sizes of helical springs often are made from rods or bars taken directly from the rolling mill.

The tables are based on the J. W. Cloud adaptation of spring formulas given in "Kent's Mechanical Engineer's Pocketbook" on page 351 where $P = \frac{S \pi d^3}{16R}$; and $f = \frac{32 P R^2 l}{G \pi d^4}$ in which

$P =$ load of spring,
$S =$ maximum shearing fiber stresses in bar,
$d =$ diameter of wire or rod,
$R =$ radius of spring, measured to center of wire,
$l =$ length of rod before coiling,
$G =$ modulus of shearing elasticity,
$f =$ deflection of spring under load.

The second formula becomes on substituting for P its value in terms of S: $f = \frac{2 R S l}{d G}$; and neglecting the difference between the circumference of a circle and one coil of a helix, it can be written: $f = \frac{64 P R^3}{d^4 G}$. A large number of tests were recently made with springs of various sizes of wire and diameters of coil to determine the accuracy of these formulas and of these tables compiled. On the whole the formulas and tables derived were found to be very close to the average results, especially on springs made from small wire.

The load for a spring, as given in the tables, is the greatest allowable pressure; therefore, a factor of safety should be used for all spring installation, depending on the nature of the service. A spring being made of elastic material and of such shape as will permit of great relative deflection, will not be affected by sudden shocks or blows to the same extent as a rigid body. Consequently, a factor of safety very much less than for the rigid members of a machine body may be employed. The factor of safety varies, of course, according to the service, and the following are considered good practice. For no vibration, use a factor 1.5; for moderate vibration, 2; and for incessant vibration, 3. To illustrate the use of the tables, a few examples will be given.

Example 1: What is the greatest allowable load for a spring made of ¼ inch round wire, 1¾ inch outside diameter? The mean diameter of the spring, which corresponds to the pitch diameter of a gear, is the outside diameter minus the diameter of the wire, and in this case is 1¾ inch — ¼ inch = 1½ inch. From Table II. we find that the greatest allowable pressure or load is 513 pounds, and that the deflection is 0.338 inch per coil.

Example 2: Assuming that the foregoing spring has 15 coils, close wound, how much is the extension under a load of 513 pounds? In calculating the deflection, we consider the two end coils as inoperative; this then leaves 13 working coils, and the entire deflection of the spring would be 13 × 0.338 inch = 4.394 inch.

Example 3: A spring made of ½-inch round wire, close wound, and 4 inches mean diameter, is used in tension subject to moderate vibration where the load is not known. How can it be ascertained whether the spring is overloaded or not? Referring to Table III., we find that the maximum deflection per coil of a spring of a given diameter is 1.040 inch. If the opening between the coils is less than 1.040 inch ÷ 2 = 0.520 inch (2 being the factor of safety for moderate vibration), the spring is safe. The deflection always is directly proportionate to the load. For example, what will be the deflection of a spring 6 inches mean diameter, made of ¾ inch round wire, when carrying a load of 1,000 pounds? From Table III we find that with a load of 2,770 pounds, the deflection per coil is 1.440 inch; then for 1,000 pounds the deflection per coil would be $\frac{1.440 \times 1,000}{2,770} = 0.520$ inch.

The designing of springs, when using these tables, becomes simply a matter of multiplying the load the spring is to carry by a proper factor of safety and then selecting a resultant pressure in the tables; from this, the diameter of the wire and the deflection can be found readily. Dividing the deflection given in the table by the same factor of safety as was used for the load, will give the actual deflection per coil, and adding this value to the diameter of the wire will give the pitch for a compression spring. The number of coils will depend upon the amount of movement the spring requires, and knowing this, we divide the length of movement by the deflection per coil, which gives the number of effective coils, and then add 1½ coils for the ends. As a rule, the mean diameter of a helical spring should be from 8 to 10 times the diameter of the wire.

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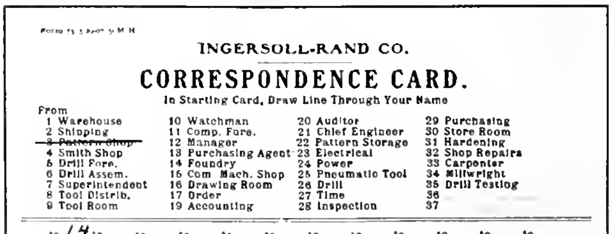
CORRESPONDENCE CARD FOR MFG. PLANTS.

In large manufacturing plants communications between the different departments are numerous, and any scheme that saves time and unnecessary writing in such correspondence is worthy of attention. The accompanying reproduction shows the head of the correspondence card used by the Ingersoll-Rand Co. Only a word of explanation is required to make its use clear. It will be noted that a list of departments is printed on the head, with numbers. If the foreman of the pattern shop, for example, wishes to communicate with the foundry, he simply draws a line through his own department and writes the number of the department to which the communication is to be sent. That constitutes all the direction necessary and identifies the source of the communication. If the note is to be sent on to another department with memorandum, the first number can be crossed off and a second number written in the places provided. Thus to forward the note from the foundry to the machine shop the number 15 is written in, the previous number 14 being crossed off.



INGERSOLL-RAND CO.

CORRESPONDENCE CARD.

In Starting Card, Draw Line Through Your Name

From
1 Warehouse
2 Shipping
~~3 Pattern Shop~~
4 Smith Shop
5 Drill Fore.
6 Drill Assem.
7 Superintendent
8 Tool Distrib.
9 Tool Room
10 Watchman
11 Comp. Fore.
12 Manager
13 Purchasing Agent
14 Foundry
15 Com. Mach. Shop
16 Drawing Room
17 Order
19 Accounting
20 Auditor
21 Chief Engineer
22 Pattern Storage
23 Electrical
24 Power
25 Pneumatic Tool
26 Drill
27 Time
28 Inspection
29 Purchasing
30 Store Room
31 Hardening
32 Shop Repairs
33 Carpenter
34 Millwright
35 Drill Testing
36
37

to 14 to to to to to to to to to to to

Size of sheet, 6 x 9½ inches.

THE MANUFACTURE OF TAPS—1.

While the methods involved in the making of a tap in the tool-room, when only one or a few tools are made at a time, are comparatively simple, and well-known to tool-makers and mechanics, the processes employed in the manufacture of taps in large quantities are entirely different from those which would be employed by the tool-maker. A great deal has been published in MACHINERY during the last few years regarding the design and construction of taps, but comparatively little has been published in the technical journals regarding the actual manufacturing processes employed by leading tap manufacturers. MACHINERY, therefore, obtained permission from the Wells Bros. Co. of Greenfield, Mass., to send an editorial representative to visit the works with the object of presenting to the readers of MACHINERY an illustrated description of the works and the methods employed.

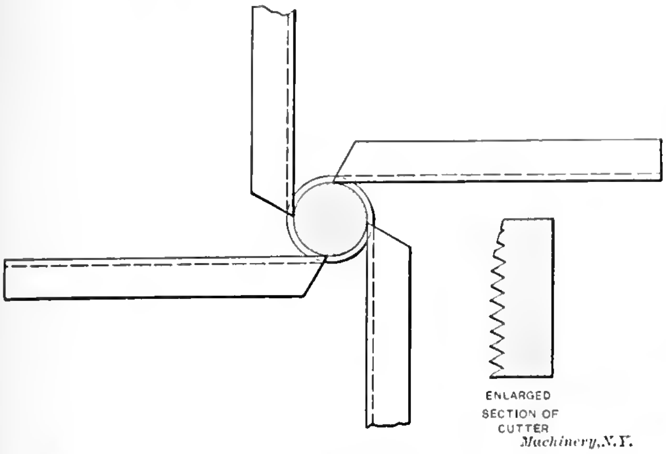


Fig. 1. Principle of Action of Dies with Inserted Chasers or Cutters, for Threading Taps.

It may well be said that Greenfield, Mass., although a small town of only ten or twelve thousand inhabitants, is actually the seat of the tap and die manufacture of the country. There are about half a dozen different firms in this town manufacturing taps and dies, and it is stated that 75 per cent of the total of these tools used in the United States is manufactured in Greenfield. The output of the Wells Bros. Co. constitutes a considerable proportion of this percentage.

History of the Wells Bros. Co.

The Wells Bros. Co. was started in 1876 by Messrs. F. E. Wells and F. O. Wells, who, together with their father, Mr. E. Wells, commenced the manufacture of taps and dies in a small factory. They began business with $1,100, and it is one of the remarkable features about the up-building of this concern that it has grown up entirely from this original investment, no money having ever been borrowed for the increase of the factory and equipment. At first the brothers employed no help. During the first year they met with some difficulties; the old factory which they occupied burned down six months after they had started business. Among the valuable things lost at that time was the tool chest of Mr. F. O. Wells, now president of the company, which contained a great many special tools employed in the making of taps, which he had been making for himself evenings, after having concluded the regular day's work. The brothers then hired a room in another factory for about a year, and, the business prospering, they concluded to erect a one-story brick building 25 x 50 feet, in 1877. From that time on there was an addition added every year, either on the top or on the sides of the original building, until the ground where this factory was erected was all covered, and further extension was impossible, or at least impracticable. In 1889, therefore, a new one-story factory 100 x 200 feet, with a power house 40 x 40 feet, was built on the present site of the works, and to this again an addition was added almost every year, except in 1893, until the present plant has reached the proportions of about 75,000 square feet of floor space. Although the factory has been added to in this manner from year to year, it presents at the present time a homogeneous appearance on account of being built in such a manner that units could be added without interfering with the general plans of the shop.

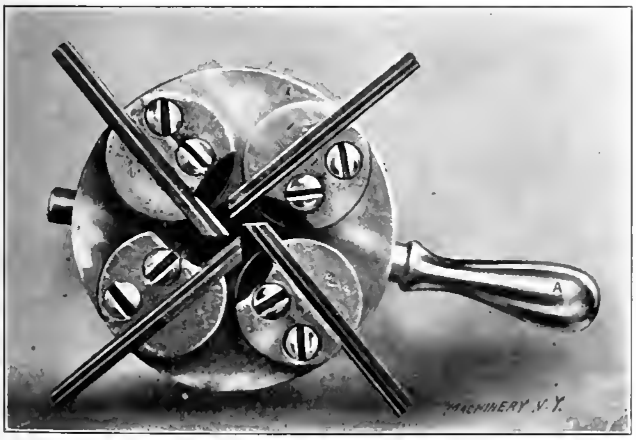


Fig. 2. Small Self-opening Die used for Threading Taps up to 3-8 inch Diameter, in Horizontal Machines.

Mr. E. Wells retired from business in 1880, at which time Mr. F. E. Snow, the present treasurer of the company, entered the firm. Mr. F. E. Wells left the business and sold out his interest about five years ago, leaving Messrs. F. O. Wells and F. E. Snow in control of the Wells Bros. Company. The growth of the company is well exhibited by mentioning the fact that while only seven or eight men were employed in 1880, about one hundred men were employed when the new factory was built in 1889, and at the present time, when running full force, the company employs about 300 men.

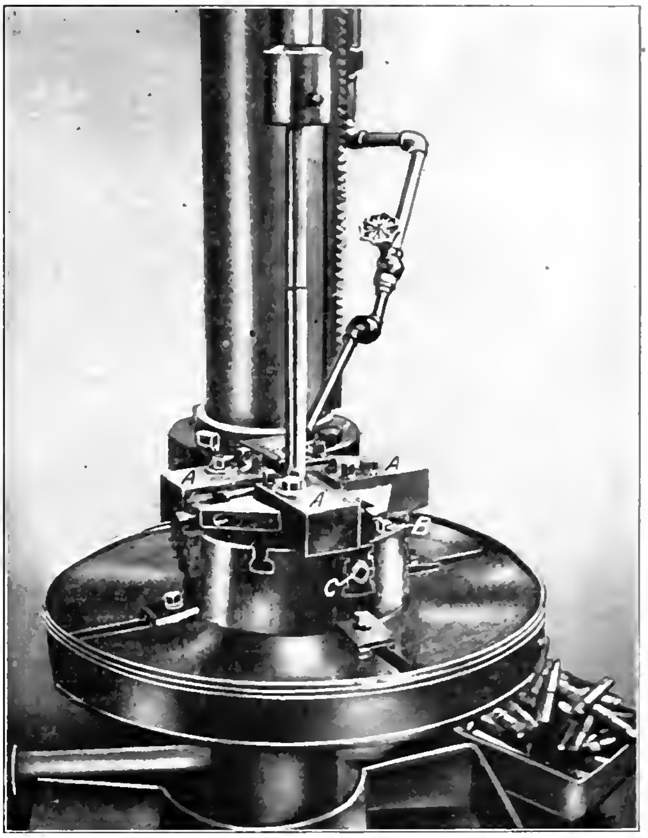


Fig. 3. Upright Tap-threading Machine used for Threading Stay-bolt Taps.

This short historical sketch of the shops will give an idea of the gradual growth of the business. It can easily be inferred that the methods employed in the manufacture of taps and dies are of the best, considering the length of time that has been allowed for the development of new ideas and special machinery. The various tools and methods described below are practically all due to the inventive ability of Mr. F. O. Wells, who has been, and who still remains, the active mechanical head of the works. After these introductory remarks we are now ready to enter upon a detailed description of the manufacturing methods employed in the making of taps.

Making the Tap Blank.

The ordinary method of turning up tap blanks in a lathe, from stock which is from 1/32 to 1/16 inch over the outside finished diameter of the thread, has been discarded except in the case of comparatively large taps, and simpler and more efficient methods adopted. Tap blanks up to 1¼ inch, or in extreme cases 1¾ inch, are turned and cut off from the bar in automatic screw machines. The bar is rolled to the finished size of the tap to be made plus 0.005 inch, the 0.005 inch being added to allow for unavoidable variations in the stock, and the over-size required in the finished tap; thus the bar for ¾ inch taps is rolled to a size of 0.755 inch. This obviates the necessity of turning the threaded portion of the tap, the only part required to be finished in the screw machine being the shank, which is turned down to the required size by hollow milling. During this operation, as well as during all subsequent cutting operations except the threading operation, soda solution is used for lubricant. When threading the taps, the cutting tools and the taps are flooded with oil. Taps larger than 1¾ inch are made from the rough bar, which in this case is 1/32 inch over the finished size of the tap. The blank, however, is hollow milled and turned in a screw machine the same as in the case of the smaller tap blanks. Very large taps, of course, are turned in lathes in the ordinary way. Most taper taps are turned in special turning lathes provided with forming attachments so that the tapered portion and the shank of the tap can be turned at one setting, the operator being able to run a number of machines. These turning lathes are of comparatively small size, a number of head-stocks and tail-stocks being placed on the same bed and run from the same shaft in the back of the machine, each machine having a clutch permitting its individual drive to be thrown in and out independently. It is interesting to note that while this system has only lately been introduced commercially for use in driving a number of small machines in factories working exclusively on small work, and in manual training schools, etc., it has been in use in these shops for over twenty years.

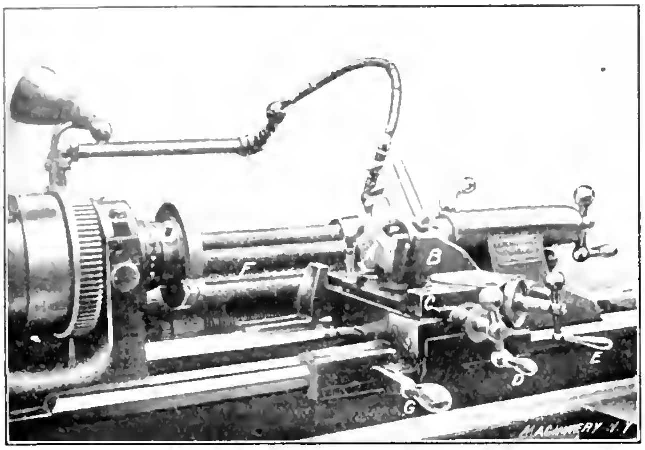


Fig. 4. Threading Lathe for Special Straight Taps.

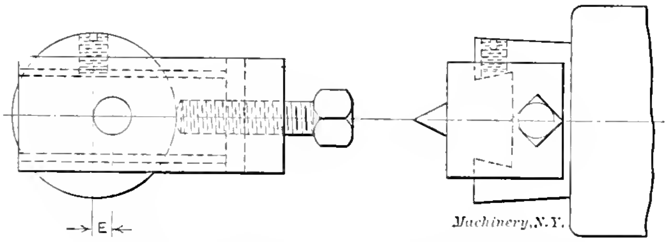


Fig. 5. Tail-center for Threading Lathes, permitting Slight Tapers to be obtained without Setting over Tail-stock proper.

Large tap blanks are cut off in cold-saw cutting-off machines. In order to save time in cutting off, and use the cold-saws to their highest capacity, holders have been devised permitting a number of bars to be securely clamped together and cut off simultaneously. A special carrier mounted on wheels and running on a track made from inverted angle irons, is provided behind the machine, and the bars rest on these carriers. This makes it easy to feed the bars along when one set of blanks has been cut off.

All diameters of the shanks and bodies of the tap blanks are measured by limit gages of the type manufactured by Wells Bros. Co. (shown in the September, 1907, issue of MACHINERY), of which a full set is illustrated in Fig. 19. These limit gages are, in fact, in use all over the shop. Referring to gages *A* and *B*, Fig. 19, it will be noted that there are two sets of adjustable gaging pins, one over the other, and when measuring the diameter of the shanks of the taps, for instance, it is only necessary to pass the gage directly over the shank which should slip easily in between the two upper gage points which determine the maximum dimensions, while the shank should not pass through the two lower gage points which define the minimum diameter permissible. It is easily seen that in this way but little dependence is placed on the operator's judgment as regards permissible limits, and the gaging is done instantly both for maximum and minimum sizes. It is far superior to the common method of using a gage with the maximum dimension at one end and the minimum at the other, because this requires that the gage be reversed, and more than double the time is required for gaging.

It is evident that when the tap blanks are cut off in screw machines in the manner described, they have no centers in the ends, and some method must be adopted for providing correctly located centers to be used in subsequent operations. In order to do this, the teat on the end of the tap blank, which is left from the cutting-off operation in the screw machine, is first ground off, and then the center is drilled in a special centering machine. Considering the fact that the finished stock used for the taps is only 0.005 inch over size, it is clear that the center must run perfectly true with the outside of the tap. An ordinary centering machine will hardly fill the requirements, but by the means adopted the object is easily accomplished. The tap blank is placed in a female center at one end which drives it, it being supported near the other end by an adjustable V-shaped rest. It is evident that when the tap blank revolves and the centering drill is brought up against it, the drill will either enter in the exact center of the blank or refuse to cut; if forced into the blank, although not being in the center, the drill, of course, would break. The adjustable V-rest is adjusted for the first blank in a set, until the operator sees that the blank is running true with the centering drill. He then drills the center of this blank, and can continue to put the centers in the remaining blanks of the same size with practically no attention other than putting shank end of the tap blank into the female center, placing the body of the blank in the V-rest, and feeding the centering drill into the other end. When a lot of taps has thus been centered at one end, the V-rest is adjusted so that the shanks run true in it, and the shank end of the taps is centered in the same manner.

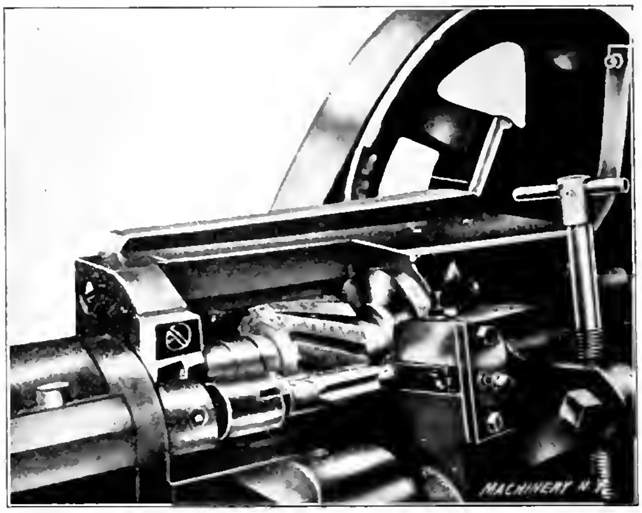


Fig. 6. Method of Threading and Relieving Ordinary Taper Taps, such as Pipe Taps, Boiler Taps, etc.

Threading.

The threading is one of the most important operations performed on a tap, and the methods employed in various tap manufacturing plants are of special interest for the rea-

son that a great many different processes are employed. The method employed by the Wells Bros. Co. consists in cutting the taps with dies, or rather with four threading tools placed in a die-holder. The principle of the action of the cutting tools and their relation to the tap being threaded is illustrated in Fig. 1. One of the die-heads, which also clearly illustrates the principle employed, is shown in the half-tone, Fig. 2. This die-head is used for small taps in a horizontal machine, and is provided with a self-opening device so as to permit the chasers or cutters to recede from the tap when this has been threaded, to permit it to be withdrawn from the die without reversal. The handle for the self-opening mechanism is shown at *A* in the illustration. Larger taps, say from ⅜ inch and up, are cut in machines with vertical spindles. In this case the tap passes clear through the die-head, and there is no self-opening adjustment for the dies; the chasers are inserted in holders which in turn are placed in a body, much in the same way as are the jaws of independent jaw chucks. There is an adjustment by means of a screw in the back of each chaser, and also an independent adjustment of each jaw in the chuck. One of these chaser-holding chucks or dies used in an upright machine and intended for threading stay-bolt taps, is shown in Fig. 3. The jaws holding the chasers are shown at *A*, the adjusting screws back of the chasers at *B*, and the provision for the adjustment of the jaws is shown at *C*.

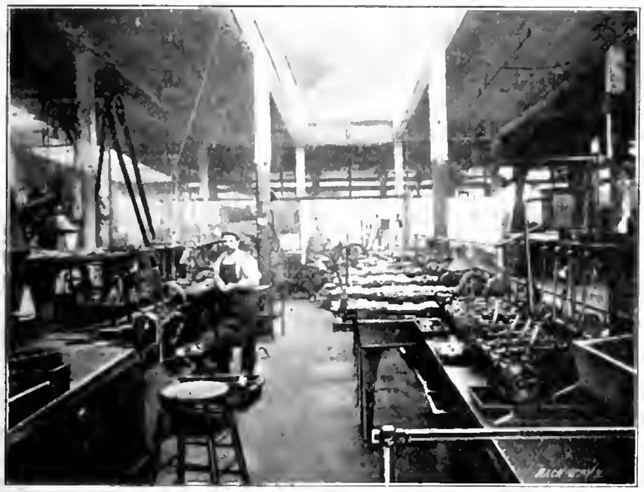


Fig. 7. View of the Special Threading and Relieving Department of the Wells Bros. Co.'s Shops.

The threading operation is performed on a special drill press having a spring balanced spindle, oil being provided from a central distributing tank by a pump driven by an independent motor. The cutting portion of the chasers is chamfered like dies, except that the chamfer is rather longer than that on ordinary die chasers. The angle of the chaser between the cutting face and the front of the tool is about 60 degrees, and the cutting point, when the chasers are adjusted, is a little back of the center of the tap. The chasers are from five to eight inches long, according to the size of die-head for which they are intended, and are provided with threads or grooves the full length, cut at an angle corresponding to the diameter and pitch of the tap to be threaded. They are hardened, by heating in lead, for a distance of about one to one and one-half inch at a time. If hardened for the full length at once, the distortion in hardening would make the chasers useless for accurate work.

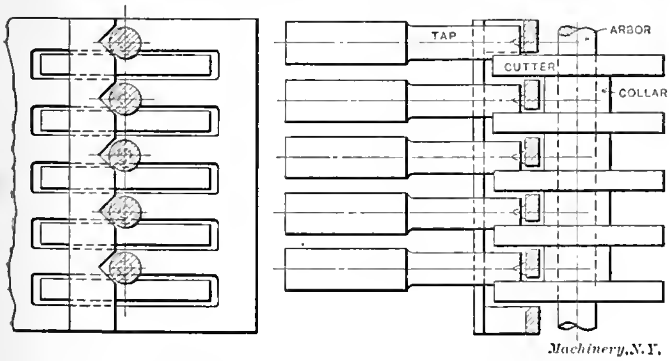


Fig. 8. Diagram showing Principle of Tap Squaring Fixtures.

With the exception of the machine shown in Fig. 3, for threading long taps, the other machines are multi-spindle tap threaders. They are all built by the company for its own use, and in general appearance they resemble ordinary drill presses. The small machines on which the threading is done horizontally, resemble horizontal tapping machines. On the vertical machines the taps drop right through the die when the thread is cut, and on the machine shown in Fig. 3, where the taps threaded are very long, there is a hole in the floor permitting any length of tap within reasonable limits to be threaded. Ordinarily the taps pass through the dies two or three times, the last time a very light finishing cut only, being taken. The stay-bolt taps pass through the die only once, at a somewhat slower speed than used when threading taps which pass through several times. The speed by which taps can be threaded when this method is employed, is rather remarkable. A ⅞-inch diameter tap having a length of thread of about 4½ inches can be finish threaded, passing through the dies three times, in about three minutes, while a stay-bolt tap having from 24 to 30 inches of thread is threaded in about five minutes.

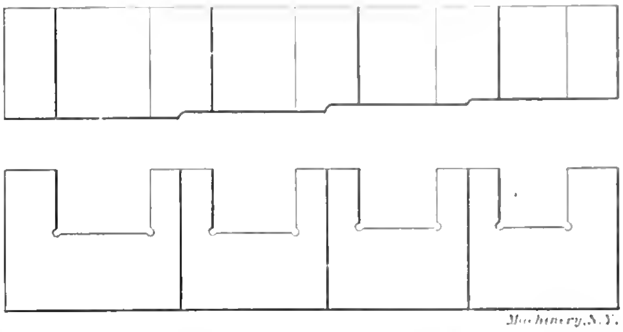


Fig. 9. Gages for the Squares of Taps.

Special Threading Lathes for Taps of Odd Size and Pitch.

When taps of odd size and pitch are to be made, it is not economical to rig up a machine with chasers held in holders of the type described, because the making of the chasers, as well as their adjustment, requires considerable skill and time; consequently these chasers are only made when a great number of taps of the same diameter and pitch are required. For odd cases, therefore, the threading of the taps is done in special threading lathes, one of which is shown in Fig. 4. The chasers for cutting the thread are somewhat similar in appearance to those used in the die-heads already described, and three of these are held in a special swiveling thread-tool holder shown at *A* in Fig. 4. Of course, when held in this manner these chasers are really nothing but ordinary thread-cutting chasers. Three of the chasers are used in one holder for the reason that the thread in the tap is produced by three cuts, one roughing, one semi-finishing, and one finishing. The swiveling tool-holder is provided with stops so that the operator can easily and quickly turn the tool from the position required for the roughing tool to the position

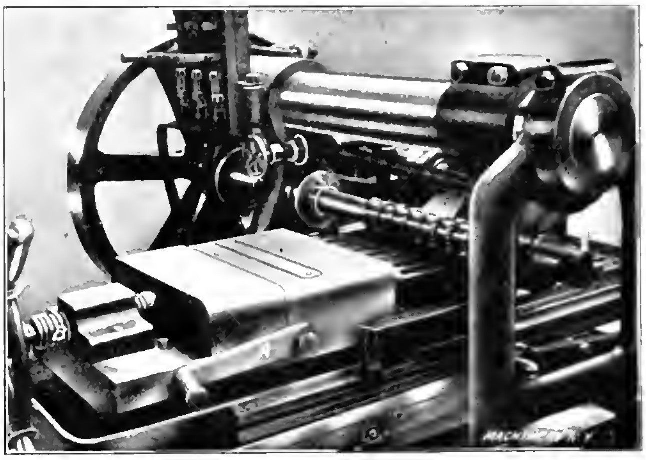


Fig. 10. Fluting Eight Taps at one Setting.

required when either of the other tools is in operation, and the holder is rapidly clamped in position after the adjustment. The holder is mounted in a special tool-carrying slide *B*, operated by handle *E*. This upper slide *B* is moved in an angle relative to the slide *C*, which latter is fed inward at right angles to the axis of the lathe spindle by the handle *D*. The handle *E* of the upper slide is operated when it is required to adjust the tool in a longitudinal direction so as to suit exactly the pitch of the thread being cut, while the handle *D* is operated when the slide is fed in and out for taking a heavier or less heavy cut.

One of the interesting details in the construction of this machine is the arrangement of lead-screws. It will be noted that in the back of the machine at *F* a number of lead-screws of different pitches are provided. These are placed in a turret-like horizontal holder, held by brackets placed in the back of the machine, and one lead-screw at a time engages with a half nut directly at the back of the carriage. Owing to the fact that the lead-screws are mounted in a turret, any one of these lead-screws, each having different pitch, can be placed in engagement with the half nut in the back of the carriage, this half nut, of course, being changed to suit the different screws. There are eight screws in the holder or turret containing them, and the pitch of each can be doubled by the use of a multiplying change gear at the head-stock.

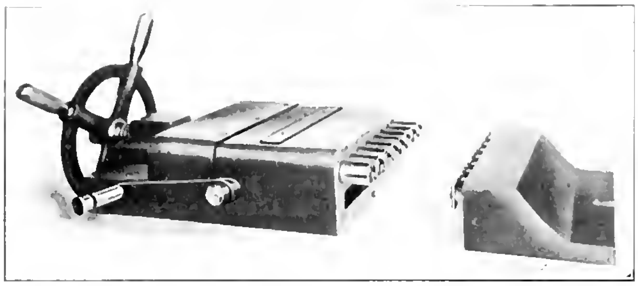


Fig. 11. Fluting Fixture shown in Place on Machine in Fig. 10.

The advantage of this arrangement is obvious, particularly with regard to the possibility of disengaging the lead-nut from the lead-screw and running the carriage back by hand, and still being sure to catch the thread in the tap being cut. The change for different pitches is also quicker than when change gears are used to effect the correct lead. The lead-screws are provided with special ratchet thread, perpendicular on one side and forming a 60-degree angle with the axis of the screw on the other. This form of thread largely obviates the difficulties due to too rapid wear of the threads in the lead-screw. In the front of the machine, at *G*, a handle is shown by means of which the tool slide can be moved back instantly so that the tool will be out of engagement with the thread cut, without interfering with the adjustment of the handle *D*. This improvement, which has lately been introduced in ordinary lathes of well-known manufacture, has been in use at the Wells Bros. Co.'s works for a great many years.

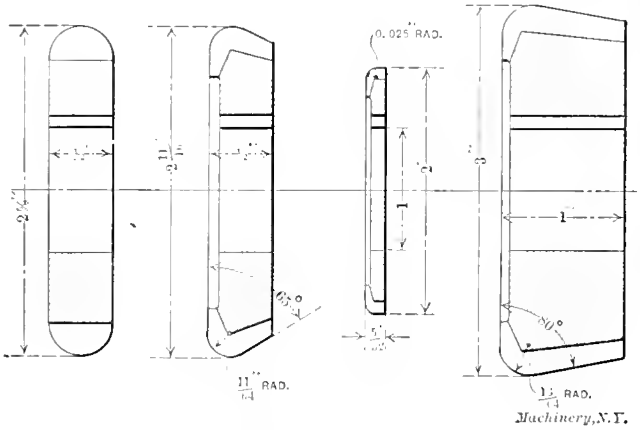


Fig. 12. Various Types of Fluting Cutters.

The taps threaded in these threading lathes are provided with a very slight back taper as commonly provided in taps of proper design. This taper is accomplished by moving the tail-stock over a very slight amount. In some cases an improvement has been introduced in the tail-center whereby the necessity of moving the whole tail-stock over is obviated, and simply the center itself is moved over towards the front. In this case the center is placed on a small adjustable slide which in turn is held in a holder which is placed in the tail-stock. The adjustment for taper turning is then done directly by adjusting this center back and forth without interfering with the tail-stock proper. The general principle of this tail-center is shown in Fig. 5, where *E* indicates the amount the tail-center is moved out of alignment with the spindle of the lathe.

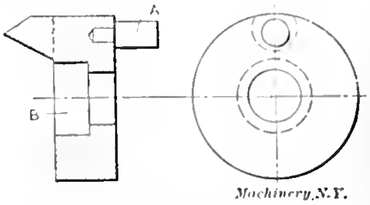


Fig 13. Special Center for Tap Fluting Fixturee.

A slight amount of back taper is also provided in the taps cut by dies in the horizontal and vertical tap threading machines. This is accomplished by having the axes of the spindle and of the dies a very small amount out of alignment. Then as the tap travels downward through the die, the angle of deviation of the tap from the absolute vertical line will increase slightly as the distance between the spindle and the die is diminished, and the dies will cut the thread slightly smaller in diameter at the upper end, due to a kind of a wabbling action of the tap in the die.

Threading Taper Taps.

Taps of comparatively steep taper, such as pipe taps, are threaded in special threading machines, the most important parts of one of which is shown in Fig. 6. These taps are threaded by a hob which mills the full length of the thread at once and relieves it simultaneously, the flutes in the taps in this case being cut before threading. The grooves or threads in the hob are not cut with a lead, but form circular grooves around the hob; the flutes are cut on a helix in this hob. The tap moves along the hob, while rotating, according to the pitch required in the tap, and it is only necessary to revolve the tap two or three times to cut a complete thread produced, in fact, by a roughing and a finishing cut, as each time the tap revolves, a complete cut of the thread all over the tap is taken. It will be noted that the tap is squared before threading, and is held by the square at one end and by the center at the other. The center is adjustable, as shown, so that the tap can be placed in proper position to give the correct taper, the hob being straight. The relieving is accomplished by giving the hob an oscillating motion while the cut is taken. Of course, it is clear that the hob, in reality, is nothing but a combination of individual thread milling cutters placed together, each cutting one thread, but made in this case in one solid piece. The relief can also be accomplished by rocking the end of the tap held in the adjustable center, back and forth by a cam placed on a cam-shaft and geared in the proper ratio to the driving spindle of the machine into which the tap square is set.

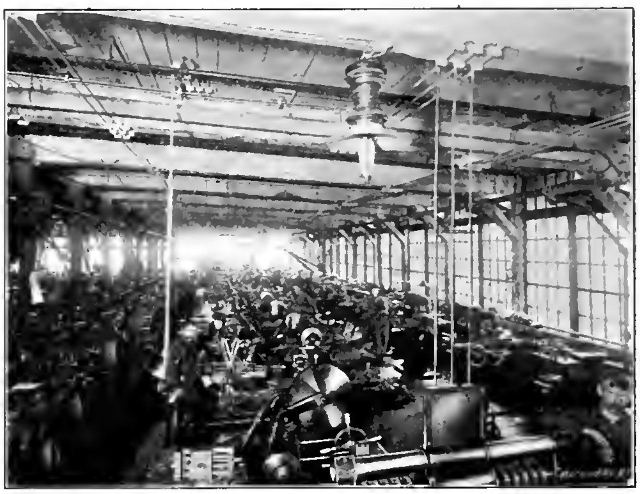


Fig. 14. Fluting, Squaring and General Milling Department.

Fig. 7 shows a general view of the department of the shop where the special threading and relieving machines are installed. This chamfering and relieving of straight taps, however, is, of course, not done before the taps are fluted, so that the taps leave this department after threading, to be squared and fluted, and are then returned to be chamfered and relieved on the chamfered portion.

Squaring the Taps.

The squaring of the taps is done in fixtures similar to those used for fluting, which are shown in Figs. 10 and 11, and cutters with inserted teeth are used for milling. The taps are squared only on one side at a time, as shown diagrammatically in Fig. 8, as many as eight taps, of some sizes, being squared at a time. The reason for squaring only one side at a time is that by so doing it is much easier to get the square exactly central with the axis of the tap, which is often not the case with taps which are squared with cutters which cut two sides of the square at once. The taps are fed longitudinally towards the cutters, so that while cutting the square, the center lines of the taps and the cutters form one continuous straight line. The size of the square is made exactly ¾ times the diameter of the tap which is the commonly employed size of square with all leading tap manufacturers. A gage used for measuring the sizes of the squares of different sizes of taps is shown in Fig. 9. It will be seen that both the length and the size of the square are gaged at one time.

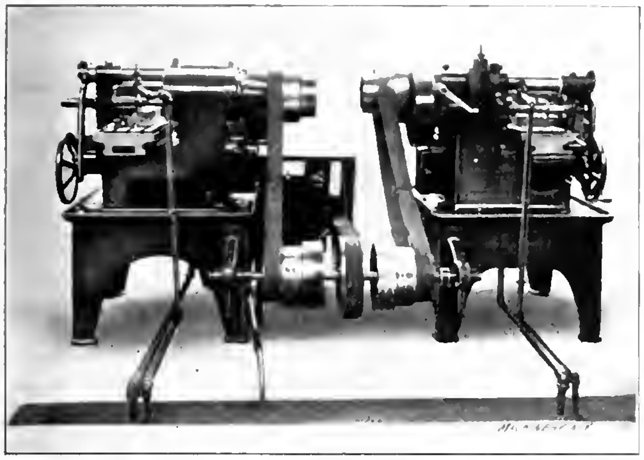


Fig. 15. Method employed for Driving Two Machines from One Motor—System of Piping for Oil and Electric Wires.

While squaring, the taps are held on male centers at the end being squared, and in female centers on the threaded end. The manner in which the centers are made in order to permit the milling cutters to pass closely by the center when squaring, is illustrated in Fig. 8. It will be seen that a small V-shaped groove is cut in a supporting plate below the tap shank. This is intended simply to support the tap when being put in place. When clamped between the centers, the tap, of course, does not rest in these V-supports.

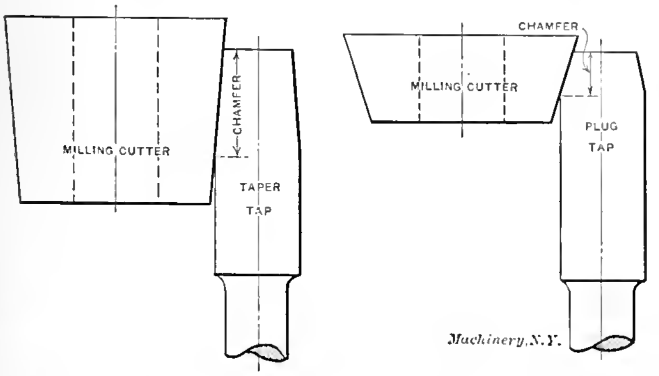


Fig. 16. Principle employed in Tap Chamfering and Relieving Machines.

Fluting the Taps.

When fluting, the taps are held in fixtures which take four, six, or eight taps at a time, according to the size of the taps. One of these fixtures, placed in the milling machine with eight taps being fluted, is shown in Fig. 10, the fixture by itself is shown in Fig. 11. It is evident that in order to permit the milling cutter to pass as close to the center of the tap as possible when cutting the flute, half centers must be employed. It has been found, however, that the ordinary half center has its disadvantages, it being required to mill off so much on the top of the holder for the half center that it gives the center a comparatively poor support. For this reason an interesting type of center, as shown in Fig. 13, is used. The pin *A* locates the center in the holder, and the counterbored hole *B* is intended for a binding screw which passes through the body of the center and binds it firmly to the body of the fixture. The simplicity of this center is plainly in evidence; it is held rigidly and is stronger than the ordinary half center.

When milling the flutes, the taps are held on these centers at the threaded end and in tapered square female centers at the squared end. The taps are all tightened in place at once by one binding screw *B*, Fig. 10, and an equalizing device is employed to make all the centers bind the taps to an equal degree. In front of the male centers a strap is placed similar to that employed in front of the male centers on which the taps are held when squared. This strap is provided with small V-grooves in which the taps rest until they are clamped against the male centers by means of the hand-wheel and binding screw. The indexing is accomplished simultaneously for all the taps by the lever *A*, Fig. 10, which is connected with the spindles for the different taps by spiral and spur gearing. Of course, bevel gears can also be used instead of spiral gears for the transmission of the motion from the transversal stud on which the index lever is placed, to the spindles which are set in a longitudinal direction. There is only one index hole on the side of the fixture, one complete turn of the index lever being required to index one-quarter turn of the tap holding spindles. As most taps have four flutes, this device, therefore, answers the purpose without any index plates, and without the use of a number of different index holes. Mistakes in indexing are thereby completely avoided. Several different types of cutters used for fluting taps are shown in Fig. 12. The first type, which is an ordinary convex cutter, is used for stay-bolt taps. The dimensions given are for a cutter used for a one-inch tap. The second cutter from the left is used for regular hand taps, the size shown being used for a ¾-inch tap. The third cutter is used for machine screw taps and small hand taps, ⅛ inch in diameter and less. Finally, the cutter to the extreme right is used for pipe taps, the size shown being for 1-, 1¼-, 1½-, and 2-inch taps.

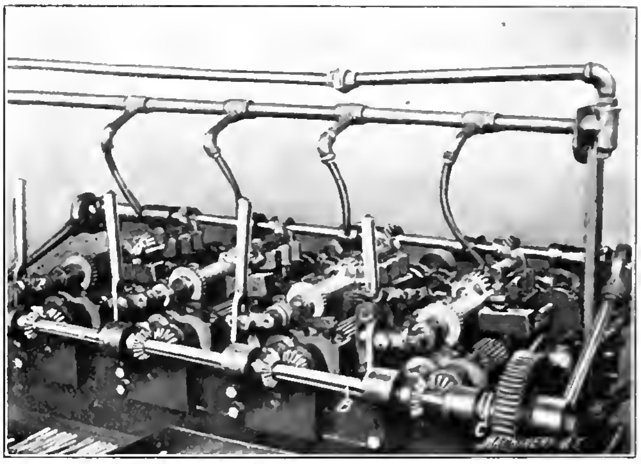


Fig. 17. Tap Chamfering and Relieving Machine with Eight Spindles, of which Four are shown in the Illustration.

A general view of the milling department is shown in Fig. 14. Directly in the foreground will be seen a machine for squaring ten taps at once, two fixtures being employed, each holding five taps, one on each side of the machine. It will be noticed that over-head counter-shafts are largely done away with in this department of the shop, and most machines are driven by individual motor drives. In some cases one motor is employed for driving two machines, and in other cases there are counter-shafts placed on the floor in the back

of the machines the object being to do away with over-head belting and line shafting.

Fig. 15 shows a simple and effective manner of coupling two machines to one motor, thus avoiding an excessive amount of counter-shafting and at the same time occupying no space that could be utilized for other purposes. It will be noted that the motor is placed in the background (which is really the front side of the machines) between the two machines which are turned end to end, having their fronts in opposite directions. Over the motor, as can be seen, is placed a bench on which work and cutters can be put. In this way the space occupied by the motor is utilized for a purpose for which space would be required in any event, and in a sense the motor does not occupy any space at all, inasmuch as the bench placed over it would be required whether the motor was under it or not. In the same illustration is also shown the manner in which the wires and oil are carried to and from the machines. The floor is made of concrete and provided with grooves or ducts covered by cast iron plates, as shown in the foreground of the illustration. The pipes supplying the lubricant to the cutting tool as well as the pipes carrying off the used lubricant, are seen emerging from the duct through the cast iron plates at both the right- and left-hand side, while the single pipe seen in the middle entering through the cast iron plate into the duct, contains the wires for the power.

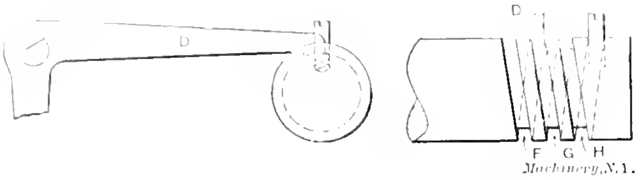


Fig. 18. Ingenious Automatic Trip for Drive of Chamfering Machines.

Chamfering and Relieving Taps.

The chamfering and relieving on the chamfered portion of ordinary straight taps is accomplished in special machines, and the principle involved in this operation is best illustrated by the line engraving Fig. 16 where two taps are shown, one taper and one plug tap being chamfered by milling cutters of different tapers. As will be seen, the whole length of the chamfer is cut at once by a milling cutter, and the tap is moved or rocked eccentrically while the cut is taken on each land so that the relief on the chamfered portion is produced simultaneously with the chamfer itself. The tap is held by the square in a chuck and on a center at the other end while this operation is performed and is mounted in a head which is journaled so that it can be swiveled or rocked by a cam. These chamfering machines, as shown in the right-hand foreground in Fig. 7, are built in units having eight spindles each; half of one of these machines is shown in enlarged scale in Fig. 17. Here the cutters which produce the chamfer are shown at *A* while the taps are practically hidden by the other parts of the machine. Oil or other cutting fluid is carried to the cutters by an oil pipe supplied from a central source.

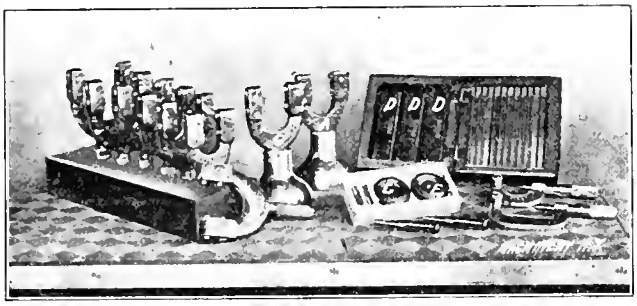


Fig. 19. Limit Gages and Gages for Testing Lead, used in the Shops for Working and Inspection Gages.

These machines are also provided with an interesting automatic stop which permits the operator to set the machine so that the cutters will go around the tap one, two, or three times, according to the requirements, before the drive is thrown out of engagement. The principle of this stop is shown in Fig. 18. It consists simply of a lever sliding in a helical groove on the driving shaft *B* in Fig. 17. The part with the helical grooves is shown in the same illustration at *C*. At one end of the helical groove the lever strikes against a screw and thereby trips another lever, by means of which the drive is thrown out of engagement. When the machine is started the operator can place the end of the lever *D*, Fig. 18, in either of the grooves *F*, *G*, or *H*, and it is evident that when placed in the groove *F*, the shaft must revolve three times before the machine will be tripped, whereas, if placed in groove *G*, it will revolve only twice, and when placed in groove *H* only once before tripping. This is a very simple and ingenious scheme for automatic and adjustable tripping of a machine of this description.

Marking the Taps.

For marking the taps, a number of devices working on the principle of an ordinary printing press are employed. The taps simply roll under the die containing the characters to be impressed in the tap shank, pressure being exerted on this die so as to give a clear and distinct marking on the shank.

The taps are now completed as far as the machining operations are concerned. They are inspected between each of the more important operations, particularly after the threading, the gages used for inspection being shown in Fig. 19. In this illustration the gages used for measuring plain cylindrical work, already referred to, are shown at *A* and *B*, and a gage of the type used for measuring the angle diameter of the thread is shown at *C*. Gages for measuring the correct lead are shown at *D* and micrometer gages used for sizes where no limit gages are available, at *F*. These limit gages are also supplied to each of the men performing the work on the taps, so that he can easily determine whether the work is done properly or not. In a coming issue of MACHINERY the hardening and final inspection of the taps will be treated, together with a description of other features of interest in the Wells Bros. Co.'s shops. E. O.

* * *

An interesting list of the largest steamships afloat is given in *International Marine Engineering*. The growth of steamships is also referred to. It is interesting to note that the average length of the twenty largest steamships in the world in 1848 was 230 feet; and in 1873, twenty-five years later, the average was 390 feet. After another quarter century, the average of the twenty largest liners was 541 feet, whereas now the average length is 700 feet. If we include the two new White Star liners, the building of which has just been begun, the list of the thirty largest steamships is as follows:

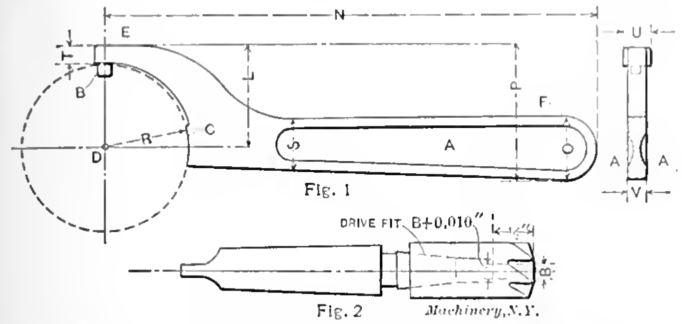
	SHIP.	Launched.	Line.	Length, Feet.	Gross Tonnage.
1	*Olympic**	1910	White Star	860	42,000
2	*Titanic**	1910	White Star	860	42,000
3	*Mauretania*	1906	Cunard	760	31,938
4	*Lusitania*	1906	Cunard	760	30,822
5	*George Washington*†	1909	North German Lloyd	700	24,800
6	*Kais. Augusta Victoria*	1905	Hamburg-American	678	24,581
7	*Adriatic*	1906	White Star	709	24,541
8	*Rotterdam*	1907	Holland-America	650	24,176
9	*Baltic*	1904	White Star	709	23,876
10	*Amerika*	1905	Hamburg-American	669	22,225
11	*Cedric*	1902	White Star	681	21,035
12	*Celtic*	1901	White Star	681	20,904
13	*Minnesota*	1904	Great Northern	622	20,718
14	*Caronia*	1905	Cunard	650	19,687
15	*Carmania*	1905	Cunard	650	19,524
16	*Kaiser Wilhelm II.*	1902	North German Lloyd	684	19,361
17	*Kronprinzessin Cecilie*	1907	North German Lloyd	684	19,360
18	*President Grant*	1907	Hamburg-American	600	18,074
19	*President Lincoln*	1907	Hamburg-American	600	18,074
20	*Lapland*†	1908	Red Star	620	18,000
21	*Oceanic*	1899	White Star	686	17,274
22	*Prinz Friedrich Wilhelm*	1907	North German Lloyd	590	17,082
23	*Nieuw Amsterdam*	1906	Holland-America	600	16,913
24	*Deutschland*	1900	Hamburg-American	661	16,502
25	*Cincinnati*†	1908	Hamburg-American	580	16,400
26	*Cleveland*†	1908	Hamburg-American	580	16,400
27	*Arabic*	1903	White Star	601	15,860
28	*Republic*	1903	White Star	570	15,378
29	*Kronprinz Wilhelm*	1901	North German Lloyd	637	14,908
30	*La Provence*	1906	French	603	14,744

Ships not yet afloat are marked (*); those afloat but not yet in service (†).

In this connection it may be remarked that the gross tonnage of a ship is the cubic contents of the vessel below the deck, one ton being considered as equal to 100 cubic feet. The net tonnage is the cubic contents of the vessel when the space occupied by the machinery, quarters for the crew, etc., has been deducted. The displacement is the actual weight in long tons of the vessel.

THE MAKING OF SPANNER WRENCHES.

The qualities required in a spanner wrench are, in the first place, that it should correctly fit the working parts for which it is intended, and secondly, that it should be strong, light in weight, and neat in appearance. The appearance of the spanner wrenches, the making of which is described in the following, is shown in Fig. 1, where the outline of the nut for which the wrench is used is shown in dotted lines. The wrench blank should be drop forged, so that it is practically finished, except for the dimension of the pin *B* and the surface *C*. The pin is then subsequently finished by milling, as will be referred to later, so that it may fit snugly in the required size hole in the nut for which it is intended, and the surface *C* is milled off to give the correct diameter from the center *D*, which, of course, is also the center of the nut, for which the wrench is used. It is evident that by drop forging the lug *C* so that it extends far enough out from the body of the wrench, the same drop forging can be made to suit a number of different sizes of nuts, within a certain range, depending upon how much of this lug is milled off in finishing surface *C*. In the drop forging, raised letters can also be provided in the hollow portion *A* of the handle, these letters giving the name of the maker, the size of the wrench, etc. This not only adds to the neat and finished appearance of the wrench, but, at the same time, produces a cheap means of marking the maker's name on every wrench, and of recording the size for which it is intended. The pin *B* should always be made solid with the wrench. Inserting a loose pin, as is the custom of some makers, usually causes trouble, as the pin is liable to work loose or break.



Figs 1 and 2. Spanner Wrench and Hollow Mill for Finishing Spanner Pin.

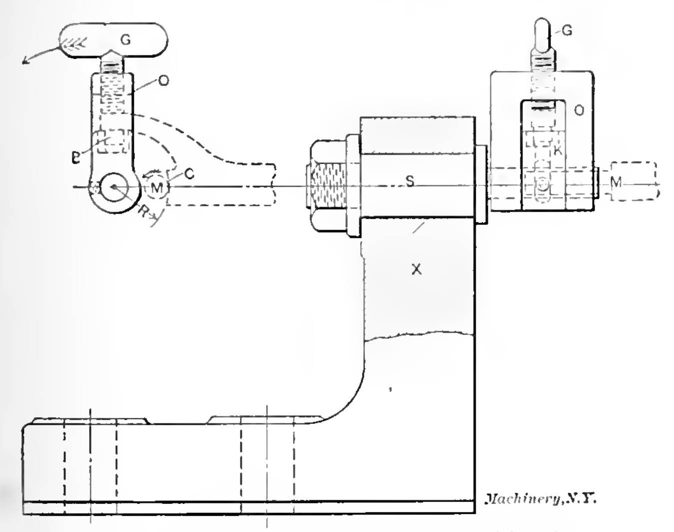


Fig. 3. Fixture for Milling Seat for Nut on Wrench.

The drop forged blank, when delivered from the forge shop to the machine department, is taken first to the drill press. The first operation is to finish the pin *B* to proper diameter, which is done with a solid hollow mill, it not being possible to use an adjustable hollow mill, because there would be no room in milling for the adjusting collar. The mill, as shown in Fig. 2, is rounded or relieved on the end to conform to the radius *R* of the wrench, so as to clear the body of the wrench when milling. The hollow milling operation is performed in a drill press, the wrench being held in a vise, resting on the surfaces *E* and *F*, while the as yet unfinished surface *C* acts as a stop against a pin driven into one of the vise jaws. Allowance must, of course, be made in locating this stop pin for the difference in radius in the rough forging and the finished radius *R* of the surface of *C*.

When the vise has been correctly set on the drill press table, it is clamped in position, and the drill press table itself is clamped in place. If the setting is not disturbed, all the wrenches of the same size will then have the pin *B* hollow milled in proper relation to the surface *C*.

The next operation is to finish the surface *C* to the correct radius *R*. The manner of performing this operation is shown in Fig. 3. The surface *C* is finished by milling with an end mill *M*, using the fixture shown for obtaining the proper radius. The fixture is mounted on the milling machine table, but can be used by fastening it to the cross-slide of a lathe, and the end mill *M* mounted in the spindle. When the fixture has once been set in proper relation to the spindle of the machine, whether it be on a milling machine or a lathe, all slides are secured, so that no accidental motion of the slides will take place, in order to insure all the wrenches being milled alike. It is very essential that the circular surface of *C* be correct in relation to the pin *B*, as these are the elements of the wrench which fit the nut. If the end mill is sharpened, and its diameter thus reduced, it will be necessary to reset the table in relation to the spindle of the machine, in order to retain the radius *R* on the wrench.

GENERAL DIMENSIONS OF SPANNER WRENCHES.

See Fig. 1 for notation used in Table.

Dimensions of Nut for which Wrench is used.		R	Maximum Diameter of Pin *B*.	N	L	P	O	S	T	U	V
Diam.	Min. Width.										
1 1/8	1/2	9/16	7/32	5	7/8	1 1/8	5/8	7/16	3/16	9/32	3/16
1 1/4	1/2	5/8	7/32	5	7/8	1 1/8	5/8	7/16	3/16	9/32	3/16
1 1/2	9/16	3/4	15/64	5	7/8	1 1/8	5/8	7/16	3/16	9/32	3/16
1 3/4	9/16	7/8	15/64	6	1 1/4	1 3/8	3/4	9/16	7/32	5/16	7/32
2	5/8	1	1/4	6	1 1/4	1 3/8	3/4	9/16	7/32	5/16	7/32
2 1/4	5/8	1 1/8	1/4	6	1 1/4	1 3/8	3/4	9/16	7/32	5/16	7/32
2 1/2	5/8	1 1/4	1/4	6 3/4	1 1/2	2 1/8	7/8	5/8	1/4	11/32	1/4
2 3/4	11/16	1 3/8	17/64	6 3/4	1 1/2	2 1/8	7/8	5/8	1/4	11/32	1/4
3	11/16	1 1/2	17/64	6 3/4	1 1/2	2 1/8	7/8	5/8	1/4	11/32	1/4
3 1/4	3/4	1 5/8	9/32	7 1/4	1 3/4	2 1/4	1	3/4	9/32	3/8	9/32
3 1/2	3/4	1 3/4	9/32	7 1/4	1 3/4	2 1/4	1	3/4	9/32	3/8	9/32
3 3/4	3/4	1 7/8	9/32	7 1/4	1 3/4	2 1/4	1	3/4	9/32	3/8	9/32

The principle of the device will easily be seen from the illustrations. The wrench is placed in the fixture and held by screw *G* bearing on the top of the wrench directly over the pin *B*, which, in turn, fits in a hole in a block *K*, so that the wrench is thereby held securely in position. The block *K*, in turn, is placed between the ends of a fork *O* in which the screw *G* is inserted. Bushings provided with different sized holes to take different sizes of pins *B* are inserted in the block *K*, these bushings, of course, all having the same outside diameter. The yoke *O* and the block *K* are both mounted on an extension of the stud *S*, which is fastened to the bracket *X* clamped to the milling machine table.

It will be seen that the handle of the wrench itself is used as a lever for the hand feed when the surface *C* is milled. The operator holds the wrench so that the mill, which should run in the direction indicated in Fig. 3, starts in cutting at the lower edge of *C*; the wrench is then fed slowly until the surface *C* is machined. As yoke *O* and block *K* are pivoted at what would be the center of the nut, for which the wrench is intended, it is evident that the mill *M* will cut a surface that will fit this nut accurately. When the surface *C* is finished, the thumb-screw *G* is loosened, the yoke *O* is swivelled towards one side, as indicated by the arrow, and the wrench is simply lifted out. The pieces *O* and *K* could, of course, be made solid with one another, but this would necessitate unscrewing the thumb-screw *G* for the whole length of the pin *B*, so as to permit the lifting out of the pin from its seat in *K*. This would consume an unnecessary amount of time. This method for finishing the surface *C* of a spanner wrench is, without question, the simplest that the writer has seen used anywhere. The most commonly used method employed in

finishing surface *C* even in so-called up-to-date shops, is by means of holding the wrench on a lathe face-plate and jacking off the surface by means of a turning tool.

The next operation to which the wrench is subjected is the filing off of the burrs left by the milling operations, and the polishing of all surfaces except the hollow surface *A*, Fig. 1. The polishing is generally done by means of a belt charged with emery, in a regular belt polishing frame, the belt permitting the polishing of all curves, nicely. This is very important, as nearly all parts of the wrench are curved one way or another. Hardly any other means of polishing would be permissible on account of the time required. The polishing, however, is hardly necessary when considering the nice surface left by the drop forging operation, but most firms turning out high grade work, polish spanner wrenches in order to add to the neatness of the appearance of the tool and to permit that nice finish on the polished surfaces, which a "case-hardening for colors" produces, to show properly.

The wrench should be case-hardened in a mixture of 10 parts of charred bone, 4 parts of charred leather, 6 parts of charcoal, and one part of powdered cyanide potash. These ingredients should be thoroughly mixed together and the wrenches laid separately in a box, so that they are not in contact with each other at any point. A cover is put on the box to keep out the air. The box is then heated until the wrenches reach a good cherry red color, the length of time, of course, depending upon the size of the wrenches and the box. Then the whole contents of the box, both mixture and wrenches, are dumped in clear water, care being taken that the wrenches pass through the air for a short distance before striking the water.

The accompanying table will give a general idea of good proportions of these wrenches. The dimensions, of course, are given merely for guidance, as wrenches of this type must be made in many cases to suit special requirements. The total length, however, and the general appearance and proportions, will probably prove valuable to those having to determine upon the design of spanner wrenches. A.

* * *

ARTISTIC BLACKSMITHING.

Longfellow's beautiful poem, "The Village Blacksmith," strikes a responsive chord in most human hearts familiar with the sights and sounds of the rural smithy. It is a paean to labor, exulting in honest toil and the sense of independence of a master workman:

Fig. 1. Wonderful Example of Skill in Forging.

> "His brow is wet with honest sweat,
> He earns whate'er he can,
> And looks the whole world in the face,
> For he owes not any man."

The sentiment of the verse is honesty, strength, industry; and it admirably expresses the common regard in which the blacksmith is held. There is in it no hint that the blacksmith's art can be the means of artistic expression; the smith is not there pictured as one on the plane with the sculptor. His work is too ordinary and too useful to be classed with the creations in clay, marble and bronze symbolizing lofty sentiments and deeds of valor. The blacksmith has always been a doer and provider; he is the oldest of craftsmen and enjoys the distinction of being the only one who *can* make all his own tools, as well as the tools for others. His may appear rude and clumsy, but they suffice unto his needs, and that is enough. But that these rude tools in the hands of a master may become the means of finer expression, calling into being creations in iron that almost rival nature's own handiwork in delicacy of tracery and beauty of outline, is the object of this tribute to the skill of one who daily earns his living at the forge.

The pieces here illustrated are beautiful examples of "sculpture in iron," requiring skill and technique that put the carver of mere marble to shame when one considers the practical difficulty of the work. One illustration shows a rose branch sixteen inches long and nine inches wide on which there are two buds and two blooming roses. An idea of the delicacy of the work is gained from the weight, it being only thirty-three and one-half ounces. The illustration brings out the delicacy of detail and fidelity to form in the original, and speaks for itself. It should be known, too, that this is no creation on which weeks or months of painstaking labor were spent; fourteen hours is the shop time required.

Fig. 2. Rose Branch with Roses, hammered out in Fourteen Hours.

The first piece shown is even more artistic, and it has the added merit of being useful. It is a card tray or an ash receiver, the tips of the leaves and the stem acting as the supports. It represents a large leaf with a rose spray twined along the edge, there being one bud and a full blooming rose exquisitely formed. These pieces were forged, fashioned and welded in Swedish iron by our contributor, Mr. James Cran, foreman blacksmith of the Pond Machine Tool Works, Plainfield, N. J., and are samples of the work he does occasionally to delight his friends and to fill in the odd moments of a busy life.

* * *

Following the establishment of two-cent first-class postage between the United States and Great Britain, comes the agreement between the United States and German postal authorities for a two-cent per ounce rate on first-class postal matter routed direct. The new agreement provides that after January 1, 1909, letters for Germany paid at the reduced rate of two cents will be dispatched only on steamers sailing from New York to German ports and *vice versa*. Letters from Germany by way of Great Britain or France must pay the five cent rate for the first ounce and three cents for each additional ounce.

JIGS AND FIXTURES—10.

EINAR MORIN.*

PRINCIPLES OF BORING JIGS.

Boring jigs are, at the present time, as commonly used as drill jigs, in interchangeable manufacture, and the requirements placed on drill jigs apply in nearly all respects to boring jigs. Boring jigs are generally used for machining holes where accuracy of alignment and size are particularly essential, and also for holes of large sizes where drilling would be out of the question. Two or more holes in the same line are also, as a rule, finished with the aid of boring jigs.

The boring operation is performed by boring bars having inserted cutters of various kinds, and boring jigs are almost always used in connection with this kind of boring tool, although boring operations may be satisfactorily accomplished with three or four lipped drills and reamers. The reamers may be made solid, although most frequently shell reamers mounted on a bar and guided by bushings are used. The majority of holes produced in boring jigs, whether drilled or bored out, are required to be of such accuracy that they are reamed out in the last operation.

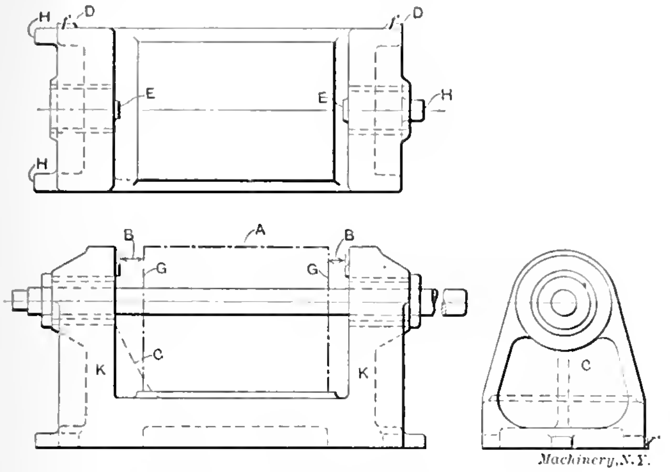


Fig. 109. General Outline of Simple Boring Jig.

The boring-bars are usually guided by two bushings, one on each side of the bored hole, and located as close as possible to each end of the hole being bored. The bar is rotated and simultaneously fed through the work, or the work with its jig is fed over the rotating bar. Boring jigs may be used either in regular boring lathes, in horizontal boring and drilling machines, or in radial drills.

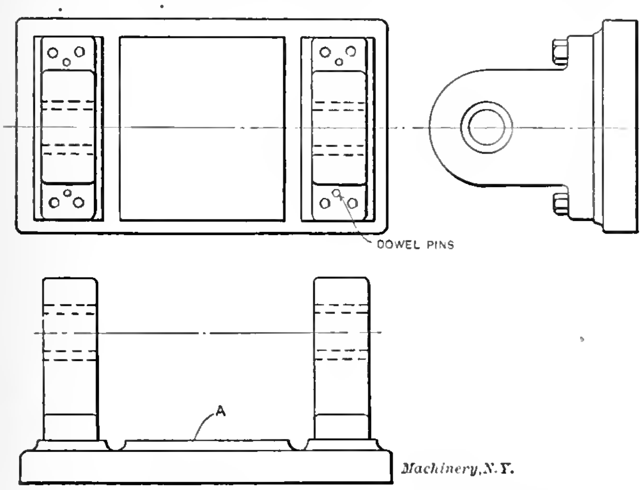
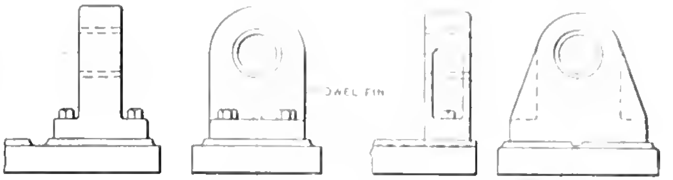


Fig. 110. Boring Jig with Base separate from Side Standards.

The jig body is made either in one solid piece or composed of several members the same as in the case of drill jigs. The strain on boring jigs is usually heavy, which necessitates a very rigidly designed body with ribbed and braced walls and members, so as to allow of the least possible spring. As boring jigs when in operation must be securely fastened to the machine table, means must also be provided in convenient and accessible places for clamping the jig without appreciably springing it.

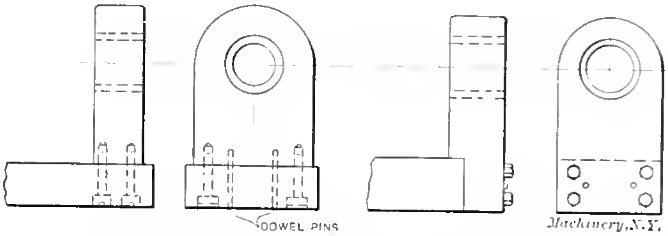
The places in the jig where the bushings are located should be provided with plenty of metal so as to give the bushings a substantial bearing in the jig body. Smaller jigs should be provided with a tongue or lip on the surface which is clamped to the machine table; this permits the operator to quickly locate the jig in the right position. As an alternative, finished lugs locating against a parallel or square may be provided. It is frequently advantageous to have small sized boring jigs provided with feet so that they can be used on a regular drill press table in cases where holes to be bored out are to be opened up with a drill piercing the solid metal. It is both easier and cheaper to do this rough drilling in a drill press.



Figs. 111 and 112. Different Methods for Securing and Locating the Uprights on Base Plate of Boring Jigs.

The guide bushings, of the same type as the bushings for drill jigs, are made either of cast iron or steel and ground to fit the boring-bar which is also ground. The bars are made of machine steel and should be made as heavy as possible, in order to prevent them from bending or springing too much should there be a heavier cut on one side than on the other. The bushings should be made rather long to insure good bearing.

The most common type of boring jig for small and medium size work is shown in Fig. 109. In this engraving, *A* represents the work which is held down by straps or clamps. In many instances when the work is provided with bolt and screw holes before being bored, these holes are used for clamping the work to the jig. In some cases it is important that the work be attached to the jig in the same way as it is fastened to its component part in the machine for which it is made, and also that it be located in a similar way. If the work is located by V-slides when in use on the machine, it is preferable to locate it by V's in the jig. In other cases the locating arrangement for the work in the machine where it is to be used may be a tongue, a key, a dowel pin, a finished pad, etc. The same arrangement would then be used for locating it in the jig. In Fig. 109 enough clearance is left at *B*, at both ends, to allow for variations in the casting and to provide space for the chips; also, if the hole is to be reamed out, and the reamer be too large to go through the lining bushing, then the space left provides room for inserting the reamer and mounting it on the bar. In nearly all cases of boring, a facing operation of the bosses in the work has also to be carried out and provisions must be made in the jig to permit the insertion of facing tools.



Figs. 113 and 114. Alternative Methods for Fastening Uprights to Jig Base.

A great deal of metal may be saved in designing heavy jigs by removing superfluous metal from those parts where it does not materially add to the strength of the jig. In Fig. 109, for instance, the jig can be cored out in the bottom and in the side standards as indicated, without weakening the jig to any appreciable extent. The rib *C* may be added when necessary, and when it does not interfere with the work to be finished in the jig. It will be seen that extended bosses are carried out to provide long bearings for the bushings. The bosses may be made tapering, as shown, providing practically the same

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* Address: Borlänge, Sweden.

stiffness as a cylindrical boss containing considerable more metal. They must be given a rather liberal diameter, as they may not always be placed exactly correct on the pattern, and consequently be a little out of center in the casting. Finished bosses should be located at suitable places to facilitate the laying out and the making of the jig, as shown at *D* in Fig. 109. The finished faces of these bosses are also of advantage when locating the jig against a parallel, when it is not provided with a tongue for locating purposes.

In some cases bosses are placed where measurements may be taken from the finished face to certain faces of the work,

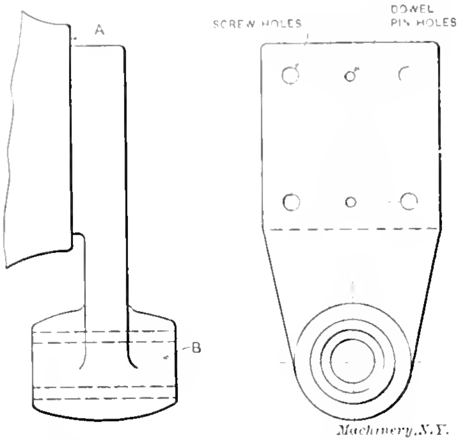


Fig. 115. A Case where the Bushing Hole is Bored Previous to locating and fastening Bracket on Jig Body.

in which case the finished bosses, of course, must stand in a certain relation to the locating point; such bosses are indicated at *E*, from which measurements *B* can be taken to surfaces *G* on the work. The three lugs *H* are provided for clamping purposes, the jig being clamped in three places only to avoid unnecessary springing action. If the jig is in constant use, it would be advisable to have special clamping arrangements as component parts of the jig for clamping it to the table, thereby avoiding loss of time in finding suitable clamps.

The walls or standards *K* of large jigs of this type are frequently made in loose pieces and secured and dowelled in place as shown in Fig. 110 to 114. In such a case the most important thing is to fasten these members firmly to the base, preventing shifting by tongues, keys, or dowels. It is evident that when the standards are made loose as in Fig. 110. it is easier to finish the pad *A* of the face, and this is of importance, particularly when difficult locating arrangements are planed or milled in the face; the pattern-maker's and the molder's work is also simplified. As a rule the standards are screwed to the face permanently and then the bushing holes are bored. In some cases, however, it may be easier to first bore the hole in a loose part, and then attach it to the main body. Such an instance is shown in Fig. 115. It is easier to locate the bracket with the bushing *B* by working from the finished hole in connection with other important holes or locating means, than it would be to first screw the bracket in place and then expect to be able to get the hole to be bored, located exactly in the center of the hub of the bracket.

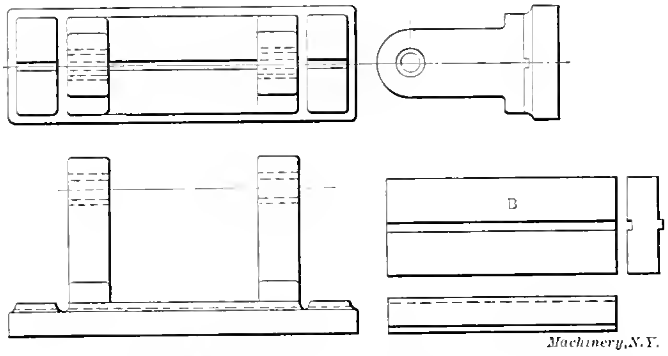


Fig. 116. Jig adjustable for Different Sizes of the Same Class of Work.

When boring jigs are designed for machine parts of a similar design but of different dimensions, arrangements are often made to make one jig take various sizes. In such a case one or both standards may have to be moved, and extra pads are provided on the face as illustrated in Fig. 116. This shifting of the standards will take care of different lengths of work. Should the work differ in height, a blocking piece *B* may be made as indicated in the same illustration. Sometimes special loose brackets may be more suitable for replacing the regular standards for shorter work. If there is a long distance between two bearings of the work, a third standard may be placed in between the two outside ones, if the design of the bored work permits, as shown in Fig. 117; this may then be used for shorter work together with one of the end standards. In Fig. 118 is shown another adjustable boring jig. Here the jig consists of two parts *A* mounted on a common base plate or large table provided with T-slots. The work *B* is located between the standards. A number of different standards suitable for different pieces of work may be used on the same base plate. The jigs or standards are held down on the base plate by screws or dowels, and generally located by a tongue entering the upper part of the T-slots.

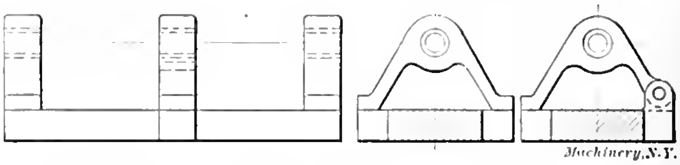


Fig. 117. Boring Jig with Removable Bearing in the Center, adapting it to Different Sizes of Work of Similar Character.

In the examples thus far given the work has been located on the jig, but it is apparent that boring jigs are frequently made which are located and supported on the work. Fig. 119 shows such a jig. The work *A*, which in this case represents some kind of a machine bed, has two holes bored through the walls *B* and *C*. This jig may guide the bar properly if there be but one guide bushing at *E*, but it is better if it can be arranged to carry down the jig member *D* as indicated to give support for the bar near the wall *B*. It may sometimes be more convenient to have two separate jigs located from the same surfaces on the top or sides. In other cases it may be better to have the members *D* and *E* screwed in place instead of being solid with *E*, and in some cases adjustable. Of course, these variations in design depend on the conditions involved, but the principles remain the same. The jig or jigs are held to the machine on which they are used by clamping arrangements of suitable type.

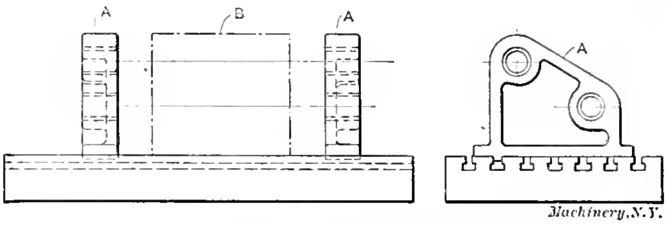


Fig. 118. Universal Base Plate for Standards of Various Descriptions for Different Classes of Work.

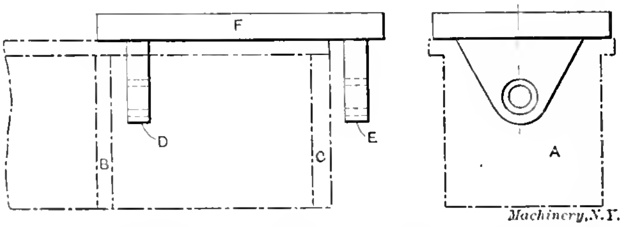
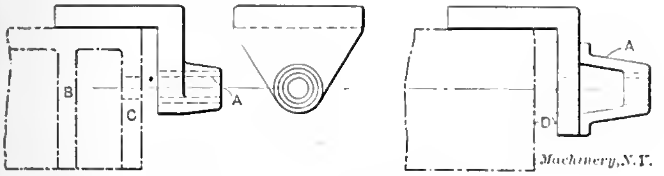


Fig. 119. A Case where the Jig is located on and supported by the Work.

The type of boring jigs described above supports the bar in two or more places, and the cutting tools are placed at certain predetermined distances from the ends of the bars, depending on the shape and size of the work. Sometimes it may prove necessary, however, to have a cutting tool inserted just at the end of the bar. Sometimes a boring jig may consist of simply one bracket as shown in Fig. 120. A very long bearing *A* is then provided so as to guide the bar true. The arrangement shown in Fig. 121 is sometimes used to insure

a long bearing for the bar. A special bracket *A* is mounted on the jig and bored out at the same time as the jig proper is machined. This provides, in effect, two bearings. In these cases bars with a cutting tool at the end are used. The reasons for using the kind of boring jig illustrated in Figs. 120 and 121 are several; in Fig. 120, for instance, there is a wall *B* immediately back of the wall *C* in which the hole is to be bored. Other obstacles may be in the way to prevent placing a bearing on each side of the hole to be finished. Instead of having a space *D* between the jig and the work as shown in Fig. 121, the jig can many times be brought up close to the work and clamped to it from the bushing side. A combination between this latter type of jig with but one bearing for the bar, and the type previously described with two bearings, is shown in Fig. 122.

Each of the different holes in boring jigs has, of course, its own outfit of boring-bars, reamers, and facing tools. In making the jig it must be considered whether it will be used continuously and what degree of accuracy will be required. When extreme accuracy is required there should be a bar provided with cutting tools for each operation to be performed. It is cheaper, of course, to use the same bar as far as possible for different operations and, ordinarily, satisfactory results are obtained in this way. It is desirable to have bushings fitting each bar, but often this expense can be reduced by using the same bushing for bars having the same diameter.



Figs. 120 and 121. Examples of Guiding Arrangements where no Support is obtainable on One Side of Hole to be bored.

It sometimes happens that one or more holes form an angle with the axis of other holes in the work to be bored. In the jig shown in Fig. 123 the bushings *A* guide one bar for boring one hole and the bushings *B* the bar for boring another hole, the axis of which is at an angle with the axis of the first hole in the horizontal plane. Then an angle plate *C* can be made in such a manner that if the jig is placed with the tapered side of plate *C* against a parallel, the hole *B* will be parallel with the spindle. This arrangement may not be necessary when universal joints are used between the spindle and the bar. If a hole is out of line in the vertical plane, a similar arrangement as that used for drill jigs, and previously described in this series, can be used.

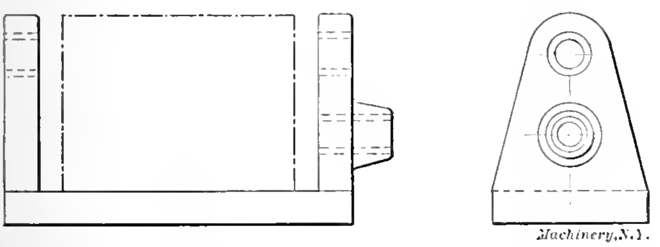


Fig. 122. Boring Jig in which One Bar has Single and One Double Bearing.

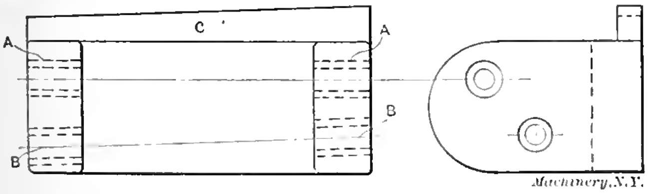


Fig. 123. Boring Jig for Boring Holes placed at an Angle to each other.

As a rule but one hole is bored out at a time owing to the fact that machines for boring generally have but one spindle. Several holes, however, could be bored out in a large size multiple spindle drill, in which case the jigs naturally ought to be designed somewhat stronger. Another method of designing jigs for boring two or more holes at the same time is illustrated in Fig. 124, the outlines only being shown in this illustration. *A* is the gear box containing the main driving gear which is mounted on a shaft *B* which in turn is driven by the spindle of the machine. The gear on shaft *B* drives the gears and shafts connected with the boring-bars passing through the bushings *C*, *D*, *E*, *F*, *G*, and *H*. The gears are proportioned according to the speed required for each bar, which in turn is determined by sizes of the holes. The housing or gear box *A* slides on a dove-tail slide *K*. A particularly good fit is provided, and the gear box can be fed along in relation to the work either by table or spindle feed. If boring operations are to be performed in two directions, a jig on the lines indicated in Fig. 125 is designed. This jig may be mounted on a special revolving table permitting the work and the jig to be turned and indexed so as to save resetting and readjusting the work and jig when once placed in position on the machine.

Fig. 124. Principle of Multiple Bar Boring Jig

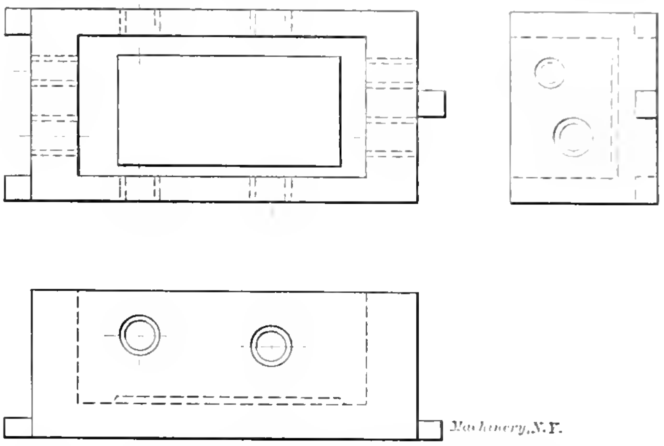


Fig. 125. Jig for Boring Holes through Work both from Sides and Ends.

The outline given above of boring jigs illustrates only the fundamental principles involved, it being considered more important to state the fundamental principles in this connection than to describe complicated designs of tools in which the application of such principles may be more or less obscure or hidden.

* * *

Messrs. Alfred Herbert, Ltd., of Coventry, England, give the following figures for general cutting speeds, to be used on milling machines: for taking roughing cuts on cast iron with ordinary carbon steel cutters, 40 feet per minute; for machine steel, 60 feet per minute; for tool steel, 24 feet per minute; and for brass, 75 feet per minute. Finishing cuts may be taken at speeds of from 50 to 55 feet for cast iron, 75 to 80 feet for machine steel, 30 to 35 feet for tool steel, and 95 to 100 feet for brass. These figures, however, should not be taken as representing the maximum rates of cutting speed which can be successfully used even with ordinary cutters, and with high-speed steel cutters it is possible to increase the cutting speed in some cases three times that used when working with carbon steel cutters.

* * *

A mix-up appeared in the note in the November issue on the use of gas engine exhaust for heating. The values should have been 11 to 15 pounds of steam evaporated per horsepower hour, from and at 212 degrees F., and 60 to 82 pounds of water raised from 32 degrees F. to the boiling point, instead of the figures given. They are approximately ten times too small in one case and ten times too great in the other. Obviously the thermal efficiency of the gas engine is figured low in order to obtain the evaporative and heating results indicated above.

GERMAN DESIGNS OF INTERNAL GRINDING MACHINES.*

OSKAR KYLIN †

The possibility of obtaining accuracy and high finish on machine parts by means of grinding has been the fundamental cause of the rapid development of grinding machines in recent years. Of late, grinding machines have also been designed which have been intended particularly for removing the greatest quantity of metal in the shortest time, the question of accuracy here being secondary. These latter designs, however, are exceptions. The many special operations to which grinding adapts itself has also caused the design of a great number of grinding machines intended for special purposes. A number of these latter machines have been brought out by the firm of Mayer & Schmidt, Offenbach, a.M., Germany, and a few of these are illustrated below. This firm is specializing along the lines of grinding machines, and besides the building of these, there is a large department devoted to the making of emery and carborundum wheels, emery cloth, and kindred products.

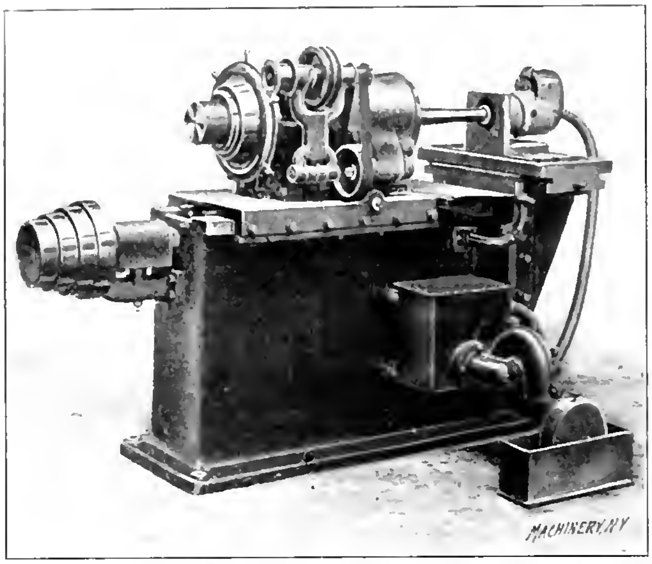


Fig. 1. Rear View of Small Size Internal Grinding Machine, showing Dust Exhausting Arrangement.

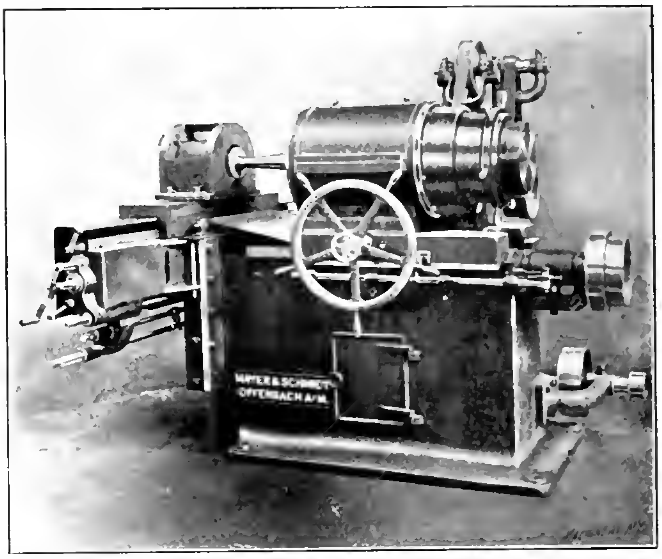


Fig. 2. Front View of another Type of Internal Grinding Machine.

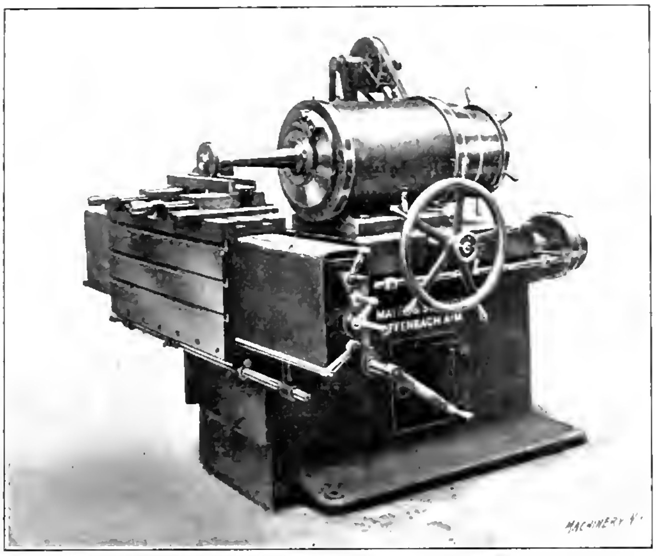


Fig. 3. Internal Grinding Machine with Planetary Motion Locked, used for Surface Grinding.

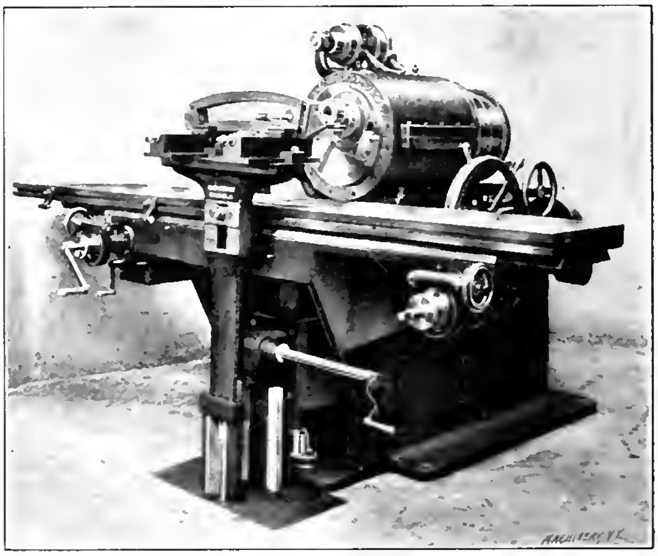


Fig. 4. Grinding Links for the Reversing Mechanism of Locomotives.

The firm's machine shop is divided up into two separate departments, one of which is exclusively working on special grinding machines, while in the other only universal grinders are made. The middle bay of the latter department, showing the space devoted to the assembling, is shown in Fig. 5. The side bays in this building are occupied by machine tools and all machining is done there. The shop is lighted in an excellent manner, due in a large measure to the saw-tooth roof construction, and in general is typical of a modern German machine shop.

One of the most interesting of the products of the firm is the type of internal grinding machine, of which various sizes are shown in Figs. 1, 2, and 3. It is more than likely that the automobile industry is largely responsible for the development of this machine, as in this industry the demand for a simple and accurate means of finishing the cylinders is imperative. The writer has seen this machine employed in most of the leading Italian automobile factories. Larger sizes of this type of machine are also built for finishing the cylinders for steam and gas engines. The first impression on examining the illustrations of this machine, is that of great rigidity throughout the design. The grinding head is mounted on a slide provided with longitudinal feed motion. The slide on which it is mounted rests directly on the bed, the sliding surfaces being, according to the common German practice, made flat instead of V-shaped, as is more common in America. The grinding head is fed forth and back automatically by means of a pulley which, in turn, drives a screw in the center between the two sliding surfaces or ways. An automatic reversing mechanism is provided, as shown in Fig. 2, where the reversing rod is plainly indicated on the side of the machine; faster or slower feeds are provided for by the cone pulley.

The most interesting feature of the machine is the eccentric or planetary motion of the grinding spindle and wheel. The spindle, in addition to its rotary motion, has also a motion around the axis of the grinding head, the grinding

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* See also the following articles on internal cylinder grinders, previously published in MACHINERY: Internal Grinding Machines, February, 1908, engineering edition; Automatic Cylinder Grinder, January, 1908.

† Address: Asklanda, Sweden.

spindle being eccentric in relation to this axis. In other words, the center line of the wheel spindle moves in a circle about the center of the head itself, at the same time as the spindle rotates about its own axis. This motion around the axis of the head is, of course, very much slower and entirely independent of the rotation of the spindle around its own center. The radius of the eccentric motion can be adjusted by hand or automatically, as required. In connection with the mechanism for adjusting the eccentricity of the spindle, a device is provided having a scale by means of which the machine can be set to grind a certain predetermined diameter of cylinder. When the diameter of the cylinder, according to this setting, is reached, the feed will stop automatically, the grinding spindle will recede from the work, and a bell will ring in order to attract the attention of the operator.

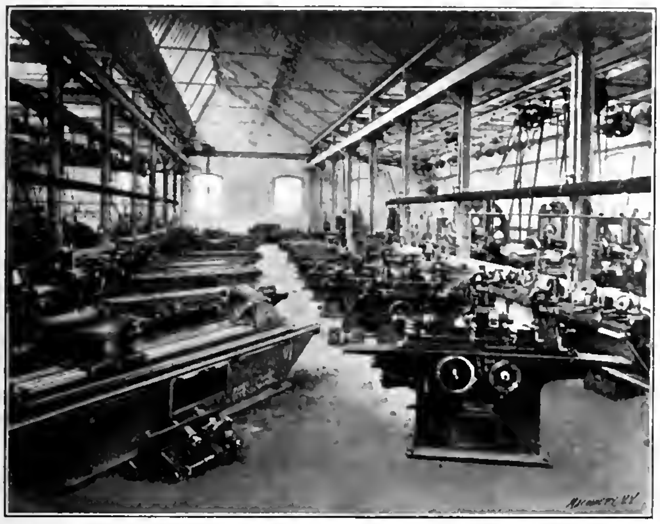


Fig. 5. Interior of One of the Shops of Mayer & Schmidt, Offenbach, a.M., Germany.

As is shown in Fig. 1, the grinding spindle is driven through a movable counter-shaft, which follows the eccentric motion of the spindle. The cylinder or work to be ground internally remains stationary during the grinding operation. As plainly indicated in the illustrations, the work is mounted on a slide having a transverse as well as a longitudinal adjustment, this being provided in order to facilitate the exact setting of the work. In Fig. 3 this type of machine is shown arranged for surface grinding of small pieces, the planetary action of the wheel spindle then being locked and out of operation.

A well devised arrangement for removing the dust and grindings, from the cylinder is shown in Fig. 1. The apparatus consists of a rotary fan which exhausts the dust through a flexible pipe from the cylinder, and delivers it into a box where the dust is collected. This feature is of great importance, on account of the means it affords for preserving the general purity of the atmosphere throughout the shop, and, as a consequence, the health of the operators.

A machine designed for the grinding of the links for the reversing gear of locomotives, is illustrated in Fig. 4. Of course, it can also be employed on a great variety of work of similar character. The general design of the machine is somewhat similar to the type of internal grinding machine already described. The work holder is adjustable transversely and horizontally, the same as in the internal grinding machine, and the work is clamped by means of two vises with parallel jaws. A swinging motion is imparted to the work holder, the radius to which the link is ground being adjustable at will.

* * *

The centrifugal pumps installed in the 39th Street pumping station, Chicago, have handled a volume of water in one day that a few years ago would have seemed quite impossible for any practical outfit of pumping machinery to cope with. This station pumped 2,000,000,000 gallons of water and sewage in twenty-four hours, a quantity sufficient to flood a square mile to a depth of nine feet! The total capacity of the pumping stations in Chicago handling sewage and sewage water is about 3,000,000,000 gallons daily.

THE ADVENTURES OF A WATER-COOLED BORING MILL.

"Say Mr. Brown," said Foreman Higginbotham to the superintendent, "wouldn't it be a good idea to put a reservoir, pump and some piping onto that boring mill over there that we keep busy on cast steel gear blanks? Water cooling works well in cutting steel in the lathe, and it seems as though it ought to help us to get more work out of the boring mill."

"Good idea!" said the superintendent. "Funny we never thought of it before. Don't know as I ever saw a boring mill rigged up for water cooling. Go ahead and try it."

So Foreman Higginbotham cut out a strip of sheet iron of the proper length, which he screwed into place around the table with a packing strip under it to keep it from leaking; then he brazed the ends together to make a tight joint. He thus had a rim on the table that would keep the water from running off the edge instead of down through the hole in the center. The next thing he did was to make a pan, which he placed in the base of the machine under the spindle, where it would catch the chips and water as they ran down through the central hole. Then he attached a B. & S. pump to the side of the frame, and connected up the proper piping and valves, and a flexible tubing connection leading to the point of the tool. After belting the pump to the counter-shaft, everything was ready for a trial trip.

Brown and Higginbotham were both present at the opening ceremonies. The operator was told to use the regular feed, but to speed the table up a couple of notches higher. The machine was started, the stream turned onto the point of the tool, and the feed thrown in. Brown, Higginbotham and the operator leaned over the table to watch results. The results came. The table was revolving rapidly, and as soon as the water struck it, it hurried for the outside diameter at top speed, where it banked up against the retaining rim. As it accumulated there, standing at an angle of 45 degrees or so, in less than no time it had reached the upper edge of the rim and was running over in a wet, swirling sheet which struck the three spectators amidships, marking a distinct water line on their outer garments. Of course! What else could be expected? They compromised on letting the water drizzle onto the tool at such a rate that it would bank up almost to the top of the rim at the completion of each operation, when the stopping of the table let it run back through the center hole into the pan prepared to receive it.

Fig. 1. The Boring Mill plays a Practical Joke.

Shortly after this compromise, an editor (who, unlike friends Brown and Higginbotham, shall be nameless) appeared on the scene. The editor was a man of ideas. He had just stepped off a train on a trunk line railroad, where the stops were too far apart and the schedule too fast to permit the locomotive to line up opposite the water tank for a drink every time it needed one. Instead, the fireman dropped his scoop into a

trough between the tracks and filled the tender on the run. With this idea in his mind, the brilliant editor suggested the plan of making a scoop for the boring mill, dipping it into the banked up water inside the table rim, then draining it, through a rubber tube, into the reservoir. No sooner said than done. The scoop was made and at the proper angle set. The editor, Higginbotham, Brown, and the operator gathered around the machine for a second trial. The water accumulated as before, but the scoop picked it up and delivered it to the reservoir in a very satisfactory and fascinating way. As the operation proceeded, however, the chips also began to accumulate close to the rim, and before long these had banked high enough to strike the scoop. Zip! Its front lip was bent backwards. Zip! It struck the chuck jaw and was sent out through the window, and the fountain display which had been a feature of the first performance, was again repeated. Having important business on hand, the editor was forced at this stage of the proceedings to catch a train for a distant city, so his clients were deprived of his valuable advice at this juncture.

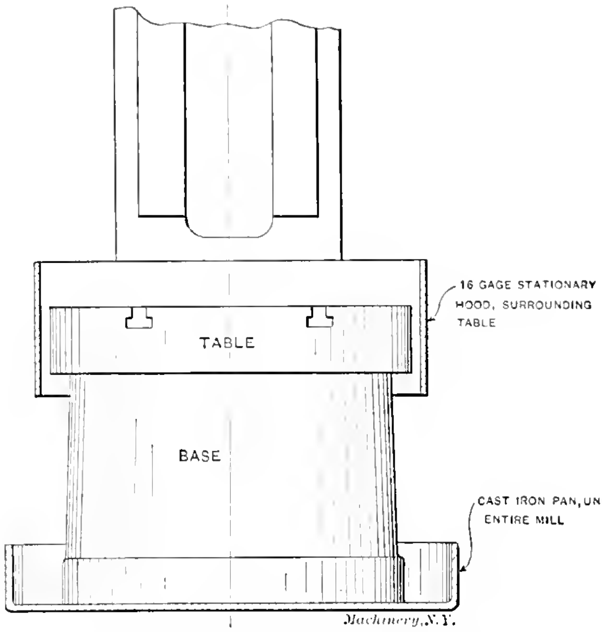


Fig. 2. The Guard which did the Work.

A few days ago the editor got a letter relating to the doings of the only man concerned who had as yet offered no suggestions. It was now the operator's turn. This gentleman, after profound thought, had removed the rim from the table and replaced it with a stationary guard (as shown in Fig. 2), which entirely surrounded the table, and served simply as a splasher to stop the course of the water, as it was thrown off by the revolving table. After striking this guard, the water dropped down into the pan in which the boring mill was set; from here it was drawn by the pump and forced back onto the tool again, none of it flying beyond the confines of the machine, even when the tool was flooded.

By the way, why should not the tool be flooded when cutting steel in the boring mill as well as in the lathe, and is there any simpler or more effective way of controlling the water than the scheme last described?

* * *

The German government is employing very commendable methods for increasing its foreign trade and for gaining knowledge of foreign trade conditions. Instead of making its consular service largely a department through which payment is made for loyal service during political campaigns, the German government endeavors to place only men known as commercial and technical experts at important German consular posts. The work of these officials has been of great benefit to German industries. The important work done by special agents sent out by our government could in a large measure be done by the consuls if men of commercial and technical ability and insight were appointed to these offices. In this respect it would be beneficial to our industries if our administration followed the example of Germany.

DON'TS FOR INVENTORS.

H. S. BUSEY.

Don't wait for inspirations. The faculties for inventing must be trained by careful study and diligent research.

Don't allow difficulties to discourage you. Persistent effort seldom fails to overcome them.

Don't overlook the little things, but practice the "art of taking pains."

Don't be satisfied with your invention until you have learned every thing possible relating to previous efforts and achievements in that particular line.

Don't submit your invention for a patent until you have made all possible improvements. If this requires much time get a caveat.

Don't send sketches or drawings to the patent attorneys without your signature and date on every sheet. Have a witness to sign them also. The attorneys file these sketches, which can be used to advantage in proving priority of invention.

Don't talk about your invention to every one you meet, but without going into details, get the opinion of one or more trusted friends.

Don't demonstrate your invention in public until you have applied for a patent, or better, have been granted one.

Don't exhibit any but a neat working model of your invention in public, and make sure it will work perfectly.

Don't exaggerate the advantages of your invention; hold your enthusiasm in check, while explaining its merits to anyone.

Don't show disappointment if your invention is not immediately appreciated; persistent and untiring effort on your part will bring reward if the invention has real merit.

Don't make any agreement or assignment without consulting a reliable lawyer. It pays to have them written in a legal manner.

Don't employ any but the best patent attorney to write up the specifications and claims of your patent, otherwise it may prove to be worthless.

Don't employ any patent attorney not registered by the Patent Office.

Don't fail to get a Canadian patent if your invention is patented in the United States.

Don't wait too long before applying for foreign patents. Get as many as can be profitably worked with your particular invention. Patents in Great Britain, Germany, and France are specially desirable.

Don't assign even a small part interest in your invention; if necessary, assign a certain portion of the net profits derived therefrom. The holder of an undivided interest in your patent can, if he choose, use the same to your disadvantage.

Don't forget that many inventors have practically lost their patents by assigning undivided part interests, or by signing agreements that they did not fully comprehend. Don't be hasty in such matters, but go over every point carefully, and consult a trusted lawyer before signing or taking any action whatever.

Don't overestimate the value of your patent or invention. Remember that the value of an invention cannot be foretold and that much depends on the way it is managed in placing it upon the market.

Don't, when offered a cash price, refuse to take it, if the sum be sufficient to cover your expenses and leave a reasonable reward for your efforts. The purchaser relieves you of all further responsibility and is taking chances on making it a commercial success.

Don't overlook the fact that shop-rights and territorial rights are sometimes more profitable than selling the patent outright.

Don't try to promote a company of your own to market your invention unless you are experienced in such proceedings, and have assurance and plenty of capital to carry on the business.

Don't assign your patent rights to an incorporated company without having positive knowledge of its financial standing, and the ability of its management. Otherwise, should the company fail, or go into the hands of receivers, the patent rights will be sold to the highest bidder.

ITEMS OF MECHANICAL INTEREST.

ICE TUMBLERS.

Drinking tumblers made entirely of ice are a novelty which has recently been introduced in Europe by the Nederlandsche Ysbeker Maatschappy (Procédé Huizer), Hague, Netherlands. One of these tumblers inserted in a paper shell for convenience in handling, is shown in Fig. 1, while Figs. 2 and 3 illustrate the mold in which it is formed and frozen. If desired, the tumbler can be made with varying degrees of transparency, or even colored by the addition of some harmless coloring matter, and, as it is only used once, it is ideal from the hygienic point of view.

Fig. 1. Ice Tumbler.

Fig. 3 shows a sectional view of the mold in which the tumbler is frozen. A measured quantity of water is first poured in the mold *a*, and then the core *c* is inserted, which forces the water upwards in the space between the two. The mold is then placed in the brine *m* through an aperture in cover plate *l*. The freezing soon begins, because of the thin layer of water exposed, and the tumbler is ready for use in from 6 to 15 minutes, with brine temperatures of 14 and —4 degrees F., respectively. In order to facilitate the removal of the frozen tumbler, the mold is made of a material expanding more rapidly than ice, and the core of a material expanding slower than ice. By sinking the apparatus into a special heater giving off just enough heat to expand the mold without injuring the tumbler, the latter is withdrawn from the mold, but still clings to the porcelain core, principally by the raised ring of ice bearing against it at the bottom; this pressure is due to the different coefficients of expansion of the ice and the porcelain, the latter being smaller. By pushing the piston *d*, which is connected with the handle *g* by the rod *f*, downward, the tumbler is removed from the core and caught in the paper shell which prevents it from coming into direct contact with the hand. The tumbler is then ready for use.

Fig 2. Mold in which the Tumbler is Frozen.

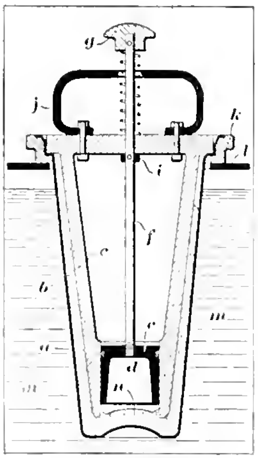
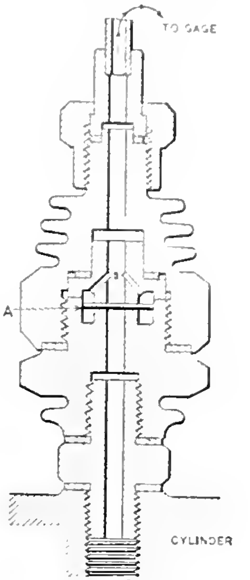


Fig. 3. Sectional View of the Mold.

It is estimated that about one hundred of these ice tumblers can be made in one hour, with the expenditure in energy of one horse-power, and at a cost per tumbler, encased in a paper shell, of one-half a cent each. A small refrigerating machine will produce these tumblers in considerable quantities, and after being made they can be stored, until ready for use, in refrigerators.

PRESSURE INDICATOR FOR INTERNAL COMBUSTION ENGINES.

It is a rather difficult matter to take satisfactory indicator diagrams for high speed internal combustion engines, and it is particularly difficult to determine from the diagrams exactly the amount of compression and the maximum pressure developed, as well as the degree of vacuum during the suction stroke. These quantities, however, can be ascertained by a simple pressure indicator, which has been introduced by Messrs. Negretti & Zambra, 28 Holborn Viaduct, E. C., London, and described in the October 30, 1908, issue of *Engineering*. This instrument is of French origin, and has been named the "acrometer." It consists essentially of a light non-return valve, interpolated in a pipe connecting the cylinder with an ordinary pressure gage, this valve with its connections being shown in the accompanying line engraving. Gases from the cylinder can flow through this valve into the gage, but cannot return, so that when the gage is put into communication with the engine cylinder the pointer of the gage will almost instantly indicate the maximum pressure in the cylinder and continue to do so even if the latter be followed by more or less throttling of the gas supply. If more gas is admitted, a higher maximum pressure will be recorded. If, on the other hand, the gas supply is throttled, thus reducing the maximum pressure, the continual loss of heat through radiation from the gage and connecting pipe, soon causes the pressure indicated by the gage to fall to that developed in the cylinder. This fall of pressure in the gage to correspond to the pressure in the cylinder is hastened by the fact that the joints above the non-return valve are not made absolutely gas-tight. To obtain the compression pressure, a few successively missed ignitions are arranged for. The pressure already indicated in the gage is then released by a valve, and when it is again closed the gage will indicate the degree of compression. In the accompanying engraving the non-return valve itself is shown at *A*, and consists simply of a disk of a platinum alloy, access to which can be gained by unscrewing the cap above it. The lower part of the instrument which screws into the cylinder is made from chrome steel, so as to better resist the action of the hot gases from the cylinder. It is stated that the device in question is used considerably in France.



Section of Valve used in Conjunction with Gage for Recording Gas Engine Pressures.

* * *

A few years ago (November, 1905) a note appeared in these columns relative to the limitation of the speed of the sewing machine because of the heating of the needle due to friction in the cloth. With ordinary thin fabrics the limit is about 3,000 to 3,500 stitches per minute, but if two or three double folds of the same material are sewed, the working speed must be reduced to say 2,500 stitches per minute, as otherwise an ordinary sewing machine needle will become so hot that it will turn blue and lose its temper. Curiously, it has been found that nickel plating sewing machine needles materially increases their working speed. The latest improvement is a peculiar alloy substantially the same as high-speed steel. The fact that the limitation of sewing speed is the endurance of the needle, makes the improvement of direct bearing upon the cost of clothing, and it is an excellent illustration of the far-reaching effects of the discovery of high-speed steel. On lock-stitch machines the limit of speed now is the ability of the mechanism to stand the tremendous strain on its reciprocating parts; no matter if the needle does become blue with heat, its temper is not affected, but on the contrary, it is even harder when hot than cold. In this case the line of future improvement is in the direction of improving the machine rather than the tool or needle.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

AN INDUSTRIAL DEMOCRACY.

The opinion that Germany will be America's chief competitor in the manufacture of machine tools in the future has been voiced by every one who, of late, has studied industrial conditions in Germany; and the subject was brought prominently before American machine tool builders at their recent convention by Captain G. L. Carden.

Without question, Germany has recently developed an extraordinary industrial efficiency; and it is interesting to examine the different causes which have placed that country and America in leading positions in the industrial field. In America, one of the fundamental causes of development in the machinery industry has been the free scope given to individual initiative, and the possibility thereby afforded for utilizing the intelligence of the workman on the problems connected with his work. In Germany, encouragement for the individual, so common with the rank and file in America, has been generally lacking; but this lack has been made up, to some extent, by the more thorough training of the few who occupy supervisory positions. In a sense, the Germans have built up an industrial aristocracy, while in America the development has been along the lines of an industrial democracy.

Captain Carden, in his address, called attention to the beneficial effect, industrially, of the military training imparted in the German army service; and this is true in so far as it is desirable to build up an industrial community which follows, more or less blindly, a few appointed leaders, but in which the individual initiative, so important a factor in the development of American industries, is almost entirely lacking. Military training, as practiced in Europe, is the most effective means of suppressing individuality, its first principle being to teach the masses to obey. In most European countries the ambition of the worker is dulled by the knowledge that he is expected to fill his place as a mere machine; and while he may attain high efficiency in his work, he is not encouraged to independent activity.

The German system represents thorough technical training, experiments intelligently planned and carefully carried out, and scientific principles applied to machine design. These have been the most important factors in the recent development of the German machine tool industry. The American system, as previously stated, is exemplified by the possibilities for individual initiative, the incentives to ambition, and the prizes for originality and development offered the masses. A combination of American and German methods and forces, working harmoniously together, should therefore produce the ideal industrial democracy.

* * *

MOVING PICTURES AN AID TO TEACHING TRADES.

The present day conditions in manufacturing, which so seriously affect the education of young men in useful trades, are attracting wide-spread interest among educators, manufacturers, workmen, capitalists, and practically all who realize the difficulty of acquiring the skill and knowledge essential to any workman who aspires to be a master of his trade. The principle of manufacturing, as now conducted, is essentially antagonistic to the education of skilled workmen, except as specialists; but a condition which results in too many specialists, and too few master workmen is detrimental to the trade.

There are many plans for the education of industrial workers, but none complete or entirely satisfactory, although all may have some very good features. The chief fault of most plans of industrial training is that the learner is removed from the commercial shop atmosphere if he receives the individual instruction desirable. If trained in the shop, he receives little individual instruction, the learner's interests being sacrificed because of the commercial necessity of promoting production.

The moving picture machine offers a partial solution of the problem of imparting individual instruction in the trades. Next to actually doing the thing or seeing a skilled workman do it, is the seeing of it done in a series of moving pictures. For example, take the operation of accurately filing a flat surface on a piece of cast iron held in a vise: A series of pictures showing the correct position and manner of handling the file, could not help making a strong impression on earnest learners of the machinist's trade. The same method would apply to the operation of chipping with the hammer and chisel, scraping, lapping, laying out, and many other hand operations almost impossible of complete description without working examples.

In machine work, the moving picture scheme could be employed with even greater success. The operation of chucking a casting on the face-plate of a lathe and boring and facing, could be shown vividly. Dozens of other operations shown in this way could be repeated indefinitely for the instruction of countless numbers of young men. They would be impressed by the methods illustrated and the spirit in which a skilled workman proceeds in doing the things portrayed. The first investment for films illustrating shop operations would be very heavy, and the plan must be worked out cooperatively in order that manufacturers may avail themselves of this system of imparting apprenticeship instruction cheaply. In our opinion there is merit in this idea as one feature of a general scheme of industrial education.

* * *

Automobile racing is of doubtful value as regards the proper development of the automobile. Under conditions governing past events, the manufacturer was free to build the automobile of practically unlimited power, consequently the speed of an automobile, that could be obtained in racing, was limited only by the purse of the manufacturer and the physical limitations that must be met in the designing of a road machine. Hereafter, however, entries for the Vanderbilt cup races must conform in cylinder diameter to the following maximum dimensions: The bore of cylinder will in future be restricted to 130 millimeters and the stroke to 130 millimeters. With this limitation of cylinder diameter and stroke, the manufacturer who hopes to succeed in future racing contests must design his engine and transmission for the highest possible efficiency, and thus some good may result because of the enforced superior mechanical design.

MANUFACTURERS VS. MONOPOLISTS.

FRED J. MILLER.[*]

What appears to us to be one of the most unpleasant incidents of the political campaign, happily now ended, is the revelation of the fact that the *Manufacturers' Record*, of Baltimore, has received at least one of the now famous "certificates of deposit" from John D. Archbold of the Standard Oil Company. Though we have endeavored to do so, we have found in the columns of our contemporary nothing like an adequate or satisfactory explanation. It publishes a letter received from John Skelton Williams in which Mr. Willilams says "They (the Standard Oil Company) had a legitimate motive for wanting to promulgate sound views regarding the products and advantages of this (the South) section." Mr. Williams tries to make it appear that the certificate of deposit was a payment made for extra copies of the paper, or for other documents issued from the publishers' office and in which the "sound views" referred to are "promulgated." The fact that this payment of $3,000, like those made to certain prominent and hitherto more or less influential public men, by Archbold, was in the form of a certificate of deposit instead of a check, indicates clearly enough that the payer, or the recipient, or both, had reasons for not wishing it to be known to others that the $3,000 had been paid. What may we fairly suppose these reasons to be? In view of the record of the Standard Oil Company, can we suppose them to be legitimate business reasons?

The *Manufacturers' Record* vigorously defends child labor as practiced in the Southern cotton mills. Is this because it has received a certificate of deposit from some one whose interests lie in that direction, or does it really and sincerely believe that this abomination, condemned by practically all disinterested sociologists, is actually a good thing for the South?

The ultimate best interests of manufacturers, North or South, can be served by no paper which is not free to express its honest convictions, or whose circulation is not based upon entirely legitimate subscriptions received from those who buy the paper because they want to read it.

A manufacturer is one thing; a monopolist is another. Sometimes the two are combined in one individual or organization; but the Standard Oil Company, though it is a manufacturer, is preeminent as a monopolist. Manufacturers, as such, do not scatter certificates of deposit among members of Congress or in newspaper offices, and those who receive such certificates from representatives of monopolies do not in return for them, give much consideration to the interests or rights of manufacturers.

The interests of manufacturers and of monopolists are usually directly opposed, and one of the most serious mistakes being made at the present time is in the failure to more generally recognize that fact. No writing upon any wall was ever more plain than is now the fact that monopolies of all kinds are to be much abated or abolished. The faces of the people in practically every country are set in that direction. It cannot be too much insisted upon that a manufacturing enterprise, though it may be large and prosperous and even incorporated, is not necessarily a monopoly; it may on the contrary be honest and beneficent, and usually is so when conducted in the face of actual or potential competition.

There is too much of confusing manufacturers with monopolists, and perhaps the most discouraging feature of the situation is that this confusion exists in the minds of many manufacturers who are by no means monopolists and whose interests are opposed to monopoly.

Such misapprehension and confusion will, we fear, be somewhat increased by the wide publication of the fact that a Standard Oil "certificate of deposit" for $3,000 has been received by a journal which by its title and for other superficial reasons, may be supposed to especially represent manufacturers and to stand for their interests.

[The above editorial, written by Mr. Fred J. Miller, fits in with an idea we have had in mind for some time, to invite short editorials from practical men, published over their own signature, on subjects of current interest. In publishing them MACHINERY assumes no responsibility for the opinions expressed. The editors reserve the right to reject articles which may not reflect ideas of sufficient importance to warrant publication.—EDITOR.]

[*] P. O. Box 27, Center Bridge, Pa.

WHY IS THE BLACKSMITH SHOP NEGLECTED?

In any thorough comparison made between the conditions under which the average machinist and blacksmith work in most of our industrial plants, the blacksmith shop usually suffers. This department is commonly housed in one of the darkest and most dismal of the shop buildings, provided with no other heat than the radiation from the forges, with no ventilation, sanitary appliances or wash rooms, and with an equipment which compares very poorly with that used in the machine shop. It is difficult to account for this difference in surroundings and conditions, because there is no valid reason why the blacksmith should not have as good light or as much comfort as the machinist. The existence of these conditions, however, indicates that the blacksmith and his work are not considered as important an adjunct to the machinery industry as the machinist and his work, and therefore may be treated with less consideration. This view, if it is held by those in responsible positions, is unsound, and shows that most men in authority over such enterprises have received no early training in the blacksmith shop, and have therefore been brought up to consider it as an adjunct of small importance to the department in which they were trained. These men are naturally slow to change their ideas in later years, and consequently the belief that "any old thing" is good enough for the blacksmith shop, has in many cases become the prevailing one. Such a condition is deplorable, because the blacksmith and his work are important enough to deserve the same consideration as the men and the work in other departments. The possibilities of blacksmithing are far greater than most mechanics appreciate; and if the blacksmith be given proper tools and equipment, and the blacksmith shop itself proper attention, a large amount of machining and expensive work done in the machine shop could be largely eliminated by forging to shape; but if the blacksmith shop is neglected, it is not likely that men who can originate new ideas will be attracted to the trade, and this will undoubtedly result in a loss to the machinery industry as a whole. Efficient men are needed in all departments—in the blacksmith shop fully as much as in other departments, in order to develop it properly and in harmony with the rest of the business.

There is no reason why the blacksmith should be subjected to more physical discomfort than other workers in the shop, and it has been demonstrated in many cases that the outlay to provide comfortable surroundings for industrial workers yields ample returns in increased efficiency. Physical discomfort and mental capacity are seldom found together; and the development of the blacksmith shop has not kept pace with the remainder of the establishment simply because mere physical strength has been considered the chief requisite in a blacksmith, and mental ability of less importance. This conclusion needs modification if the full possibilities of the blacksmith shop are to be realized.

* * *

As every technical graduate has discovered, there are many factors entering into the design of machinery which cannot be calculated by mathematical processes or determined from standard tables. One of the commonest and most important of these factors is the commercial one, which deals with the tastes and prejudices of the purchaser, and the possibility of persuading him to exchange good money for a good machine. The instinct for commercially correct design is one of the most difficult, and at the same time one of the most valuable qualifications that an engineer can acquire.

A very striking example of one of these incalculable commercial factors came to our notice the other day in connection with a certain special machine tool, which was being built for a customer located in a region where the trade unions are particularly active. One of the rules of the union to which the prospective operators of this machine belong, is that no member shall operate two machines. As a consequence of this rule, and of the desire of the manufacturer to increase his output and his profits, the simple expedient was evolved of building two machines on one base. The design was preposterous from any imaginable mechanical view-point, but from the purchaser's position the logic of the construction was very clear. The machine has been in use some time, and appears to satisfy both the workmen and the employer.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

One of the French railroads has ordered special railway cars for transportation of automobiles. These cars are provided with stalls and appliances for securing the automobiles in the cars so as to safeguard against injuries to the automobile while in transportation.

Count Zeppelin's new airship, the fifth one of his construction, has been completed, and at the initial flight carried ten passengers and maneuvered for three and one-half hours in the air, rising to a height of 600 feet and attaining a speed of about 30 miles.

It has often been pointed out that the limiting factor of large ocean vessels is the harbor facilities of the various ports of call. In order to accommodate the new White Star Liners, *Olympic* and *Titanic*, of which mention was made in a previous issue, negotiations have been completed for the construction at Southampton of a large dock to have a depth of 40 feet of water at low tide, so that it can accommodate these vessels at any hour of arrival.

Experiments have been undertaken by the British Admiralty at Portsmouth, England, for testing the De Forest system of wireless telephony. Communications were kept up between vessels out of the barbor, and vessels lying in the harbor, and messages were distinctly heard over a distance of more than fifty miles. Some interruptions occurred, however, owing to the use of wireless telegraphy by the ships in the neighborhood.

The first mono-rail passenger line to be installed in the United States is likely to be built within the limits of New York City on the route of the old horse-car line from the New Haven Railroad tracks to City Island. The cars will be carried on two 2-wheel trucks, the wheels running tandem on a single rail. Stability is obtained by two overhead trucks carried on arms, each truck running on L-shaped overhead rails, carried on standards. These guide rails also act as conductors for the current. It is not conclusively proved, however, that any real advantage, either as regards cheapness of construction or operation, is to be gained by this construction over the ordinary two-rail track.

The hour-glass is commonly regarded as an ancient timepiece of no practical importance to-day, and more of a historical curiosity than anything else, but the hour-glass and modifications of it still have important uses. For timing hardening and tempering heats in twist drill manufacture and for similar purposes, where the operator requires to have an accurate gage of the time elapsed in seconds or minutes, there is nothing so simple and so reliable as a sand glass, of such proportion that the sand will run out in a specified number of seconds or minutes. No calculation is required of the operator; he has no timepiece to watch but simply the running stream of sand. It has a valuable characteristic in that it enables the user to anticipate the exact moment at which the sand will run out and thus gage the time to a fraction of a second. This is very difficult to do with a watch.

The National Conservation Commission intends to take a comprehensive census of the standing timber in the United States. Several estimates have been made in the past, but, of course, the figures given are more or less unreliable. It has been assumed that there is an available stumpage of 1,400 billion feet, and that the annual use is about 100 billion feet. Assuming these figures to be correct, and neglecting growth in the calculation, it will be seen that our timber supply will be exhausted in 14 years. Assuming the same figures to be true, and also an annual growth of 40 billion feet, we would have a supply for 23 years. Some estimates of our stumpage give as high as 2,000 billion feet, which would give us a supply for 20 years, neglecting growth, and a supply for 33 years assuming an annual growth of 40 billion feet. It is apparent from these figures that we are much nearer the exhaustion of our timber supply than most people have ever imagined.

The Westinghouse Electric & Manufacturing Company has been awarded the contract to electrify the Manhattan and Queens terminals of the Pennsylvania Railroad, the initial amount of the apparatus required under the contract amounting to $5,000,000. The electrification of the terminals will include the long stretch of track between Newark, in New Jersey, and Jamaica, L. I. The Westinghouse Co. has already built a huge electric locomotive and this engine, operated over a special track on Long Island, has met the requirements for speed and power. A speed of 120 miles an hour has been reached in tests and the engine will develop 4,000 horse-power. A hundred of these engines, bigger and more powerful than any electric engines ever built, will be built for the Pennsylvania. The model engine has been put to severe tests for elasticity of construction, for power, speed, and action on rails and curves. A rough estimate of the amount of horse-power to be used in the electric zone, under river and land, is about 250,000 horse-power.

In a note in *Engineering*, issue of October 30, 1908, a comparative table compiled by the Swedish Patent and Registration Office is given, showing the percentage of patents in force in various European countries after a certain number of years from the issue of the patent. The patents, it appears, lapse on account of non-working, which, of course, indicates that the patent has proved to be of small or no value. The term of patents in most European countries is fifteen years, and the table shows that during the fifteenth year only six per cent of the total number of patents issued are still in force in Sweden, while in Germany and Great Britain this figure is 3.5 and 3 per cent, respectively. Italy shows the smallest percentage of patents alive for a period of fifteen years, there being only two out of every 100 patents in force for that number of years. This indicates how few inventions are really of practical value. Of the patents, those for inventions in the chemical field proved to have the greatest longevity. Next come the electrical patents, and the patents that appear to be of the smallest value in proportion to the number issued are those relating to ordinary mechanical appliances.

An interesting example of the increase in land values following an important engineering undertaking is given by *Mercator*. Referring to the Assuan Dam in Egypt, this publication states that the total cost of the dam will be $12,000,000, but this expenditure has so far made possible the irrigation of an area of about 175,000 acres, and the increase in the land value has amounted to about $25,000,000. During the next three years about 275,000 acres additional land will be irrigated, and the increase in the value of this will be about $40,000,000. It is the intention later to increase the height of the dam about 25 feet, which would enable the irrigation of an additional 500,000 acres. The expense for this work would be about $2,400,000 and the increased value of the irrigated land $75,000,000. Something like a total expenditure of $14,400,000 will thus be followed by a corresponding increase in land value of $140,000,000. This is simply a single example of how all improvements of a public character tend to increase the value of land. If this increase in value were turned into the public treasury, it could be made to pay easily for all public improvements required. A similar example may be had in New York City, where the building of the subway produced an increase in the value of the land in the upper part of Manhattan Island and the Bronx largely exceeding the cost of the subway itself. If this increased value, due to public improvements, reverted into the public treasury, there would always be ample means for extending public works.

INTERCHANGEABLE INVOLUTE GEAR TOOTH SYSTEMS.

Abstract of Paper by Mr. Ralph E. Flanders, read before the American Society of Mechanical Engineers, December, 1908 Meeting.

The purpose of this paper is to investigate and compare various interchangeable involute gear tooth systems, including the standard form. This investigation was suggested by the many departures from the standard form which have been made in recent years. These departures are becoming more and more numerous, and their increasing use on certain classes of work suggests that the standard form may be unfitted for a considerable part of the field it was intended to cover.

Briefly, the results of this investigation may be summarized as follows: First, the present standard system is involute for but a comparatively short portion of its outline—in fact, for not over 35 per cent of its total height; the shape of the remaining portion of the tooth is known only to the makers of the cutters, so that the system is a private commercial standard instead of an open public engineering standard. Second, marked improvements can be effected by adopting a new standard, in the direction of avoiding interference, giving greater length of involute contact, increasing durability, and, especially, in the matter of increasing the strength; it seems to be clearly shown that a new standard should be adopted, at least for heavy gearing.

Scope of the Investigation.

The standard form of gear tooth for cut gearing has a pressure angle of 14½ degrees and an addendum (in a one diametral pitch gear) of one inch or $1 \div P$. The pressure angle of an involute gear is the angle that the line of action makes with the common tangent to the pitch circles of two gears in mesh; or it may be stated as the angle made by the side of a rack tooth of a given system, with the perpendicular to the pitch line (see a in Fig. 4). In any system of involute gearing the pressure angle remains the same for all gears in the series. The addendum is the height of the tooth above the pitch line. As this also remains the same for all the gears in a series, a system of interchangeable involute gearing may be defined by giving the pressure angle and addendum.

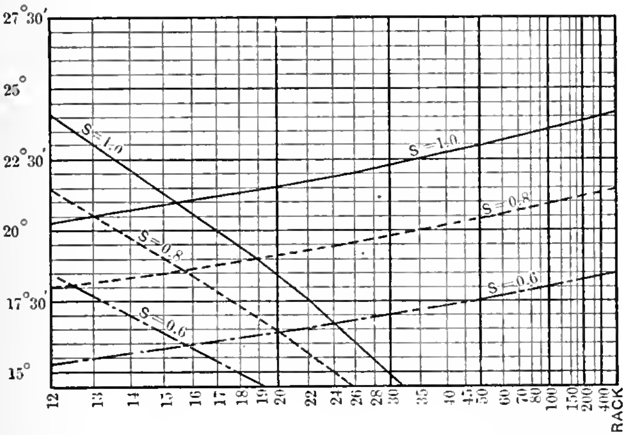

Fig. 1. Effect on Interference of Changes in Addendum and Preseure Angle.

For the sake of simplicity, in all the calculations herein recorded, the teeth are supposed to be of one diametral pitch. The pressure angles investigated range from 14½ to 27½ degrees. Three heights of addendum are considered: 1.0, 0.8 and 0.6 inch respectively, for one diametral pitch. These limits are thought sufficient for the purposes of this paper. It should further be stated that in all calculations where it is necessary to assume the number of teeth in the smallest gear of a series, that number is taken to be 12, the same as in the standard system. The following reference letters are used:

S = height of addendum,
a = pressure angle,
N = number of teeth,
n = number of teeth in continuous action.

Effect of Varying the Pressure Angle and Addendum.

The effect of varying the addendum and pressure angle is investigated with reference to the following practical considerations: Interference; number of teeth in continuous action; side pressure on journals; strength; efficiency; durability; permanence of form; quietness and smoothness of action; suitability for practical cutting processes; and miscellaneous practical considerations.

Fig. 1 illustrates the effect of changing the addendum and the pressure angle on the question of interference. The lines rising toward the right in the diagram indicate the largest number of teeth in the gear in any given system of interchangeable gearing, which will mesh with a 12-tooth pinion without correction for interference with the flanks of the teeth of the latter. Thus, in a system of interchangeable gears in which $a = 17\frac{1}{2}$ degrees and $S = 0.6$, the diagram shows that all gears having more than 50 teeth must be corrected to avoid this interference with the 12-tooth pinion. The lines rising toward the left indicate the minimum number of teeth possible in the smallest pinion in an interchangeable series, to avoid entirely the phenomenon of interference. Thus with the standard form in which $a = 14\frac{1}{2}$ degrees and $S = 1.0$, if 32 be taken as the number of teeth in the smallest gear of the series, instead of 12, it will not be necessary to correct the rack of any other member of the system for interference.

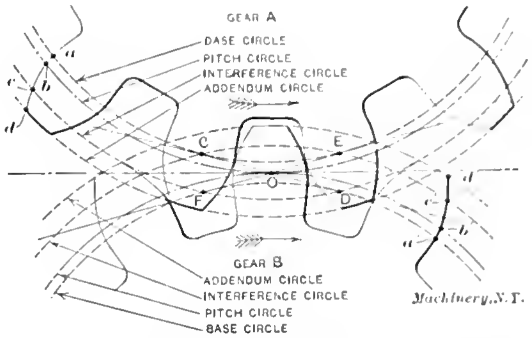

Fig. 2. Extent of Interference between Two 12-tooth Standard Pinions.

The following formulas were used in calculating this diagram. For the maximum number of teeth possible without interference with the 12-tooth pinion,

$$N = \frac{36 \sin^2 a - S^2}{S - 6 \sin^2 a}$$

For the minimum number of teeth possible without interference with an uncorrected rack,

$$N = \frac{2S}{\sin^2 a}$$

It will be seen from the diagram that with the standard form of gearing, in which $a = 14\frac{1}{2}$ degrees and $S = 1.0$, interference occurs to such an extent that the correction of the face of the tooth has to be carried clear down to the smallest gear in the series, it being impossible for two uncorrected 12-tooth pinions to mesh without interference. This condition is shown in Fig. 2. The contact between the two gears, running in the direction indicated and with gear A as driver, takes place along the line CD, being determined by the points of tangency of this "line of action," as it is called, to the "base circles" of the two pinions. That part of the face of the teeth of gear A (see shaded portion at the right) which lies outside of the interference circle passing through point F, extends beyond any possible contact with the mating

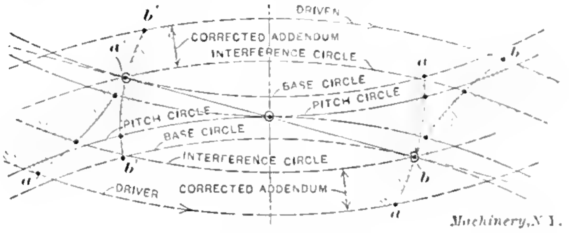

Fig. 3. Limits of True, Involute Action with Two 12-tooth Standard Pinions in Mesh.

pinion, and so is useless for conjugate action in its uncorrected form. Not only is it useless but it is positively harmful as well.

Fig. 3 shows, in diagrammatic form, the positions of the teeth of the two gears in Fig. 2 at the beginning and end of their action; contact begins at *C* and ends at *D*. As the gears continue to revolve, tooth face *aa* of gear *A* will interfere with tooth flank *bb* near the base circle, making proper meshing of the teeth impossible, no matter what the form given to the flanks of the teeth below the base circle. This phenomenon of interference is discussed in all treatises on gearing.

Everything outside the interference line then, in Fig. 2, must be corrected for interference. The amount of this correction increases with the number of teeth in the gear, reaching its maximum in the rack as shown in Fig. 4. As will be explained later, the nature of the correction depends on the form arbitrarily given to the flanks of the teeth of the smallest pinion, below the base circle.

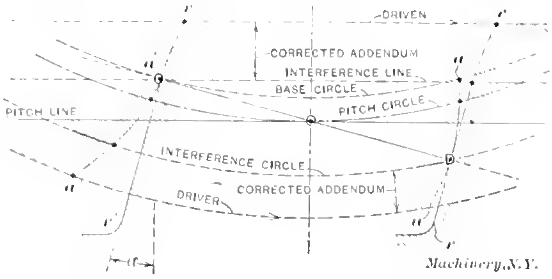

Fig. 4. Limits of True Involute Action with a 12-tooth Pinion and Rack (Standard) in Mesh.

The next thing to consider is the number of teeth in continuous action. Fig. 5 shows the maximum and minimum number of teeth in contact, for any system of interchangeable involute gearing in which the 12-tooth pinion is the smallest. The minimum contact occurs in the case of two 12-tooth pinions in mesh, and the maximum in the impractical case of two racks in mesh. As will be seen, the 14½-degree series of whatever height of addendum, gives less than continuous action, being about 0.987. It will also be noticed that below the points of interference for the 12-tooth pinion (represented by the junction points of the maximum and minimum lines with the interference line) the contact is constant. Thus, for a system in which $\alpha = 20$ degrees and $S = 1.0$, the amount of contact between any two gears of the series from 12 teeth to a rack, is constant at about 1.40, while for a system in which $\alpha = 22$ degrees 30 minutes, and $S = 1.0$, the amount of contact varies between 1.36 for a minimum and 1.58 for a maximum. Figs. 3 and 4 show this condition, which indicates that if in any series there is interference in the case of the two pinions having the smallest number of teeth allowed by the series, the amount of action obtained in that case is constant for any other case throughout the whole series, up to that of two racks meshing with each other. As far as the author knows, this condition has never before been noticed.

In Fig. 3, which shows two minimum pinions of a series meshing with each other, the action is limited to the line *CD*. In Fig. 4, which shows the minimum pinion meshing with a rack, the action is still limited to the same line *CD*. It cannot extend beyond *C* in one direction, because it cannot pass the point of tangency in the base circle of the pinion. It cannot pass beyond *D* in the other direction, because the points of the pinion teeth are corrected beyond the interference circle, losing their true involute form. In the case of any other gear meshing with a rack, the action is limited to *C* on one end owing to the correction for interference of the points of the rack teeth, and at *D* on the other end owing to the correction for interference of the points of the gear teeth. And in the case of any two gears, the action is similarly limited to the line *CD* by the corrections for interference at the points of the teeth. As may be seen, then, a pure involute system in which $\alpha = 14\frac{1}{2}$ degrees and $S = 1.0$, just fails of continuous conjugate action in the case of any two gears of the series.

The formula used for calculating the maximum curves of Fig. 5, above the interference points, is as follows:

$$n = \frac{2\,S}{\sin\alpha \times \cos\alpha \times \pi}$$

The formula used for calculating the minimum curves is as follows:

$$n = \frac{2}{\pi\cos\alpha}\left[\sqrt{(6 + S)^2 - (6\cos\alpha)^2} - 6\sin\alpha\right]$$

The formula for calcuating the interference line, which gives the contact below the interference points, is as follows:

$$n = \frac{12\tan\alpha}{\pi}$$

One of the great practical advantages of the involute gear is the possibility of varying the center distance without interfering with true conjugate action. The comparative amount of separation possible for any two proposed systems, without losing continuous action, may be estimated from Fig. 5 by comparing the amounts of continuous action for the two cases. Naturally the one having the greater number of teeth in continuous action will stand more separation than one which has less. This point could be calculated, but by processes so devious that it did not seem worth while to spend the time for it.

With increase of the pressure angle there is an increase in the side pressure on the journals. Since the side pressure on the journals is the resultant of the tangential pressure between the mating teeth at the pitch line, and the radial outward thrust due to the angularity of the meshing surfaces at the pitch line, it varies directly with the secant of the angle. The curve shown in Fig. 6 is therefore a secant curve.

The rational formula for the strength of gearing is the well known one developed by Mr. Lewis.*

As the strength varies directly with his factor *y*, this factor forms the basis of comparison for different forms of teeth.

Fig. 7 shows the maximum and minimum values of *y* for certain selected forms of gear teeth. It will be seen that the values of *y* rise rapidly with the decrease of the addendum, and more slowly with an increase of the pressure angle, which does not affect it so much.

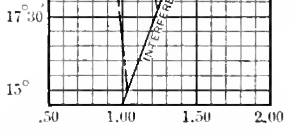

Fig. 5. Maximum and Minimum Number of Teeth in Continuous Action.

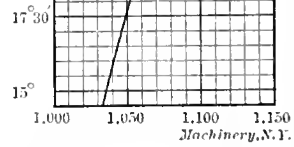

Fig. 6 Side Pressure on Bearings.

Fig. 8 shows that the values obtained for *y* vary somewhat from those obtained by Mr. Lewis (it will be noted that his values have been multiplied by π to make the formula read for diametral pitch). This variation is probably due to the fact that in this investigation the outlines from which the factors are calculated have their teeth corrected for interference, thus bringing the normal pressure at a greater angle at the points of the teeth; and to differences in the method of laying out the fillets.

The work lost in friction in the case of two gears meshing with each other is proportionate to the product of the rate of sliding and the normal pressure on the surfaces in contact. This rate of sliding varies directly with the distance of the point of contact from the pitch point *O* (Figs. 3 and 4, etc.) of the gears. The pressure is constant throughout

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* Kent's Pocketbook, page 901.

the action, except that when two teeth are in contact it may be considered that the pressure is evenly divided between them. The diagram in Fig. 9 was calculated by a modification of the method devised by an English engineer, Mr. Bruce.* The calculations are made for a single case of gearing, an 18-tooth pinion driving a 60-tooth gear. This case was selected as typical.

The diagram for durability is shown in Fig. 10. The wear between the teeth of two gears is proportionate to the continued product of the pressure, the rate of sliding, and a third factor which depends on the shape of the surfaces in contact. This factor is greater for sharply curved convex surfaces and less for a large radius curve rubbing on a flat surface, for instance. This being the case, it seemed to the author that a reasonable basis of comparison for different systems of gearing could be made by multiplying the values given in the diagram of Fig. 9 by a factor determined from the shapes of the surfaces in contact, and plotting the reciprocal. In determining this factor, the author has followed Mr. C. H. Logue,† who obtains it by adding together the sums of the curvatures (that is, the sums of the reciprocals of the instantaneous radii) of the gear teeth at the pitch line. This should give a value which is approximately an average of the conditions existing throughout the entire action. (It should be understood that Figs. 9 and 10 indicate comparative values only. Positive calculations of efficiency or durability are not here contemplated.)

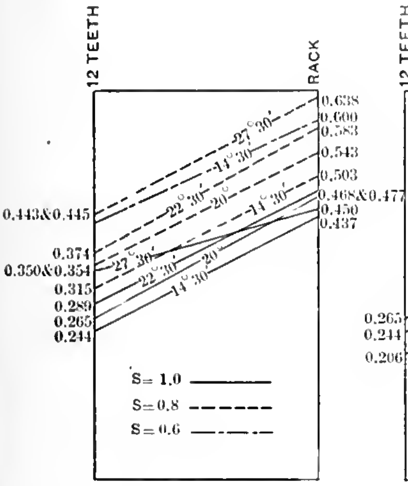

Fig. 7. Maximum and Minimum Values of Strength Factor for Typical Cases.

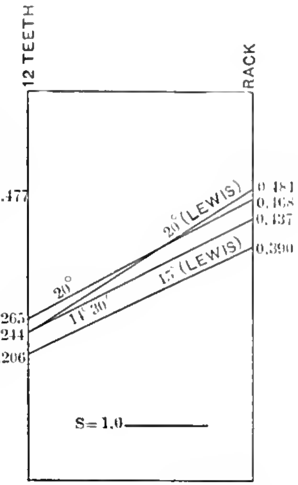

Fig. 8. Comparison of Values for y Here Obtained with those Calculated by Mr. Lewis.

The question of permanency of form may be considered aside from that of durability. By durability we mean the lasting quality of the gear, without reference to whether or not it keeps its shape in the wearing process. A gear which has permanency to a high degree might wear out very rapidly, but it would retain nearly its true form throughout the whole of its short life. In Fig. 11 is given a series of diagrams showing the tendency of a correctly formed tooth to wear at different points of the tooth outlines, in the case of a 12-tooth pinion and the rack, and for the same pressure angles and addendums that were selected for the strength diagram of Fig. 7.

Besides the various factors for which diagrams are given, there are a number of important ones of such a nature as to be incalculable. One of these factors is the suitability of a system for use in different methods of tooth cutting. Any form of tooth which involves interference is very unsatisfactory for use in any generating process, for instance. The formed cutter process works with equal facility on any form of tooth, except that the increase in the pressure angle gives somewhat more side clearance, leading to a freer cutting action.

The vital incalculable factor is smoothness of running. Smoothness of action depends theoretically on perfect conjugate action between the mating teeth. In practice it depends as well on accuracy of cutting tools and accuracy of machine setting. The cutter may be set out of center, or set deeper than required, or have its face ground at an angle considerably away from the radial plane required to give the true cutting shape. The standard form of gear tooth, developed by the Brown & Sharpe Manufacturing Company, has been improved by long practical experience, to a point where it takes care of these practical inaccuracies in a very satisfactory way.

Relative Importance of the Various Considerations.

As to the importance of the various considerations mentioned above being affected by changes of the pressure angle and addendum, it may be said that the difficulty due to interference (apart from its effect on strength, efficiency, etc., which is considered under those heads) is that of making the shape of the gear indeterminate. The design of the standard gear is empirical. While the writer has followed the plan of making the flanks of the 12-tooth pinion radial, and generating the fillet by means of an extended and rounded rack tooth, produced by such a radial flank, he does not know that this is the form of the standard tooth. The exact form is known only to the makers of standard cutters and is not public knowledge. It will be seen that this matter of interference makes of the standard system practically a short tooth system so far as the theoretical bearing is concerned. This is plainly shown in Fig. 11, for Case 1, which is the standard involute gear tooth. The bearing extends over but a very small part of the tooth faces and flanks. The bearing can, of course, be carried clear to the points of the teeth by making the non-involute parts of the teeth on some other conjugate system. This would give more action than Fig. 5, but since only a part of it is involute, the excess of action would be lost as soon as the center distance is changed. A conjugate correction of this kind is made by the manufacturers of standard cutters.

The number of teeth in continuous action, shown in the diagram of Fig. 5, is of importance principally in relation to smoothness of action. It is not generally considered possible to count on distributing the load evenly between two teeth in calculating the strength of gearing, though it will be noted that where n is slightly more than unity, two teeth are in bearing at the beginning and end of the action, when the fiber stress in the teeth is at the greatest. In the matter of smoothness of action, it is necessary to have one pair of teeth take up the load before the previous pair drop it. Increased smoothness of action, due to smoothing out irregularities in cutting, could be effected by having two, three or more sets of teeth in action at one time, but this is impracticable with interchangeable involute gearing. A considerable length of contact is also of advantage in permitting a considerable variation in the center distance, without loss of continuity of action, as previously explained. In this respect the increased pressure angles will be seen to have considerable advantage over the standard form.

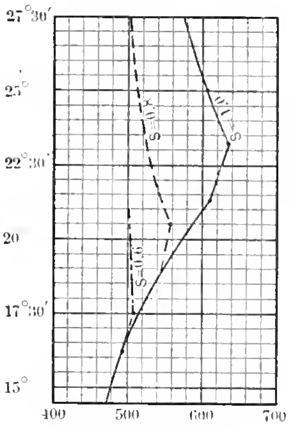

Fig. 9. Comparative Amount of Lost Work.

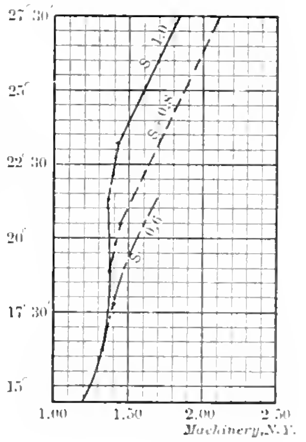

Fig. 10. Comparative Durability.

The side pressure, shown in Fig. 6, is an almost negligible factor. As may be seen, the increase for even so great an angle as 27½ degrees is only 9 per cent above that given by the standard form. At 22½ degrees it is 3 1/3 per cent

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* *American Machinist*, October 10, 1901.
† *American Machinist*, February, 1908.

above. As the shaft bearings can take care of this slight increase of side pressure in a perfectly normal and satisfactory way, the question scarcely enters into consideration.

The matter of strength is an important one. If a stronger form of tooth can be used, many mechanisms can be gotten into a much smaller space than is otherwise possible. A case in point is the design of geared speed and feed mechanism for machine tools, in which the space problem is usually serious. By decreasing the face of the gear to correspond with an increase in the strength factor *y*, the problem of the designer would be greatly simplified. Instead of reducing the width of the gear by using a stronger form of tooth, advantage can be taken of the stronger form to increase the number of teeth and make them of finer pitch. This gives smoother action, owing to the small inaccuracies in the fine teeth. Smoother action at high speed also means increased strength, owing to the lessening of stresses due to impact.

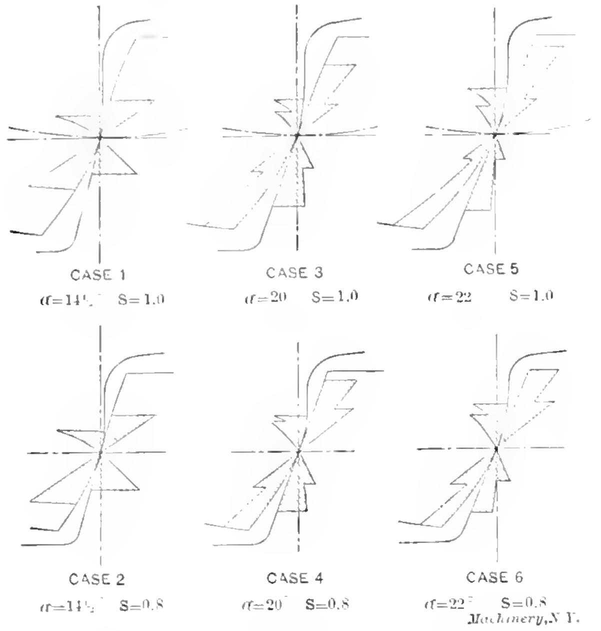

Fig. 11. Permanence of Form.

It is becoming recognized that impact at high speeds is greatly affected by the accuracy of the surfaces in contact; and even where the strength is sufficient, the matter of noise in high speed gearing is of great commercial importance. People would not buy noisy gearing if they could help it, even if it fulfilled their requirements in every other particular.

The question of lost work (plotted in the diagram of Fig. 9) is not a matter of serious moment. The efficiency of well-made spur gearing is so high[*] that the slight variations indicated by the diagram are of small practical importance. This diagram, of course, takes no account of the increase in lost work due to increase in journal pressure, which is an inconsiderable factor with well made bearings.

Durability is of much more importance. Gears have been almost invariably designed hitherto for strength rather than durability, but it is becoming recognized that in many cases the principal factor in gear design is the wear of the teeth. If then the methods by which the diagram of Fig. 10 is calculated are rational, the results there shown are of considerable importance.

Permanency of form is another important factor. Gears which the writer has seen worn out in hard service, show very plainly the severe concentrated wear inside the pitch line indicated in Case 1 of Fig. 11. The advantageous effect of an increased pressure angle on permanency is worthy of consideration.

The fitness of a tooth form for various cutting processes is of importance in determining the future of the apparently attractive generating method of cutting gear teeth. One form of generating process has come into extensive use in spite of the handicap of the 14½-degrees angle, with the various corrections for interference required. There is reason to believe, however, that this process works better with forms of teeth in which the angle is increased or the addendum decreased. Were the change advisable for other reasons, this fitness for generation would be an added advantage, though it would scarcely be worth changing on this score alone. So far as cutting teeth by the formed cutter process is concerned, an increase in the pressure angle is favorable, as more side clearance is obtained for the cutter; while decreasing the addendum gives less volume to cut out, and a consequent cheaper production of gears. It might also be mentioned in this connection that the decrease in face or pitch that could be obtained by the use of stronger forms of teeth, would also result in cheapening the gear, owing to the fact that less metal would have to be removed.

Comparison of Typical Involute Tooth Systems.

It is proposed to give, in connection with this discussion of the effect of the variation of pressure angle and addendum, a comparison, by the diagrams herewith presented, of varous typical forms of gearing in relation to the practical points just discussed. For the purposes of this discussion the following forms are considered:

Case 1: $\alpha = 14\frac{1}{2}$ degrees, $S = 1.0$.
Case 2: $\alpha = 14\frac{1}{2}$ degrees, $S = 0.8$.
Case 3: $\alpha = 20$ degrees, $S = 1.0$.
Case 4: $\alpha = 20$ degrees, $S = 0.8$.
Case 5: $\alpha = 22\frac{1}{2}$ degrees, $S = 1.0$.
Case 6: $\alpha = 22\frac{1}{2}$ degrees, $S = 0.8$.

Case 1 has the standard pressure angle and addendum. Case 2 is practically the system employed by the C. W. Hunt Co.; 3 is the system used by William Sellers & Co.; and 4 is practically the "stub tooth" system. The last two will show the effect on the Sellers and "stub tooth" systems respectively, of increasing the pressure angle from 20 to 22½ degrees. The table, in which these various forms with their corresponding advantages and defects are tabulated, suggests that by a change in the present standard of gearing, marked advantages could be obtained on the following scores: avoidance of interference, giving a greater number of teeth in true involute action, and permitting more separation with continuous contact; increase of strength; increase of durability; increase in permanency of shape; and increase in fitness for generation and cutting by formed cutters. On the other hand, such changes mean an increase in side pressure, comparatively little change in efficiency, and an incalculable

COMPARISON OF SELECTED EXAMPLES OF INVOLUTE GEAR-TOOTH SYSTEMS.

Point of Comparison.	Case 1.	Case 2.	Case 3.	Case 4.	Case 5.	Case 6.
	Standard Pressure Angle and Addendum.	Hunt Standard (approximate)	Sellers Standard.	"Stub-tooth" (approximate).		
Smallest pinion in series to avoid interference............	32	26	17	14	14	11
Maximum number of teeth without correction for interference with 12-tooth gear..	None	None	None	36	35	Rack
Maximum and minimum number of teeth in continuous contact	0.98	0.98	1.38	1.38 1.18	1 58 1.36	1.44 1.13
Proportion of side pressure on bearing to tangential pressure	1.033	1.033	1.064	1.064	1.082	1.082
Strength factor of rack...............	0.437	0.503	0.468	0.543	0.477	0.583
Strength factor of 12-tooth gear......	0.244	0.315	0.265	0.354	0.289	0 374
Comparative loss of work from friction.	475	475	572	552	628	532
Comparative durability	1.21	1.21	1.39	1.44	1.40	1.63
Permanency.........	See Fig. 11		......	......	......	......

For incalculable factors, see text.

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[*] Mr. Lewis' Experiments, Kent's Pocketbook, page 899.

and unknown change in smoothness of action. Side pressure and efficiency (as has been shown) are of comparatively minor importance. Smoothness of action is of prime importance. The results of a change in this respect can only be arrived at by learning the experience of the users of the various forms of gearing.

It should be noted that the above comparison relates to pure involute action only. As the shape of the non-involute portion of the standard tooth is not public knowledge, it was impossible for the author to analyze its action. Could it have been analyzed, it would doubtless have shown better results for the standard form in Figs. 5 and 11, and not quite such good results in Figs. 9 and 10.

Whatever the condition relative to high speed work, however, it seems to the author that the preceding discussion points clearly to the wisdom of an alternative gear tooth standard of shorter addendum and increased pressure angle for such work as heavy mill gearing and slow speed gearing in general, in which smoothness of action is not a prime requirement. Increased strength and permanence of form would appeal particularly to engineers whose work permits them to design machinery by rational rather than by empirical methods.

Aside from the specific cases mentioned, correspondence and conversation with makers of cut gearing bears testimony to a growing demand for, and use of, a stronger form of tooth. The adoption of a standard for this work would give all the advantages which come from standardizing; the preparation of tables of dimensions and of strength; the devising of odontographic tables for the fillet at the root of the tooth, and for the correction—if any is needed; and the reduction in the stock of form tools necessary for doing a general line of gear cutting work.

In any event, a standard of gearing of known form, which can be laid out by any engineer who desires to employ it, would be an advantage, if such a consummation is possible without sacrificing any of the good qualities which we are accustomed to expect from the present standard.

ALCOHOL AS A FUEL FOR INTERNAL-COMBUSTION ENGINES.

Abstract of article by Thos. L. White in the *Engineering Magazine*, September, 1908.

It is the purpose of this article to consider the suitability of alcohol as a gasoline substitute, and as there are many types of engines, designed to fill widely varying needs, the subject is one which has many sides and may easily be made confusing or misleading unless the issue under discussion is very clearly defined. In considering the difficult matter of changing over from gasoline to alcohol, it is important to remember that the two fuels differ in a dozen essential particulars; that the current type of motor is a gasoline instrument evolved under gasoline conditions; and that the greatest variety of opinion exists as to how far the accepted rules of construction will have to be modified to suit the change. Moreover, there is the important economic fact to be considered that some millions of gasoline motors are at present in use, and that it is not only a sound but a necessary policy to try to maintain their constructional features as far as possible, changing nothing unless there is a distinct necessity for each change, or a distinct advantage resulting from it. That there are to be had special alcohol machines, which are excellent for certain purposes, is beside the real issue which is concerned with using alcohol in the high-speed, low-compression engine.

The evolution of engine types in the past has not been so much along the lines indicated by considerations of fuel economy as along the lines indicated by considerations of handiness, reliability, and flexibility. If alcohol possesses advantages of this character, when burned in the present type of gasoline motor, and if any operative disadvantages incidental to its use (such as difficulties of starting up) can be eliminated, and some increase of efficiency attained by recourse to less radical means than high compressions, then there will be no need to consign the present engine to the scrap-heap in order to be able to burn alcohol. It is the opinion held in this article that alcohol has several such advantages, and that its efficiency in the gasoline motor can be increased without virtual reconstruction. Incidentally, it is well to remember that in the matter of compression there is no golden mean. The gasoline engine compresses to 80 pounds at most, and till this is increased to over 130 pounds, the gain in thermal efficiency resulting is not worth the trouble of the alteration.

While it has always been the aim of designers to make the gasoline motor as flexible as the steam engine, the narrow range within which a charge of gasoline and air can vary in composition and yet remain explosive has always prevented any regulation of the power by the manipulation of the mixture. In the case of alcohol and air, however, the variation of the proportions compatible with perfect combustion is four times as great, and it has been determined by experiment that the specific power of the working stroke of an alcohol engine can be reduced to 25 per cent of maximum, by the operation of an auxiliary air throttle. In automobile practice this means that the adoption of alcohol would tend toward fewer cylinders and simpler gears. The actual limits within which alcohol and gasoline mixtures are respectively explosives are 4 per cent to 14 per cent, and 2 per cent to 5 per cent, tested at atmospheric temperatures and pressures.

The alcohol motor has been severely criticised because of the alleged difficulty in the matter of carburation, which is occasioned by the high latent heat in alcohol. It is difficult to see wherein the drawback from this cause exactly lies, and as far as one can tell the criticism seems to arise from the widespread notion that all preheating of the in-going charge is prejudicial to the efficiency of the motor. The fact is that preheating the mixture *after* the fuel is in a state of vapor is harmful in two ways: First, the whole body of the ingoing mixture being thereby expanded, the actual weight of mixture that enters the cylinder during the suction stroke is decreased, so that the specific power of the motor is lessened; second, the efficiency of the motor is reduced, for while there is no lessening of the negative work done during the compression stroke, the energy of the succeeding expansion stroke on which it is a *pro rata* tax is less, there being less fuel present. Preheating the mixture, however, or its constituents separately, within limits and before the fuel (in this case alcohol) has become converted into vapor, has no tendency whatever to rarefy the charge, and is consequently without effect, at any rate on that score, on either the specific power or the efficiency of the motor.

To the question of carburation is closely related the question of starting up from cold. The alcohol motor has been widely attacked in this connection and as widely defended, and the only satisfactory course seems to be to disregard all evidence of a merely general character. Even specific cases cannot be regarded as having much weight, unless the accompanying conditions were normal, for the pertinent issue is not whether a start can be made from cold under the most favorable conditions, but whether a start can be made under any conditions that are likely to occur in practice. The question also seems to be a separate one for each type of motor, technically because the character of the difficulty to be overcome varies with different constructions, practically because the matter is of more importance in the case of the automobile engine than in the case of the stationary engine. The high pressure German motors may be considered separately, as they constitute a class in themselves, being unsuited to burn gasoline. According to the principle adopted for vaporizing the fuel, they fall naturally, for the present purpose, into two divisions respectively, typified by the Durr motor, in which pre-heat is relied on, and the Deutz motor, in which the alcohol is sprayed into the ingoing air, vaporization being effected by the aid of the heat generated during the compression stroke. In neither case can a start be made from cold, for in the one the necessary pre-heat is wanting while in the other the compression by hand is too slow to volatilize the alcohol in the mixture.

In the case of the low-pressure or gasoline motor, it is impossible to make any accurate subdivision, the type varying all the way from the farm motor, with a rate of 100

R. P. M and a ratio of stroke to bore of 2 to 1, to the fastest automobile motor with a rate of 2,000 R. P. M. and a ratio of stroke to bore of 1 to 1. Carefully conducted experiments go to show that when the speed is moderate and a good expansion is provided for, the gasoline motor will start up from cold on alcohol under laboratory conditions, but there is little evidence to prove that any gasoline motor can be set in operation when the circumstances are unfavorable, as, for instance, in moderately cold weather. So far as the fast running type is particularly concerned, the problem is not so much to be able to start up at all times and under all conditions on alcohol, as to be able to run at all on this fuel with any show of efficiency; and there are many reasons for agreeing with the statement of the Fuels Committee of the Motor Union, that the solution lies in combining the alcohol with benzol or acetylene, not merely to facilitate starting up, which is regarded as an incidental gain, but to bring the alcohol nearer in character to gasoline, so that it can be used under the gasoline conditions by which the limitations of the ordinary motor are determined.

The principal difficulties experienced when alcohol is used in the high speed motor, arise from the fact that this fuel ignites slowly, compared with gasoline, and that when ignited the propagation of the flame throughout the mixture is not sufficiently rapid to suit a piston velocity of over 12 feet per second, and a piston travel which, at any rate in the case of the automobile motor, is strictly limited in range. The disadvantages, direct and indirect, which result from this sluggish ignition and tardy inflammation are several, and all important. Combustion, instead of being completed when the compression and temperature are greatest, is continuous during the entire expansion. From a thermodynamical standpoint this means that a portion of the heat units contained in the alcohol are not being liberated to the best advantage. It has been claimed for the alcohol motor that this phenomenon of delayed combustion is a positive advantage, giving a smooth, even thrust on the piston and a high mean pressure. That such an effect has been observed in alcohol motors is beyond doubt, but it must be attributed, not to the sustained inflammation, since it is most noticeable in very slow-running motors in which combustion is completed during the early portion of the expansion stroke, but to the presence of steam produced from the burning of the alcohol and from the water with which this fuel is always diluted. Provided that this steam (which is of course superheated almost up to the dissociation point) receives its heat content at the maximum temperature of the expansion, its presence and action is in every way an advantage, for it represents internal as against external cooling of the cylinder walls, and the retention of heat units in the working fluid, which would otherwise pass into the water jacket.

If, however, the superheat of the steam is regenerated as the expansion proceeds by the continued burning of the fuel, this regeneration is effected at the cost of the thermodynamic loss stated above, a loss which is avoided if the steam receives its whole energy at the beginning of the expansion. To the credit of delayed combustion must be laid not only the work losses due to a portion of the fuel being burned at a disadvantage, but also losses due to a portion of the fuel being only partially burned or not burned at all. The exhaust is found to be contaminated with products of combustion other than water and carbon dioxide, and ceases to be odorless and unobjectionable.

Once it is clear that the problem of substituting alcohol for gasoline as a fuel in the high speed motor, reduces itself to seeking a more vigorous ignition and a more speedy inflammation, and conceded that these desirable ends can be obtained by the addition to the alcohol of some compound which will generally accelerate its action in the motor, the natural suitability of acetylene as a corrective can hardly be overlooked. This gas, which has the same formula of composition as tar benzol, has the further property, which is shared by no other fuel, that it is an endothermic compound. In its formation heat is absorbed, and there resides in the acetylene molecule the power of spontaneously decomposing and liberating this heat, if it is subjected to a temperature or pressure beyond the capacity of its unstable nature to withstand.

If the liberation as heat of the reserve energy of acetylene (which, it should be noted, is an operation quite distinct from combustion, in that it can take place in the absence of oxygen) is effected when the acetylene is diffused through the body of an inflammable mixture, it is found that each detonating molecule of acetylene becomes a center of inflammation and the whole mass is burned with a speed and vigor that is only limited by the proportion of acetylene present. In the case of alcohol, the practical question is whether the conditions favorable to the spontaneous decomposition of acetylene are induced, when air carburated with alcohol and acetylene is compressed and ignited in the motor in the usual way; and the experimental answer is that they do. The rise of pressure set up in the mixture when the ignition takes place is accelerated by the detonation of the successive portions of acetylene as they are involved in the advancing pressure wave, and it is found that the ignition line in a pressure-volume diagram taken on a motor burning a mixture of alcohol and acetylene is even at 2,000 revolutions, as vertical as the corresponding line in a pressure-volume diagram taken on the same motor when it is burning gasoline.

All denatured alcohol contains a percentage of water, and it is a fact that alcohol containing from 10 to 15 per cent of water is in every respect a better fuel than pure alcohol. The action of the water is very obscure, and it has not been satisfactorily determined how far the percentage can be increased without the consequent lowering of the calorific value of the mixture more than offsetting the benefit in the motor. What is relevant here is that the advantages derived from the presence of comparatively large percentages have been principally experienced in connection with high compressions, and to get similar results in the low-compression high-speed motor, the damping effect of a large admixture of water calls especially for the accelerative action of acetylene on the inflammation and ignition.

In conclusion, if we consider that the automobile motor is an instrument in which power must be sought by high piston velocities, and that starting with Daimler's motor this condition has been accepted without question as the basic canon of construction of this class of engine, it seems almost inevitable that the use of alcohol, in the automobile field at any rate, will continue along the lines of carburating the alcohol.

* * *

It is not improbable that the United States government will soon authorize plans for the construction of a gas-engine battleship. The gas engine and gas producer plant has peculiar advantages for battleships. In the first place, there is the saving of fuel and space—in themselves very important. The chief features of the gas-engine battleship that command the attention of naval experts, however, are the absence of smoke and funnels. The funnels are a great source of danger in time of attack as it is impossible to armor them so as to insure non-penetration, and the smoke betrays the coming of a fleet long before the vessels themselves can be discerned. The strategic importance of avoiding funnels and smoke, therefore, can scarcely be overrated. It is probable that future battleship design will center around the use of gas engines and gas producers as the motive power.

* * *

A great deal of time is spent in the average machine and metal working shop in clearing away the chips which accumulate on drilling and other machines while at work. The application of the rotary pressure blower for blowing these chips away and keeping the work clear, is a recent innovation. By directing a jet of air from the blower directly onto the work a close observation may be kept by the workmen without the necessity of constantly wiping away the chips by hand or with a brush. Perhaps 10 per cent of the total working time on each job would be a low estimate for the operation of simply clearing the work of these chips. This being true, the small cost of a pressure blower pays for itself many times over in doing the work. Besides this, a certain amount of the air may be diverted to other uses at the same time.

NOVEL PUMP CONSTRUCTION FOR PRESSES.

W. M. FLEMING *

Many interesting problems are presented to manufacturers of power pumping machinery, in the adaptation of power pumps to replace the less economical but somewhat more flexible direct-acting steam pump. The Deane Steam Pump Co., Holyoke, Mass., recently supplied a special small triplex power pump equipment for use in connection with a hydraulic press system, which is a case in point. The triplex power pump installation replaces a direct-acting steam pump and materially reduces the cost of operation.

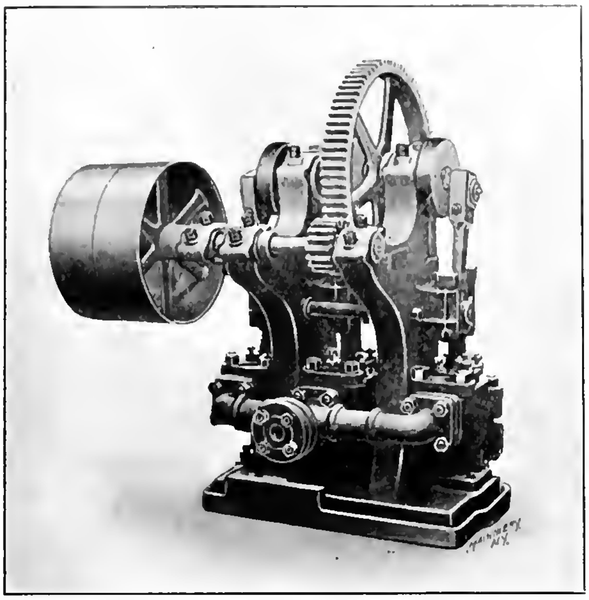

Fig. 1. Low-pressure Deane Single-acting Geared Pump.

The problem presented to the manufacturer in this case was to provide, for any one of three presses operating successively: first, a comparatively large quantity of water at low pressure for advancing the press ram until it met with considerable resistance, due to the load, and second, to supply a gradually diminishing supply of fluid at gradually increasing pressure, until the maximum desired load on the press platen has been obtained, at which point the discharge from the pump must cease automatically, but the pressure must be maintained on the press for a period of several hours.

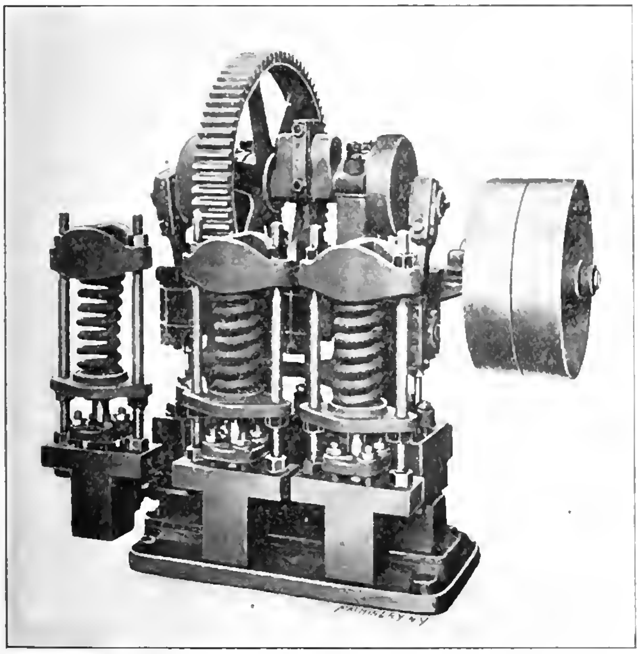

Fig. 2. High-pressure Deane Triplex Geared Pump with Spring Alleviators.

These peculiar conditions of service were taken care of by the installation of two pumps: a low-pressure and a high-pressure machine. The low-pressure pump is shown in Fig. 1, and as can be seen, is simply a power pump of the vertical triplex outside packed single-acting pattern, designed for a working pressure of 1,000 pounds. This machine is connected with a header from which water may be drawn through a check valve into any one of the three presses supplied. It is started manually and stopped by means of an automatic hydraulic belt shifter, when the pressure in the header or discharge from the pump rises to 1,000 pounds.

The special high-pressure pump shown in Fig. 2, and in section in Fig. 3, has the discharge from each individual cylinder piped to a press through a proper three-way operating valve, and operate continuously, discharging back to the suction when not to the press. This pump is novel in that it has a separate spring-controlled alleviator directly connected to the pulsation chamber of each cylinder. The alleviators are designed with a capacity equal to the capacity of the pump plunger and the springs of the alleviators are of such size that, when the pressure in the pump cylinder exceeds 1,000 pounds per square inch, the springs just begin to compress. When the pressure rises to 6,000 pounds per square inch, the springs compress to such an extent as to permit the alleviator cylinder to take the entire amount of water displaced by the pump plunger, and under these conditions no discharge from the pump occurs.

As previously stated, there are three presses supplied by the two pumps, the presses being worked consecutively. When the first press is made ready for operation both pumps are started manually. The low pressure operating valve is opened, advancing the press ram until the ram strikes the load, and the resistance increases so as to raise the pressure in the discharge line from the low pressure pump to 1,000 pounds per square inch. At this point this pump is automatically thrown out of action. A check valve in the line between the discharge header from the low pressure pump and press No. 1 closes, and the high-pressure pump, Fig. 2, continues to advance the plunger of the press until the maximum required pressure of 6,000 pounds per square inch is reached. As this pressure is approached, the alleviator goes into action and ultimately receives all of the fluid displaced by the pump plunger, returning the fluid to the pump cylinder on the suction stroke of the plunger, thus reducing the load on the pump to practically friction load. The second press is made ready meanwhile, and the low-pressure pump again started manually and the operation repeated on the second press.

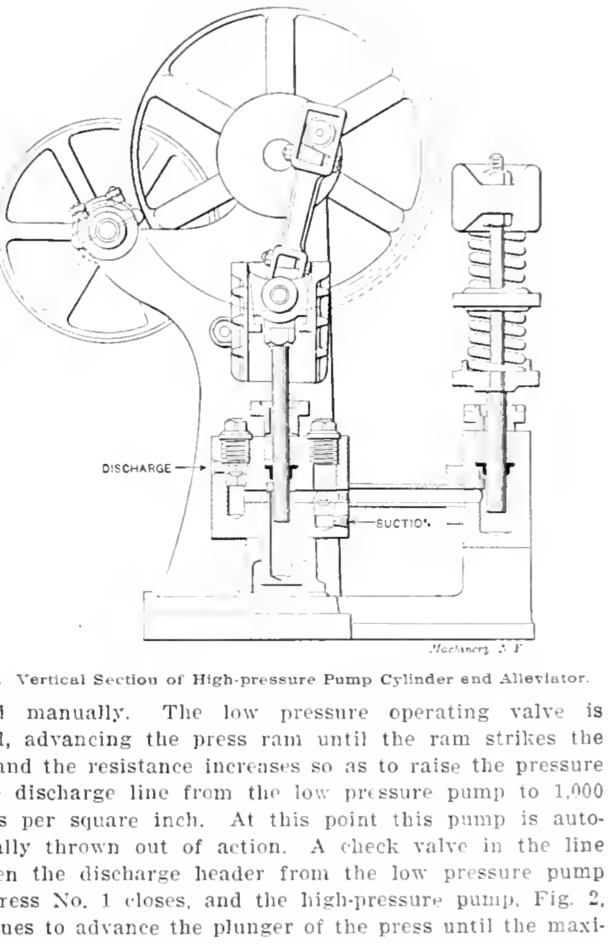

Fig. 3. Vertical Section of High-pressure Pump Cylinder and Alleviator.

From this description and from the drawing, it will appear that this outfit constitutes a very compact and mechanically efficient pumping plant for the service described. The saving of power by its use over the use of the direct-acting steam pump is appreciable, and the use of the low-pressure pump materially reduces the time of what may be termed, inactivity of the presses.

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* Address: 370 Maple St., Holyoke, Mass.

MACHINE FOR CUTTING OUT METAL SHEETS.

The machines illustrated in Figs. 1 and 2 are specially constructed for the purpose of cutting out metal sheets into any desired shape. With them, templets of all sorts, sweeping boards for foundries, and similar pieces can be blanked out with great rapidity. This type of machine is not intended for repetition work, as such work is done more suitably by means of special dies and punches; but it is essentially a machine to replace the hammer and chisel work which is often necessary when only one or two pieces of a similar shape are required.

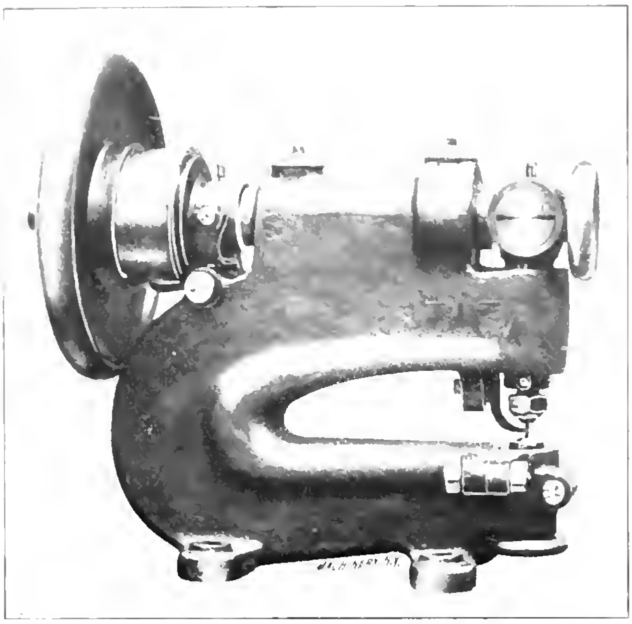


Fig. 1. Machine for Rapidly Blanking out Special Irregular Shapes in Sheet Metal. Size from Punch to Throat, 12 Inches.

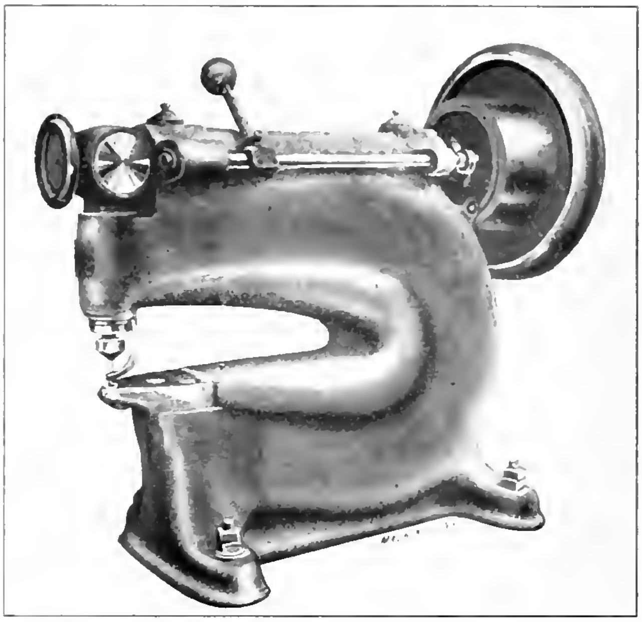


Fig. 2. View, from the Opposite Side, of a Larger Type of the Machine shown in Fig. 1. Size from Punch to Throat, 24 Inches.

Two sizes of these machines are illustrated. The one shown in Fig. 1 has a 12-inch gap, is suitable for plates up to 1/8 inch in thickness, and runs at comparatively high speed, making 300 revolutions per minnte. Fig. 2 illustrates a larger machine, having a gap of 24 inches, but it is also limited to plates having a thickness of 1/8 inch or less. The speed of the larger type is 250 revolutions per minute. These machines are provided with a round punch of a special shape, such as shown in the enlarged view at *A*, Fig. 3. The cutting edge of the tool is in front, and can be set in any direction to suit the work. The back of the punch is prolonged to act not only as a stay for the punch, but also as a guide for the sheet being cut. This extension, which works in the die held in the anvil just below the punch, is long enough to work up and down in this die throughout the stroke. The die can be raised or lowered by means of a screw, to enable the operator to pass a sheet of metal under the punch, so that he may begin to cut at some point in the middle of the plate.

When the machine is in operation, the sheet being cut is guided by the operator so that the punch removes the metal as close as possible to the desired outline previously scribed. The sheet is fed by being pressed lightly against the punch, which causes it to feed inward against the punch extension with each upward stroke. As the end of the punch extension is never above the die, it acts as a guide and greatly facilitates in feeding the work which moves in quite rapidly, owing to the high speed of the machine.

The stroke of the machine is slightly greater than the thickness of the piece to be cut, and the movement is obtained by a special eccentric motion which is illustrated in the sectional view, Fig. 3. As will be seen, an eccentric or off-set pin is journaled in a cylindrical piece which reciprocates horizontally as the ram moves vertically. This method of transmitting the motion from the shaft to the ram greatly simplifies the construction. In the engraving, Fig. 4, the shape of the chip taken at each stroke is illustrated by the dotted lines. In Fig. 5 some of the examples of the work done on this machine are shown. The locomotive connecting-rod templet seen in the upper part of the engraving, is approximately 0.118 inch thick, and was blanked cut in 12 minutes, while the moulder's strickle shown just below it, which is 0.078 inch thick, required but a single minute. Work of this kind can be done so easily that very little practice enables the operator to cut out forms so closely to the previously scribed lines, that a little filing will finish the work.

* * *

THE DIPLOMATIC DRAFTSMAN.

TIBBAB.

In the drafting-room of a certain shop manufacturing a number of articles requiring special automatic machines, I once witnessed a deception practiced by one of the draftsmen, that always ended in saving money for the shop, time in getting out the machine, repeated changes in design, and annoyance for the draftsman. This latter result may have been the ruling passion, yet the other things accomplished must not be forgotten. I have somewhere seen diplomacy defined as the art of getting something from the other fellow and at the same time making him believe that he has gotten something from you. If this is true, then the draftsman in question was a past-master as a diplomat. This game of diplomacy was played with the shop superintendent.

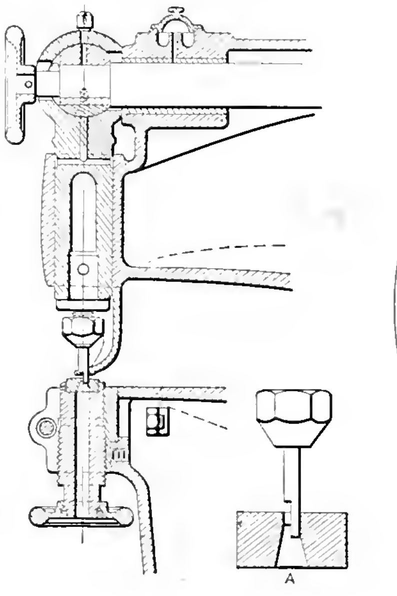


Fig. 3. Sectional View of Reciprocating Parts and Die-holder.

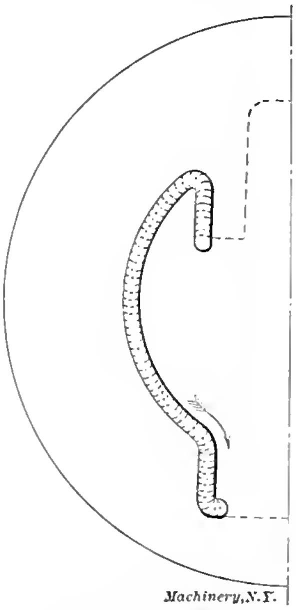

Machinery,N.Y.

Fig. 4. Half-view of a Templet, illustrating by the Dotted Lines the Successive Punchings.

Now the wise superintendent, if he has a machine of a given series to design, will give the draftsman the limits of the product to be turned out on that machine, possibly a few leading dimensions, and leave the rest to him. That

is, if he is a good draftsman—but a wise superintendent never has anything but a good draftsman. He may get the others a little cheaper, but they are expensive. The superintendent of the shop in question was a wise superintendent, for he did all of the above named things, but he was unwise inasmuch as he did not let it end there. He wanted to get into the detail of design too much. He wanted to see that a cam face was not ⅛ inch too wide when ¼ of an inch would have made no great difference. With this characteristic fully developed, it was his habit each morning during the hour devoted to the drafting-room, to change the diameter of a shaft ¼ inch, the width of a slide ½ inch, the diameter of a cam roller or its stud by some small amount until, by making a few changes small and inconspicuous in themselves, he had mapped out enough changes, erasures, moving of parts, etc., necessary to accommodate these minor changes, to keep the draftsman busy about all day. He also had a habit of impressing the draftsman with the fact that the changes must be made, and the changes were made. During the next week, however, things that had appeared too light, might, when changed, seem too heavy, thus necessitating another alteration.

Do you wonder that it was discouraging for the ambitious man to work there? Do you believe me when I say that the drafting force was continually changing and that it was hard to keep a good man?

There were in the drawing-room only a draftsman, tracer and blue-print boy—the latter two embodied in one person who seemed to be a fixture. The draftsman was, however, a transient: First, because the superintendent knew a good man when he saw him work and unless he was good would soon get rid of him; and, second, because the good men would not or could not stand the dictation of the superintendent and would leave. At last, along came a man, "the best man who ever pushed a pencil over a piece of paper," according to the statement of the superintendent. Not only was this man a good draftsman, but he was also a good reader of character. He seemed to size up the superintendent immediately, and, at the same time, seemed to know just how to handle the situation. I have seen him repeatedly lead the superintendent over the parts that he had been accustomed to change, to some minor part, usually something that would not affect the parts already designed, and discuss this with an energy that would make one believe that it was the only vital part of the machine. Over and over again would the two men study this part until the time came for the superintendent to go, or until he was called away. He usually went away with the remark that he would take that up the next time; and, under the artful guidance of the draftsman, he usually did. Thus did the draftsman guide the superintendent from part to part in such a way that the changes made did not affect the previous design. The draftsman was happy, more work went through the drawing-room, there was a more systematic progression in the designs, there were no changes in the drawing force, and there was a superintendent who was better satisfied, less anxious, and had a lighter burden to bear. I know the superintendent was better satisfied, for his visits to the drawing-room were less frequent, and I have once or twice heard him remark, "If there is anything you want to talk over with me on this design call me in, otherwise go ahead."

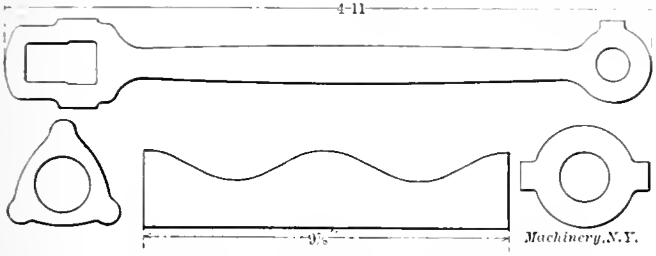
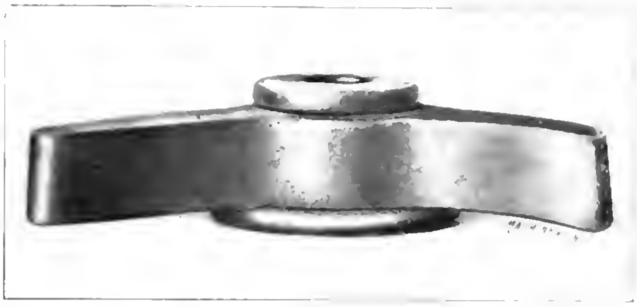


Fig. 5. Examples of the Work for which the Machine is Adapted.

This confidence in the man was not due to his great ability as compared with those preceding him, but can be attributed only to the fact that the draftsman had educated the superintendent to the fact that minor changes are not necessary in machine design. The draftsman, too, was wise enough to call in the superintendent and discuss at length any of the essentials with which he was not familiar. At no time during the period in which the man was a draftsman, and up to the time he was made assistant superintendent, did he appear conceited or in any way pretend to know more than the superintendent. I believe this to be one of the greatest helps.

I want to be just to the superintendent and speak of his good qualities as I have of his weaknesses. He was a wonderful man as a shop superintendent, leaving the details of the several departments to his foremen, having the confidence and esteem of the workmen, and at the same time making dividends for the company every day. Had the drawing department been a large one with a chief and a number of men, I believe his attitude would have been the same as toward all other branches of the factory and that he would have left all details to the man in charge. He had but to learn that the small department could be handled in the same way.

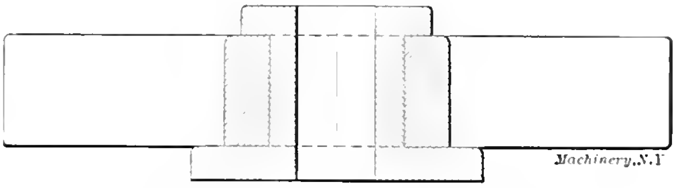


A Casting Puzzle—The Bushing with Flanges is One Piece and is a Loose Fit in the Pawl.

* * *

CASTING PUZZLE.

The accompanying half-tone illustration and line engraving illustrate a difficult piece of casting made by the Taylor & Fenn Co., Hartford, Conn. The casting is a brake ratchet pawl with bushing, used on street railway cars. Both the bushing and the ratchet are solid castings. It will be a puzzle, we expect, to most mechanics to figure out how this work is accomplished. The clearance between the two castings is only a few thousandths inch.



Cross-section of Brake Ratchet Pawl and Bushing.

* * *

An ingenious and simple method of cutting master plate cams to accurate lead, is used in the shops of the Windsor Machine Co., Windsor, Vermont. Suppose, for instance, it is desired to cut a plate or disk cam having a portion of its periphery formed with a uniform rise, at the rate of 1.360 inch to a revolution of the cam. The blank is mounted on a work arbor in the usual way, and a plain cylindrical cutter of sufficient length is clamped in place on the spindle. The indexing is set for a number of spaces obtained, for instance, by dividing the lead per revolution by 0.005. This gives $1.360 \div 0.005 = 272$. The blank is adjusted at the proper height for the cutter to machine the top of the desired rise. The dogs are set as when cutting gear teeth, and the slide runs back automatically, the work indexes and the cutter feeds forward again. During the indexing the work head is fed downward by hand 0.005, the number of thousandths agreeing with the number used for dividing the lead to get the indexing. This combination of the automatic feeding and indexing of the machine, and the feeding of the head down 0.005 inch at each indexing, is continued until the required cam outline has been completed. The working edge is then carefully dressed off with a file, after which the master cam is ready for use.

MACHINE SHOP PRACTICE.*

GASHING AND HOBBING A WORM-WHEEL.

In the construction of worm gearing, the distance from the center of the worm to the center of the worm-wheel may be fixed, or, in some cases, variations, within reasonable limits, may be permitted. When the center distance is fixed, which will be the condition governing the work under consideration, the mechanic may have the opportunity of testing the accuracy of his work by assembling the finished gear in its place, which is, of course, desirable. We shall assume, however, that in this case, such opportunity is not afforded.

The worm itself should first be accurately finished as it can be used advantageously in testing the center distance when hobbing the worm-wheel. We shall assume that this has been done, and that the wheel blank has also been turned, and will consider the method of hobbing the teeth in the latter in a universal milling machine. It is first necessary to gash the blank. This operation consists of cutting teeth, which are approximately the shape of the finished teeth, around the periphery of the blank, by the use, preferably, of an involute gear cutter of a number and pitch corresponding to the number and pitch of the teeth in the wheel. If a gear cutter is not available, a plain milling cutter, the thickness of which should not exceed three-tenths of the circular pitch, may be used. The corners of the teeth of the cutter should be rounded, as otherwise the fillets of the finished teeth will be partly removed. After the gashing operation, the teeth are finished to conform to the shape of the worm by revolving the blank and a cutter known as a hob, together, sinking the latter into the blank until the teeth are cut to the required depth. As the worm which meshes with and drives the worm-wheel, is simply a short screw, it will be apparent that if the axes of the worm-wheel and worm are to be at right angles to each other, the teeth of the wheel must be cut at an angle to its axis in order to mesh with the threads of the worm. The method of setting the work and obtaining this angle will first be considered.

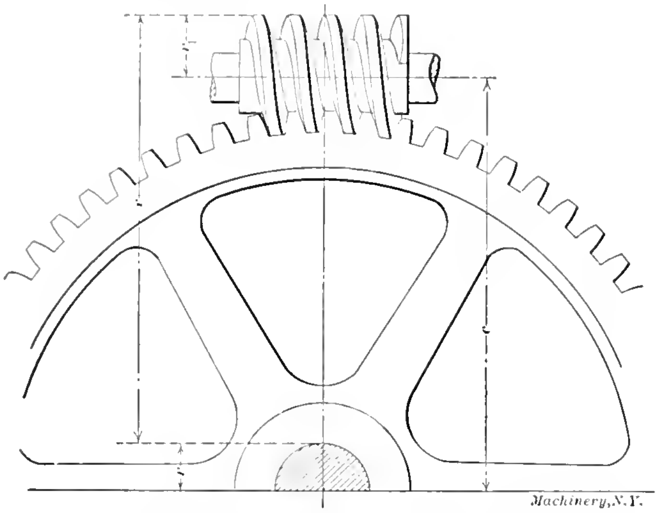


Fig. 1. Determining Center Distance between Worm and Wheel.

After the dividing head and tail-stock have been clamped to the table and the cutter has been fastened on its arbor, the table is adjusted until the point of the center of the dividing head and the center of the cutter lie in the same vertical plane. (See Shop Operation Sheet No. 1.) If the cutter used has a center line around its periphery, the table may be set by raising it high enough to permit the index head center to come in contact with the cutter; the table can then be adjusted laterally until the center coincides with the center line on the cutter. When the table is set, it should be clamped to the knee slide. The blank to be gashed is now pressed on a true-running arbor which is mounted between the centers of the dividing head and tail-stock as illustrated on Shop Operation Sheet No. 86, and the driving dog is secured, to prevent any vibration of the work. The table is now moved longitudinally until a point midway between the sides of the blank is directly beneath the center of the cutter arbor. To set the blank, place a square blade against it on first one side and then the other and adjust the table until the distances between the blade and arbor, on each side, are equal. Of course, if the diameter of the arbor were greater than the width of the blank, the measurements would be taken between the latter and the square blade. The table should now be set to the proper angle for gashing the teeth. This angle, which should be given on the drawing, may be determined either graphically or by calculation. The first method is illustrated in Fig. 2. Some smooth surface should be selected, having a straight edge as at *A*. A line *B*, equal in length to the lead of the worm thread, is drawn at right angles to the edge *A*, and a distance *C* laid off equal to the circumference of the pitch circle of the worm. If the diameter of the pitch circle is not given on the drawing, it may be found by subtracting twice the addendum of the teeth from the outside diameter of the worm. The addendum equals the linear pitch × 0.3183. The angle *a* is then accurately measured with a protractor, as shown in the illustration. The table of the machine is then swiveled to a corresponding angle which can be measured by the graduations provided on all universal milling machines. If the front of the table is represented by the edge *A*, and the worm has a right-hand thread, the table will be swiveled as indicated by the line *ab*; if the worm has a left-hand thread the table will be turned in an opposite direction. The angle that the teeth of the worm-wheel make with its axis, or the angle to which the table is to be swiveled, may also be found by dividing the lead of the worm thread by the circumference of the pitch circle; the quotient will equal the tangent of the desired angle. This angle is then easily found by referring to a table of natural tangents.

When the table is set and clamped in place, as many gashes are cut in the periphery of the wheel as there are to be teeth. If the diameter of the cutter is no larger than the diameter of the hob to be used, the depth of the gashes should be slightly less than the whole depth of the tooth. This whole depth may be found by multiplying the linear pitch by 0.6866. Before starting a cut, bring the cutter into contact with the wheel blank, set the dial on the elevating screw at zero, and sink the cutter to the proper depth as indicated by the dial. When the cutter is larger than the hob, the whole depth of tooth should be laid out on the beveled side of the blank, and a gash cut in to this line. The depth as indicated on the dial should then be noted and all the gashes cut to a corresponding depth.

When the gashing is finished, the table is set at right angles with the spindle of the machine, and the cutter is replaced with a hob which is practically a milling cutter shaped like the worm with which the wheel is to mesh. The outside diameter of the hob and the diameter at the bottom of the teeth, are slightly greater than the corresponding dimensions of the worm in order that there may be clearance between the latter and the worm-wheel. Before hobbing, the dog is removed from the arbor. The hob is then placed in mesh with the gashed blank, and, as the two rotate together, the blank is gradually raised until the body of the hob between the teeth just grazes the throat of the blank. After the work has made a few revolutions, to insure well-formed teeth, the hob and wheel are disengaged, and the finished worm is placed in mesh with the latter, as shown in Fig. 1, after the chips have been thoroughly removed from the teeth on which the worm bears. The worm is now turned along the periphery of the wheel until its axis is parallel with the

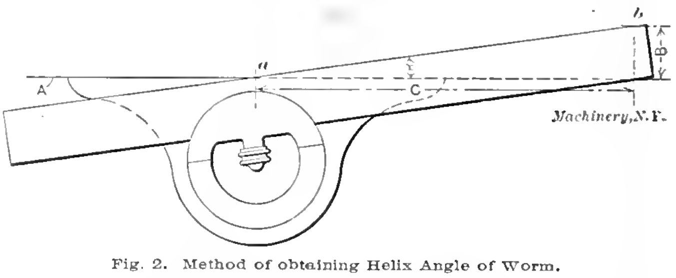


Fig. 2. Method of obtaining Helix Angle of Worm.

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* With Shop Operation Sheet Supplement.

top of the table. It may be set in this position by testing the top surfaces of the threads at either end with a surface gage. Set the pointer of the gage so that it just touches the top of a thread and measure the distance x from the pointer to the arbor. Subtract from this dimension the difference between the radii r and r_1 of the arbor and worm, and the result will be the center distance C. If the worm is accurately made and the worm-wheel blank turned to the exact dimensions, this center distance should be very close to the distance required. If necessary, the hob may be again engaged with the wheel and another light cut taken. When testing the center distance, as explained in the foregoing, it is better to lower the knee sufficiently to make room for the worm beneath the hob, and not disturb the longitudinal setting of the table, as the relation between the wheel and hob will then be maintained, which is desirable in case it is necessary to re-hob the wheel to reduce the center distance.

When worm-wheels are made in large quantities, they are cut in machines especially designed for this purpose, in which the wheel blanks, instead of being mounted on a free-running arbor, are driven by gearing at the proper speed. This makes gashing the blank previous to hobbing unnecessary, as the change gears insure a correct spacing of the worm-wheel teeth.

* * *

BENDING STRESSES IN CAR TRUCK ARCH BARS.

W. E. JOHNSTON.*

The stresses occurring in bent and offset rods and bars appear to be underestimated rather frequently. A particular instance of this is met with in the design of the bottom arch bar shown in Fig. 1. Several of these gave indications of weakness in service with loads as indicated. The material in the bars was the usual grade of arch bar iron.

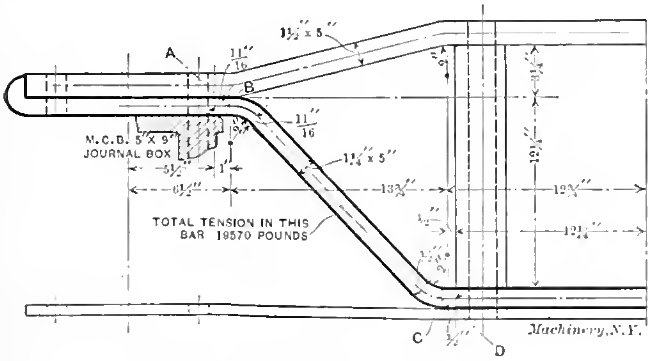

Fig. 1. Data of Railway Car Truck Arch Bar.

In calculating the stresses in this bar, the first step is to locate a center line so as to determine the amount of the offset, which is the lever arm on which the tension in the bar acts to produce bending moments and resultant stresses in addition to those due to direct tension. It is apparent that when the load comes on the bar, it will bend down over the edge of the journal box, and up around the edge of the column, and the two bends will straighten out slightly, as shown exaggerated for clearness in Fig. 2, which indicates the character of the stresses set up by these deflections. Assuming that the journal box bolts and column bolts are tight, so that the arch bar is held firmly to the journal box and columns, without deflection between the bolts, the portions of the bar extending out beyond the edge of the journal box at the top and the column at the bottom will act as beams, rigidly fastened at one end and loaded at the other, carrying the load out toward the adjacent bends to the points where the bending moment reverses. The bending moment reverses midway between the bends also. A line AD, Fig. 2, drawn through points B and C on the lines of reversal, will be the center line of the pull on the bar, and the length of a perpendicular to this line from any point on the center line of the bar itself, between the bearing on the journal box and columns, multiplied by the pull, will be the bending moment acting on the bar at that point.

Since the section of the bar is uniform, it will be sufficiently accurate for practical purposes to draw the line AD Fig. 1, so that the perpendiculars on it from the center line of the bar at the edges of the bearings on the journal box and columns, will be equal to the longest ones that can be drawn from the center line at the adjacent bends. In this case, these perpendiculars are 11/16 and ½ inch respectively, as shown in Fig. 1, and will be the lever arms on which the force P will act to produce bending moments. The total pull P is about 19,570 pounds. The area of the bar is 5 × 1¼ inch = 6¼ square inches. The stress, due to direct tension, is then $\frac{19{,}570}{6.25} = 3{,}130$ pounds per square inch. The greatest offset is 11/16 inch. The section modulus S of the bar for bending vertically is $\frac{bd^2}{6} = \frac{5 \times (1\frac{1}{4})^2}{6} = 1.302$. Consequently, the fiber stress on the inside of the bend below B is $f = \frac{Pl}{S} = \frac{19{,}570 \times 11/16}{1.302} = 10{,}333$ pounds, due to bending. The total tensile stress on the inside of the bend is evidently the sum of the stresses due to straight tension and to bending, or $3{,}130 + 10{,}333 = 13{,}463$ pounds per square inch, or about 4 1/3 times that due to the direct pull alone. As a matter of fact, the journal box and column bolts are seldom tight, and the consequent deflection in the bar above the journal box and below the columns will increase the offsets at the bends slightly, and the maximum stresses due to bending are actually a little greater than calculated above. However, since the upper arch bar and the tie bar are in more or less intimate contact with the bottom arch bar, and assist to some extent in keeping it straight, the difference is probably very small.

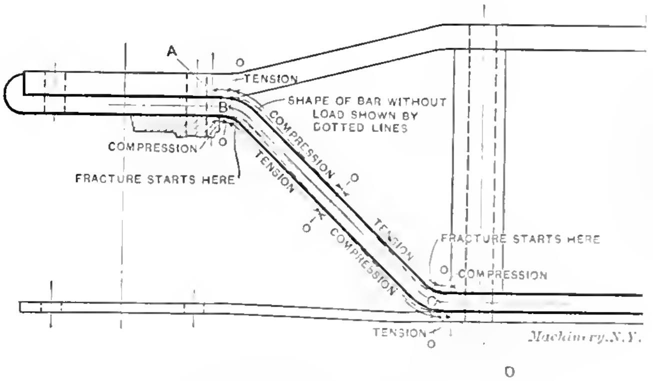

Fig. 2. Illustrating Character of Stresses in Arch Bar.

Examination of some of the broken arch bars confirmed the opinion that the breakage was due to excessive tensile stresses on the inner sides of the bends, as the fracture always started on the inner side at or near the point of greatest offset, some occurring at the top and some at the bottom. It seems, therefore, that large radius bends in arch bars are an element of weakness rather than of strength, unless they are made to fit the journal boxes and columns reasonably closely. By curving the edge of the bearing on the columns and making the radii of the bends in the arch bar a little greater than those on the journal boxes and columns, but with the centers on the same vertical line, probably the best possible results will be secured, the difference in the radii being made just sufficient to cover the unavoidable inequalities in the forgings and castings.

* * *

During the past few years the coinage of penny and half-penny pieces in England has been extraordinarily heavy, and the cause has been ascribed to the introduction of the "penny-in-the-slot" machines placed in the railway stations and public places. Last year an officer of the British mint estimated that not less than £250,000 ($1,250,000) is permanently locked up in these machines and withdrawn from circulation. A single company, it is stated, in twelve months, took no less than 33,984,671 pennies out of their machines.

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* Address: Northern Pacific Railway Co., St. Paul, Minn.

NEW DEVELOPMENT IN STEEL CASTINGS.

Every mechanical engineer is familiar with steel castings, and probably every one has often employed them and wished that he could be justified in a much wider use; but difficulties of quick supply, of uncertainty of sound castings, of all too frequent hard spots, of rough surfaces, of washed cores, of obliterated finer details, of inability to get thin sections, of drawing and weakness at rib joints, have each or all compelled a resort to much heavier gray iron castings or to expensive bronze castings, or to even more expensive forgings.

When the engineer is told that he can get castings in steel within twenty-four hours, with no hard spots, with a surface as good as gray iron, with absolutely sound material one thin machining cut below that surface, without blowholes or coldshuts; that he can give himself a free hand in design even to the extent of committing the hitherto unpardonable sin of running a quarter-inch or even thinner rib into a two-inch or heavier section and with a fillet of a quarter-inch radius, and do that without fear of drawing or weakness in the corner—that engineer will shake his head incredulously.

When the engineer is further told that he can get all of this and practically make his own suggestions as to elastic and ultimate limit, elongation and contraction per cent, and can specify carbon, tungsten, nickel, manganese, vanadium and other alloys exactly as he would for bar stock or forgings—then that engineer may be pardoned if he considers that his informant is either trying to fool him or has himself been fooled. But such castings are here, and are shown in the accompanying illustrations.

The collection of steel castings shown in Fig. 1 is fairly comprehensive; at the bottom there are cranks, crosshead, propeller, auto truck axles, gasoline engine crankshaft, truck-wheel and worm gear. On the shelves above, a heterogeneous collection of sections of light walls, complicated corework, light ribs with almost feather edges and all with sharp details, present themselves. Modestly showing itself is a gear cutter, near the left-hand of the lower shelf, that is cast from high carbon steel, finished and hardened just as though it had passed through the blacksmith's hands instead of the molder's flask; better still, nothing in its behavior will ever let the user suspect its unorthodox origin. Near it is a hollow casting, with thin, circular heat radiating ribs; work of this character is considered creditable to the gray iron founder when as clean and sharp as this, but was not heretofore considered as even a possibility for the steel founder. On the next shelf at the extreme right the peculiar double crescent terminating in the cross-cored hollow stem involves walls of only one-eighth inch thickness; yet perfectly clean, sound, uniform material and as clean core surfaces as are ever found in gray iron are its characteristics.

Further along the clean work of the cast bevel pinions compels the admiration of those who know. That holds also for the tortuous snakelike exhaust manifold with its very thin cooling ribs to be seen on the same shelf at the left.

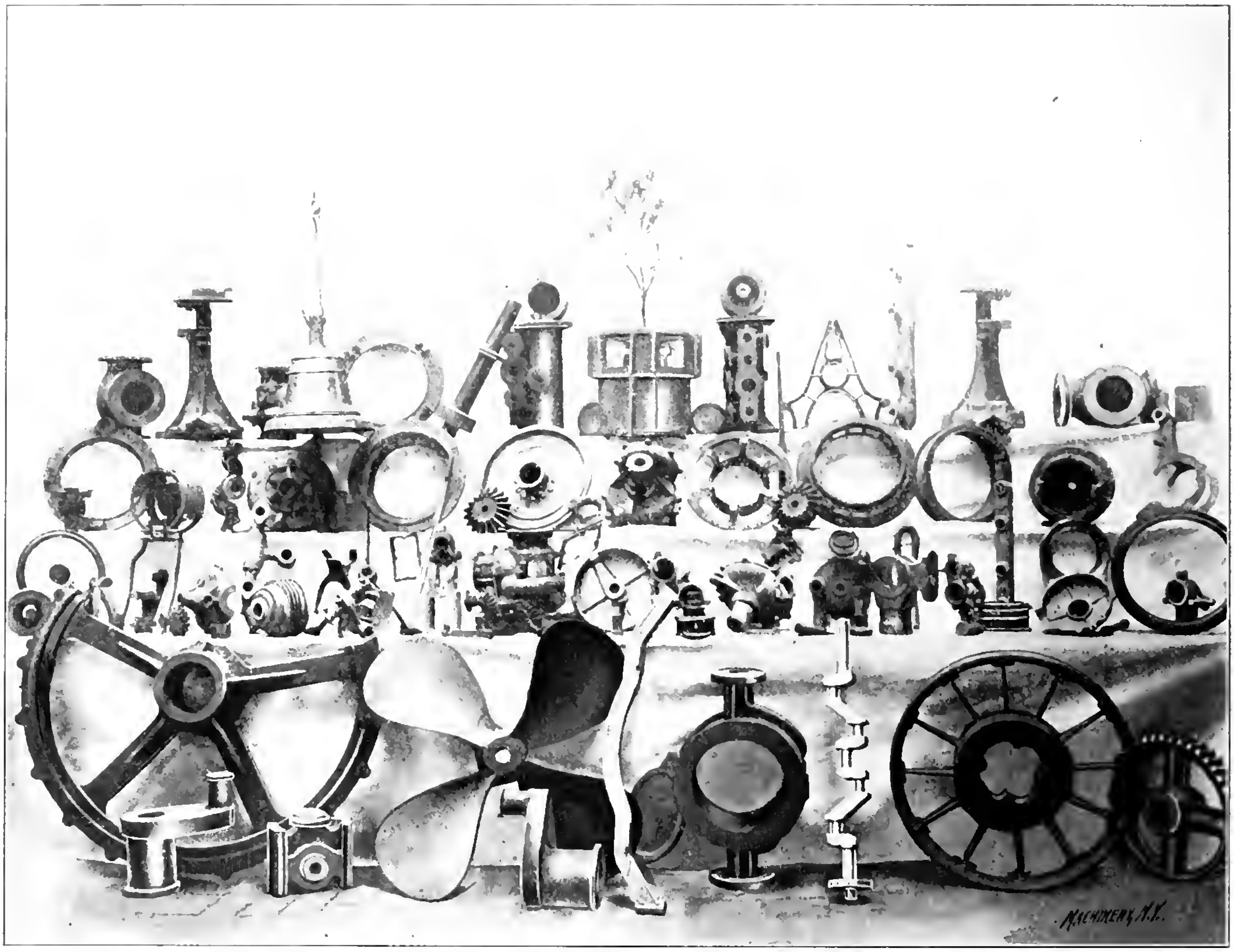


Fig. 1. Group of Steel Castings made by German process, illustrating Great Variety of Applications.

Passing by the ship's bell and other objects on the top shelf with a mere glance, the eye is held by the spray of oak leaves. The material would have made glad the heart of Tubal Cain, for the leaves are forged and shaped cold from cast test bars of soft steel, practically wrought iron, and the stems welded.

The wheel at the bottom right should have received more than mere passing mention; doubtless the designer had his own reasons for the extraordinary combination of light spokes and heavy rim; the maker of these castings has no fault to find, for being afforded this opportunity to show that light spokes joined to heavy hubs or rims, are all easy to him and that he could, as a matter of every-day work, surmount difficulties that are alike beyond the gray iron founder as beyond the steel founder not possessed of the new knowledge.

In Figure 2 the larger central piece is a valve used by the German Navy to withstand pressures of 2,250 pounds per square inch. The faces of the flanges all have a light cut

taken off in accordance with the specification. Most remarkable is the spidery support of the central stem guide hub. A critical examination of the line section of Fig. 3 of this casting disclosing its complicated coring and thin, quarter-inch, walls abruptly joining the three-quarter-inch heavy flanges, first creates distrust of the possibility of the production of this thing in steel, then surprise and admiration as the photograph and actual casting are viewed. Originally this piece was made of a light grade manganese bronze; even then a large percentage failed to pass the inspection pressure test. In this much cheaper steel casting wastes are altogether negligible.

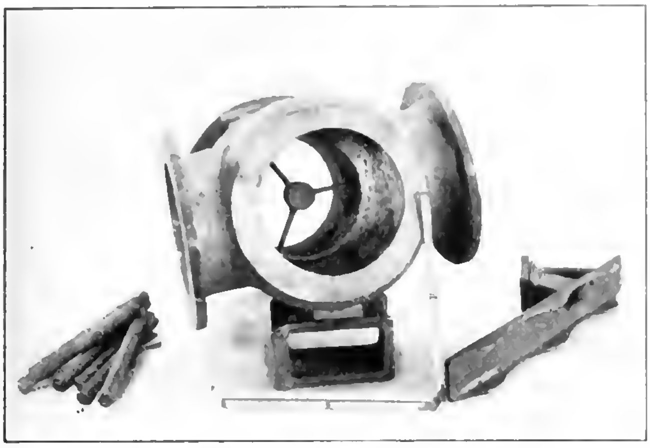


Fig. 2. Thin Steel Casting Valve Body for German Navy, carrying 2250 pounds Pressure.

Referring again to Fig. 2, the casting supporting the valve is a German railway truck detail. The piece to the right is not a carpenter's plane, but a portable yardsman's brakeshoe as used in German freight yards; it must be and is very light; the edges thin down to one-eighth inch. At the left is a bundle of cast test bars.

The group of Fig. 4 will interest the automobile engineer more particularly. The bevel gear housing, the steering gear details, the crank-shaft and the exhaust manifold all show clearly the clean-cut quality of the surfaces, the sharp definition of detail, the quality that makes a cast crank-shaft feasible, the remarkable coring and thin walls, that are all characteristic of this virtually new art of steel founding.

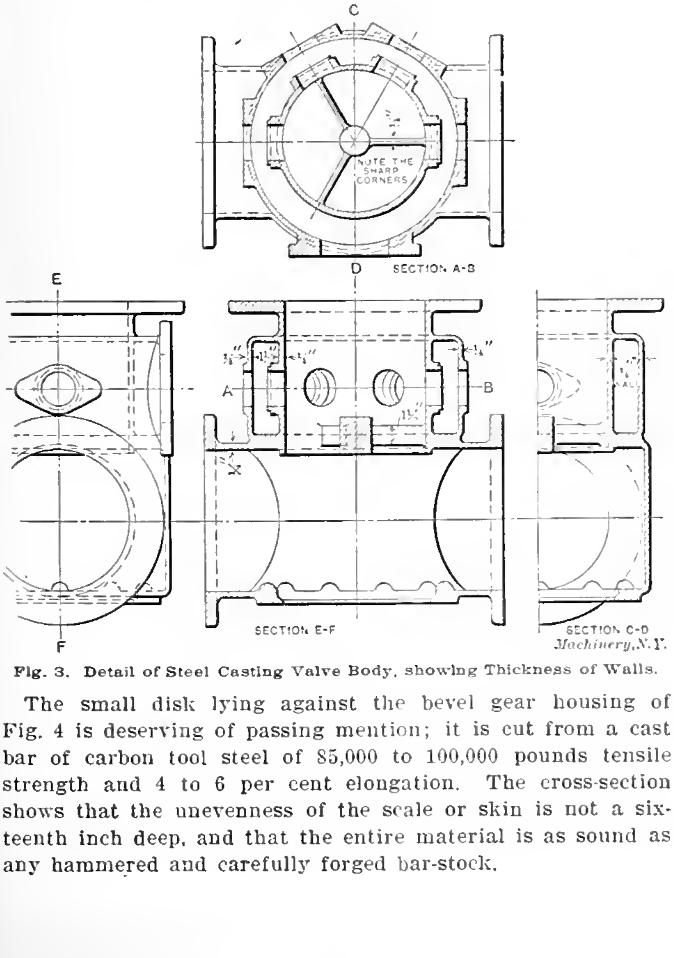


Fig. 3. Detail of Steel Casting Valve Body, showing Thickness of Walls.

The small disk lying against the bevel gear housing of Fig. 4 is deserving of passing mention; it is cut from a cast bar of carbon tool steel of 85,000 to 100,000 pounds tensile strength and 4 to 6 per cent elongation. The cross-section shows that the unevenness of the scale or skin is not a sixteenth inch deep, and that the entire material is as sound as any hammered and carefully forged bar-stock.

The majority of the castings shown in Figs. 2 and 4 are a standard composition known as extra ductile weldable; that has 25,000 to 27,000 pounds elastic limit, 49,000 to 53,000 pounds ultimate strength, 26 to 27.5 per cent elongation and 41 to 42 per cent reduction of area; these are qualities characteristic of only the best Swedish iron forgings. The next standard melt gives about 70,000 pounds ultimate strength, and after that about 100,000 pounds is frequently supplied.

Other special physical characteristics or desirable alloys are furnished as required. The minimum quantity must be one crucible charge of 200 pounds. The only limitation is that the specification must be one that is procurable in rolled or hammered bar-stock. Cutters in self-hardening or high-speed steel of simple or complicated shapes are a regular output. The usual heat treatments, as oil tempering, hardening, etc., that are employed with forgings and bar stock are applied to these steel castings also whenever they are of the corresponding composition.

As to the process itself, that is founded on the well-known crucible type. The novelty resides in the addition to the crucible charge compounded in accord with the specified analysis, of a "bomb" or "pill" that imparts the fluidity, smooth flowing and gas free qualities that make possible the avoidance of the various ills of the ordinary process. That suitable melting arrangements, molding methods, sand composition, facings and many other apparently minor matters go to the attainment of the final result, is evident enough to all familiar with the older processes. Further details that would interest the practical founder are not yet ready for publication.

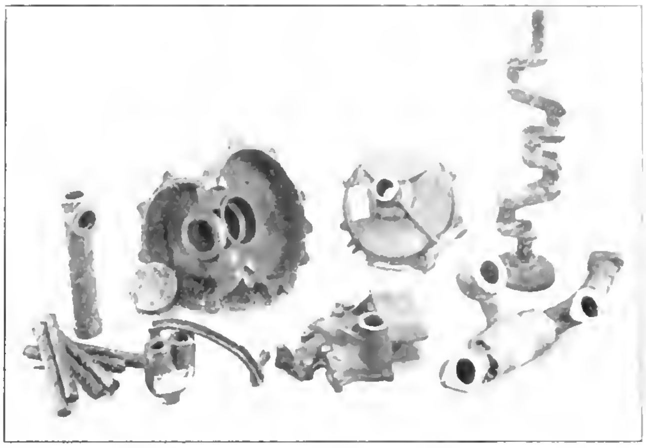


Fig. 4. Automobile Parts made in Steel by German Casting Process.

The process was originated in Germany where it has been worked near Berlin for four years on a fairly large scale. The various large electrical companies use certain grades for their field magnets because of the remarkable permeability and great density and freedom from blow-holes of the soft grades; Lahmeyer, f. i., uses certain mixtures for high speed turbine work. The locomotive builders are permitted to use these castings where the government that owns all the railways in Germany excludes all other steel castings. Automobile builders consume considerable quantities. Governmental as well as private naval establishments are heavy consumers. The general machine industries take up considerable in gear blanks, with cast as well as blocked-out teeth. Strange to say, even grate bars that are usually made of the very cheapest of cast iron, are an increasing product; this is because the very soft grade possesses a very high resistance to heat, does not warp or burn, and has a life so much in excess of the cast iron as to justify the higher first cost.

Mr. Henry Hess, president of the Hess-Bright Mfg. Co. of Philadelphia, Pa., has acquired the process for North America, and is preparing to establish the industry here. Castings will be imported during the interim until the American plant is at work.

* * *

The total length of street and interurban lines in the United States operated by electricity is now more than 38,000 miles. There are still 776 miles of street railway operated by cables, steam, or horses.

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

IRONWORK ORNAMENTATION OF A MECHANIC'S HOME.

The accompanying half-tone illustrations show a city door yard in Greater Pittsburg, which is the result of the labors of a mechanic during Saturday afternoons and holidays for a period of two years. A helper was employed occasionally. The novelty of the work is that the greater part of the ornamental ironwork shown is waste from a machine shop and scrap from a scrap iron yard, even the fence being procured in a scrap yard, minus posts, hinges, scrolls, and other ornaments. The house is on the corner of two streets.

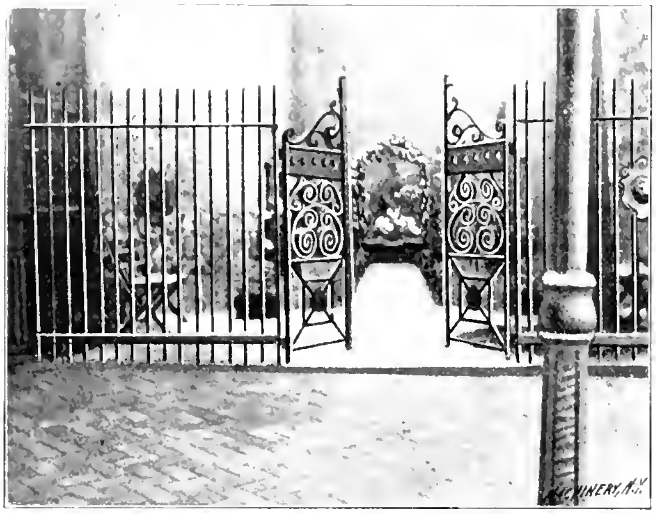


Fig. 1. Front View of Yard with Ornamental Fence and Gates.

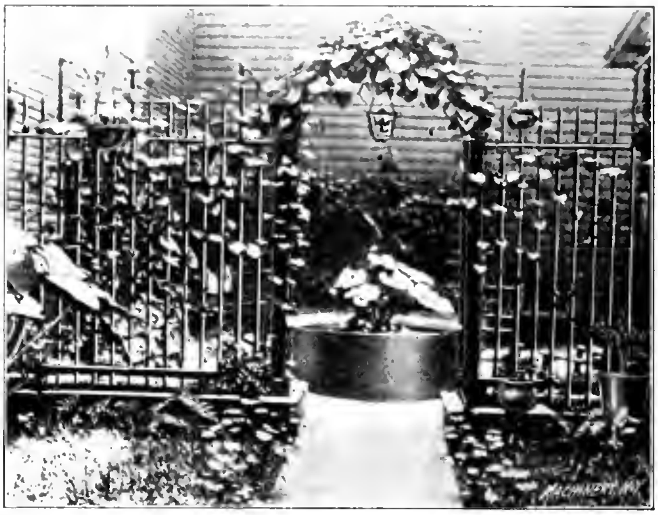


Fig. 2. Interior View of Yard showing Fish-Pond in Center.

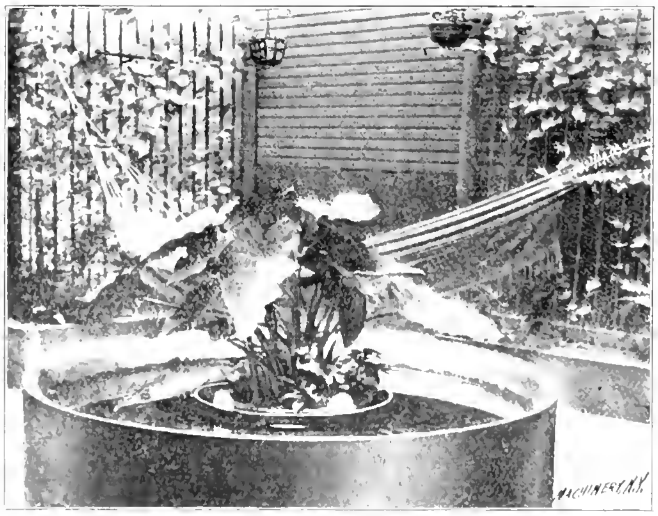


Fig. 3. Portion of Yard, with Fish Pond made from Cast Iron Pulley lined with Concrete.

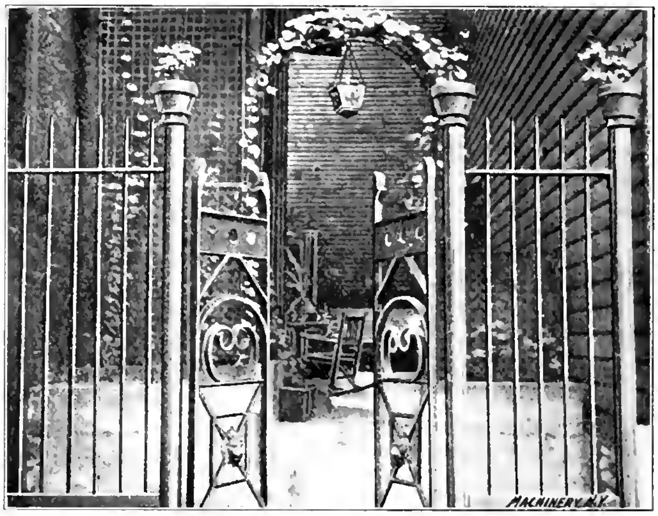


Fig. 4. Entrance from Side Street, showing Pipe Fence Posts and Cast Iron Flower Pots.

Fig. 1 shows a front view of the yard and the ornamental fence and gates. The hinges of the gates have ball bearings. The lions' heads and scrolls are made of iron, copper plated with a verde green finish. In the yard are a sunken garden, concrete flower pots, hanging baskets, lamps, and a fish pond in the center.

Fig. 2 illustrates this portion of the yard and shows the fish pond, which is made from a 5½-foot diameter gas engine pulley, 24-inch face, and weighing 865 pounds. The interior is lined with concrete and faced with cement. The center of the pond, in which the plants are growing, is a discarded fire pot of a furnace, 24 inches diameter, 24 inches high, and weighing 245 pounds.

Fig. 3 shows a near view of the fish pond. This view also shows a fence used as a trellis for vines, and concrete flower beds 8 feet long, 15 inches wide, with 3-inch thick walls reinforced by iron wire woven and laid in the mold before the concrete is poured. The fence posts are 3-inch iron pipe, imbedded 2½ feet in concrete and are amply strong to sustain the hammock.

The fence on the side street is illustrated in Fig. 4. This view illustrates the means for securing the fence to the post by angle brackets of iron. The flower pots on top of the posts were molded from a regular 8-inch flower pot, and are made of cast iron, weighing 11 pounds each. The tops of the posts are threaded, and standard 3-inch caps are riveted to the bottoms of the flower pots, and they are then screwed onto the posts. This view also shows the back porch, the lattice of which is made from an elevator car. The posts of the back porch are made from 3-inch iron pipe, imbedded in concrete. The sliding elevator door was also utilized, and a lock is provided which secures the door and protects the refrigerator and contents which are stored in the porch.

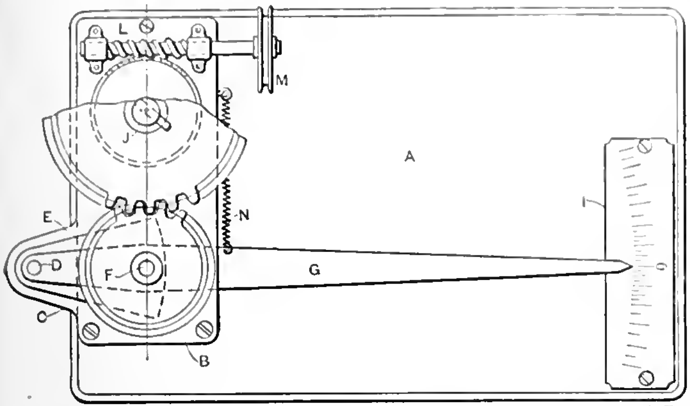
Pittsburg, Pa. W. A. PAINTER.

DEVICE FOR TESTING TRUTH OF CUT GEARS.

The illustration shows a device for testing the truth of cut gears used in the construction of gas and gasoline engines. All cut gears are tested after the machining is done, or if they are case-hardened, after the hardening process. Only gears that are absolutely true are put in the engines; however, a slight variation from truth will pass inspection. Gears that have been case-hardened will vary more or less, consequently a test must be made to see that no imperfect ones are used. In engines of this class, all gears are meshed closely to avoid any back-lash and to prevent as much as possible any noise in the running. If a pair of gears have become slightly oval in shape during the hardening process,

long and short diameters will exist which are not noticeable to the naked eye. Assembling gears of this kind will result in a "rattle" or a "bind" in each revolution, and to avoid such gears is the purpose of the test.

The device for making this test consists of a cast iron plate *A* ribbed at the bottom and machined on the top surface; a cast plate *B* with a projecting arm *C* in which is secured a shoulder stud-screw *D*; a cast-iron segment plate *E* drilled and reamed at one end to fit fulcrum stud *D*, and having at the opposite end a shoulder stud *F* on which revolves a master gear of the same pitch as the gears to be tested; an indicator pointer *G* drilled to pass down over fulcrum stud *D* and axle stud *F*; a graduated brass plate *I* secured to base *A*; and a shaft *J*, the lower end of which revolves in a step bearing beneath the plate *B*. To this shaft is secured a worm-wheel, and on the part which projects above this worm-wheel are placed, and rigidly secured by means of a key, the gears to be tested. The worm *L* is made of machine steel and case-hardened, and is driven by a ½-inch round belt passing over wheel *M*. A steel spring *N* is fastened to plate *B* and index hand *G*. The segment plate *E* is machined on its bottom face which rests and slides on the upper face of plate *B*. On the upper face of plate *E* rests the index hand, and on top of this is a steel washer around axle stud *F*. On this washer rests the master gear, which is perfect in every detail. The gear to be tested is revolved by means of the wheel and worm, and any irregularity in the diameter will show on the graduated plate.



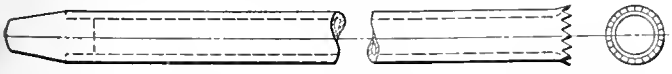
Machinery,N.Y.

Testing the Truth of a Cut Gear by revolving it with Master Gear and noting changes in Center-to-center Distance.

DETROIT.

MAKING AND HARDENING A DRILL FOR BRICK.

The accompanying illustration shows a cheap and serviceable form of drill for brick walls, which can be made from wrought iron, gas or steam pipe. A solid plug is welded in one end to close it up and serve as a head for the drill, and the other end is serrated after the same manner as a hollow mill or core drill, and slightly spread to give it clearance. As the drill is made from wrought iron, ordinary methods of hardening are of little use; but by heating the working end of the drill to a fusing temperature, along with a piece of thin cast iron, and allowing them to come in contact while in the fire, part of the cast iron will adhere to the wrought iron and can be pretty evenly distributed over the teeth by turning the drill. After a fair coating of the cast iron has adhered to the teeth, remove the drill from the fire, shake it or give it a light rap upon something solid to remove any surplus cast iron, and insert in a cold water bath. The teeth of a drill treated in this manner are so hard that they can not be touched with a sharp file, and will wear until the rest of the drill is completely worn out if it is not subjected to heavy hammering.


Machinery,N.Y.

Brick Drill made from Wrought Iron Pipe.

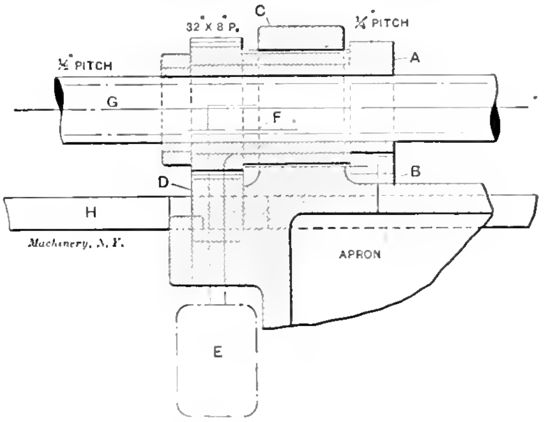
JAMES CRAN.

Plainfield, N. J.

CUTTING AN ACCURATE SCREW FROM AN INACCURATE LEAD-SCREW.

"We find, after testing, that the feed screws of the machines supplied by you to our order are not accurate enough for our purpose; before placing any further orders with you we should like your assurance that this matter will receive your attention."

Thus ran an epistle received by us from one of our best customers, and one of the first things done after reading it was the testing of the lead-screw of our precision (?) screw-cutting lathe. It was found to be about 0.090 inch out in six feet, so that our customer had just cause for complaint. A conference of heads of departments was held, and various methods of overcoming the difficulty suggested. One idea was to have a threaded bush to take the thrust of the lead-screw, arranged so that as the lead-screw revolved the bush was also turned by suitable gearing, pulling the lead-screw and carriage bodily with it as it screwed out of its bearing. This scheme, though a good one, was vetoed because, as one of the foremen pointed out, it could only rectify the aggregate inaccuracy; local errors would not be provided for. I then had a turn, and claimed that I had a scheme whereby *all* local errors were rectified. The idea of all the local inaccuracies in the lead-screw being corrected in the screw being cut, was deemed impossible and at first sight it does seem to be a rather difficult thing to accomplish, but after an explanation of the proposed method it was acknowledged that the scheme was practicable. We did not use it, however, as it was thought advisable to install a new lathe, and with this machine we got a lead-screw which was guaranteed to be within certain limits; however, it might be interesting and useful to readers of MACHINERY to know how we proposed to accomplish the seemingly impossible task of cutting an accurate screw from an inaccurate lead-screw.



Machinery, N.Y.

Fig. 1. Section in the Plane A—B, Fig. 2.

The first thing to do is to measure the pitch of the lead-screw at a number of places and find what the inaccuracy is. A large change gear is mounted at the end of the screw and, assuming that the lead-screw is ½ inch pitch, six turns of the change gear should move the carriage exactly 3 inches. Every 3 inches seems to be a convenient distance, though longer or shorter distances could be measured in exactly the same manner; of course, the lead-screw would have to be turned a larger or smaller amount. After the change gear has been revolved, we will say 6 times, a vernier or micrometer is used to measure the actual movement of the carriage. By this means we can tell how much the actual movement differs from the theoretical movement, or, in other words, how much the pitch of the screw is out. This difference or error, for every 3 inches of the whole length, is tabulated, care being taken to also record whether the pitch is large or small. When the screw has been measured throughout its length, the next operation is the correction of the errors. The method whereby this is done is shown diagrammatically in Figs. 1 and 2.

Referring to Fig 1, a special lead-screw nut *A* is screwed directly onto the lead-screw and kept from revolving by the pin *B*. On the outside of the nut revolves the 32 × 8 pitch gear, the shank of which is threaded externally and screwed into the bracket *C* which is screwed to the apron. Meshing

with the 32 × 8 pitch gear, is a rack *D* upon the top of which presses the weighted lever *E* pivoted at *F*. At the lower end of the rack is fixed a runner *J*, as shown in Fig. 2. It will be seen that if rack *D* be moved either up or down the carriage will be moved independently of the lead-screw *G*, and a simple calculation will show that 0.050 inch movement of the rack will move the carriage 0.001 inch, so that if we can arrange some means of raising and lowering the rack at the right time and the right amount, we shall be able to cut a screw which will not be a copy of the lead-screw because it will not have its errors. At the front of the bed and directly under the runner on rack *D* is a fence-like structure *H* made of wood. This consists of a number of boards, joined together by battens at the back, and arranged so that the runner may work on the end of the grain of the wood. Knowing what the errors in the screw are, and also knowing that to raise or lower the rack 0.050 inch gives a carriage movement of 0.001 inch, it is quite an easy matter to reckon up how much the vertical movement of the rack must be to compensate for the errors we have previously tabulated; so that if we divide the board *H* into 3-inch spaces by vertical lines, we are in a position to mark out the profile required to meet our particular needs. Suppose that in the first 3 inches the pitch of the lead-screw was 0.003 inch short; we should know then that the *fall* between the first and second 3-inch marks *K* and *L* would require to be 0.150 inch. Proceeding in this manner, the whole of the profile is marked out. Then, if care is used in cutting to the marks and in mounting the board in position, we are ready to get to work on our screw, knowing that the errors in the lead-screw will be corrected by our automatic compensating gear. Of course, when cutting the corrected screw, the counter-shaft will have to be reversed, as the lead-screw nut must not be disengaged. I forgot to mention that it would, perhaps, be advisable to take the measurements of the lead-screw after the solid nut *A* has been put into position, as the conditions then would be more like the conditions when actually cutting the screw.

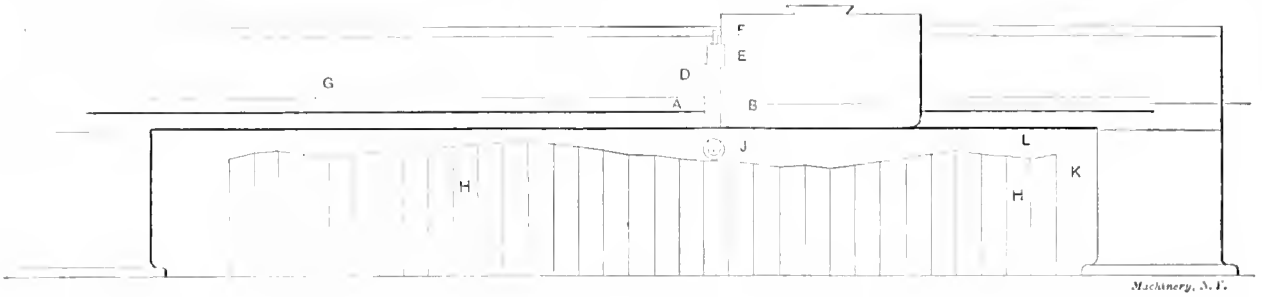


Fig. 2. Device for Correcting Inaccuracies in the Lead-screw by an Automatic Movement of the Carriage regulated by the Rise and Fall of Roller J.

As mentioned before, we didn't have to operate on our old lathe, but if I am ever placed in similar circumstances, and a new machine is out of the question, I should have no hesitation in trying this method of making the inaccurate lead-screw cut one that is accurate.

RACQUET.

INTERMITTENT CAM—CAM ROLLERS.

The writer recently had occasion to give a shaft an intermittent motion with an angular movement of 90 degrees, the shaft to revolve in one direction and the power to be obtained from a parallel shaft having a speed ratio of 4 to 1. A pair of intermittent gears would have done the trick perfectly, but were not used as excessive shock was feared on account of the high speed to which they must be run.

On one end of the shaft to be rotated, a disk with four cam rollers *A* spaced to 90 degrees, was placed, and working over this plate was the cam *B*, as shown in Fig. 1. The development of this cam is shown in Fig. 2. Though originality is not claimed for the design, it may be of interest. The cam imparts the regular crank motion, as shown further on, and the action is, therefore, quiet and easy. To lay out the cam, a circle *AHGB* is chosen for the path of the cam rollers of the driven shaft, and divided into four parts. The cam action is to take place on the line *AB*, which line is perpendicular to the center line of the centers *M* and *D*. Upon *AB* the semi-circle *ACB* is drawn and divided into any number of equal parts, and the points thus found projected onto the line *AB*. Radial lines *DE*, *DF*, etc., are then drawn from the center *D* through these points to the circle *AHGB*, transferring the harmonic motion to the path of the cam rollers. The arcs *OT*, *EU*, *FX*, etc., are then drawn. The outermost position of the cam roller with respect to the cam, will be seen at *A*, likewise the innermost at *O*. Arcs are drawn through these outer and inner positions of the roller centers. A distance *JS* is chosen, depending upon the time required for the action. This time must not be too long, else interference of the cam and rollers will result, and if too short, a sharp point at *O* is developed. *JS* is divided into the same number of parts as the arc *CB*, and radial lines drawn to the center *M*. At the intersection of these lines and the arcs *OT*, *EU*, *FX*, etc., which have been previously drawn, we have the centers which the cam rollers must successively occupy. Three arcs are then approximated to cut these centers, giving the cam track desired. One-half only of the cam is shown developed, as the other side is symmetrical.

In order that the cam slot can engage the next roller, either a pawl must be used to hold the roller plate (using only the effective part of the cam by cutting away the dwell), or notches cut into the side of the cam itself to admit the next roller into the track. These notches *C*, Fig. 1, can be laid out at the time the motion is plotted, but the method used in this instance for determining the shape and position of the slot was a more natural one, as a lay-out of both cam and roller plate was made on cardboard and the parts cut out and pivoted on thumb tacks; then by revolving the disks, having previously blacked the rollers, the shape of the notch developed itself. It will be seen that two rollers are engaged in the track at the dwell of the cam, thus making a more rigid stop than is obtained with intermittent gears.

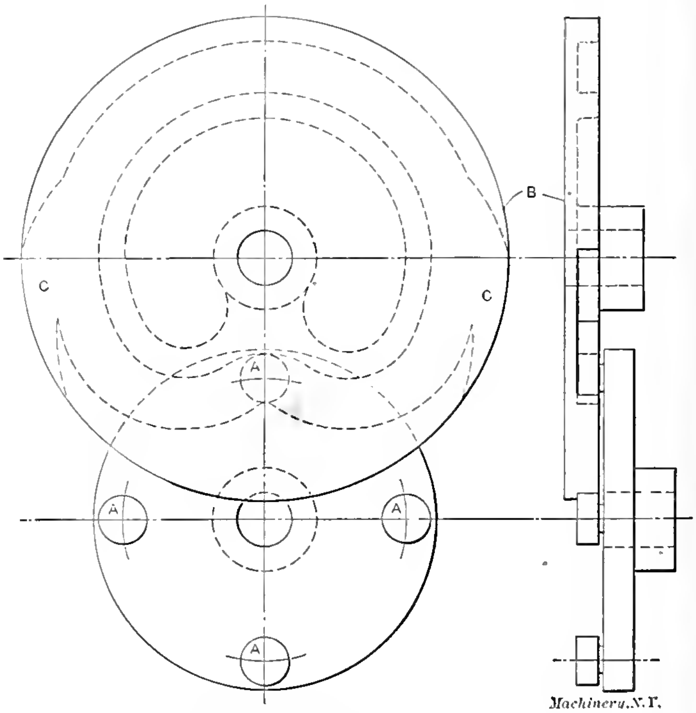


Fig. 1. Cam, and Disk with Rollers, by which an Intermittent Movement is Imparted to the Driven Shaft.

As a rule, cam rollers belie their name, in that they do not roll; they stick once, then a flat soon appears on the

periphery, or the stud wears thereby, destroying the true cam action. The ball bearing rollers shown in Figs. 3, 4 and 5, overcome these difficulties and from experience I know that these rollers roll, require little attention, and insure the true cam action being maintained. Fig. 3 is a somewhat heavy type, the two bearings being contained in a sleeve which protects them from dirt and dust. This roller has the advantage of being supported from each side. The bearings used are an article of manufacture. Fig. 4 illustrates a roller designed to overhang its point of support. The cam arm should be rather heavy to keep the roller true, especially if designed for a movement that is heavy, or if at times subject to very quick action; otherwise the roller may cant a bit, as shown exaggerated by the dotted lines. This is a point that is often overlooked in the ordinary roller, and while it is desired to avoid this overhung style, at times this type is by far the most convenient. In Fig. 5 a light type of roller is shown. As this type is small, the design is changed slightly, the internal ball race being removed. As will be seen, this race is cut in the stud which holds the roller to the arm or plate.

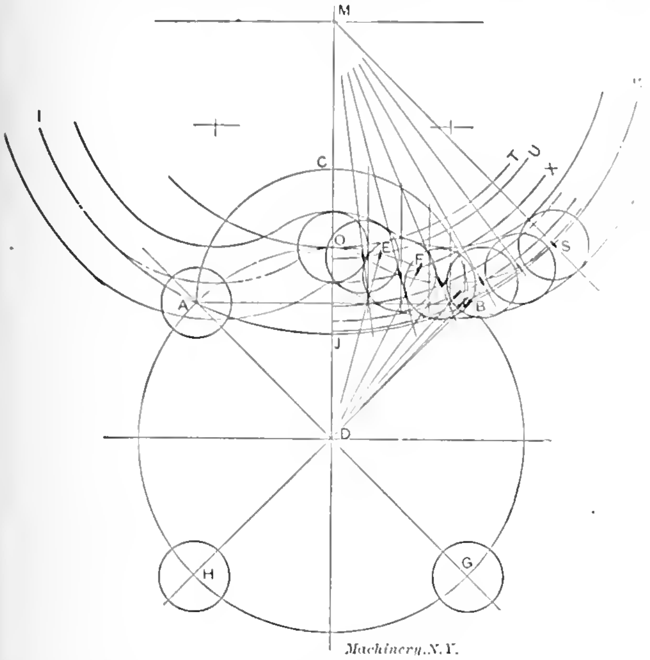


Fig. 2. The Development of the Cam shown in Fig. 1.

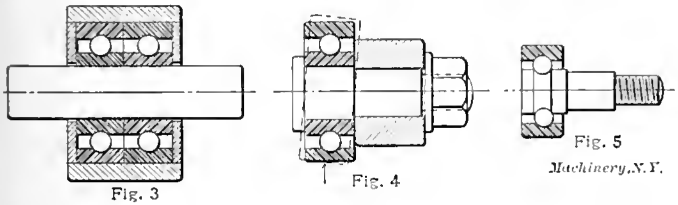


Fig. 3 Fig. 4 Fig. 5

Figs. 3, 4 and 5. Three Types of Ball-bearing Cam Rollers.

CYRUS TAYLOR.

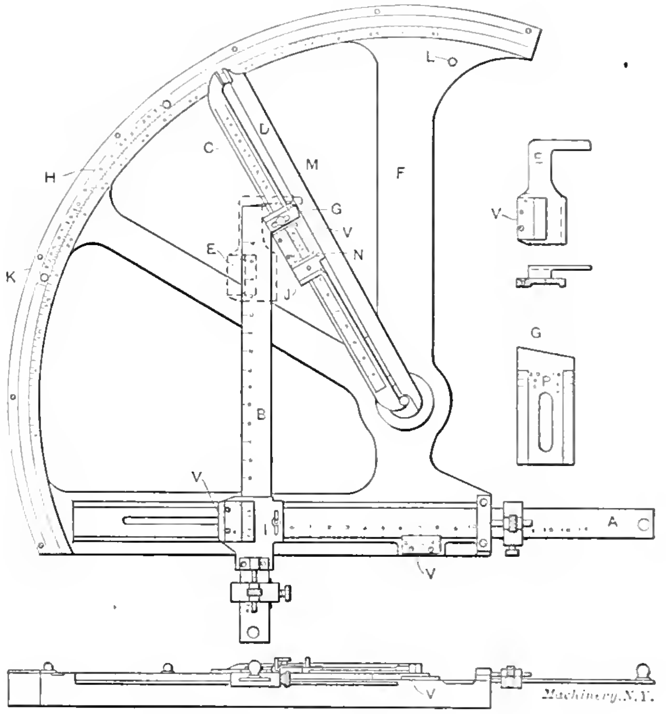
London, Eng.

A BEVEL GEAR GAGE.

In order to overcome the necessity of calculations for bevel gears, the gage illustrated in the accompanying engraving was constructed. The range of this gage will permit calculations of bevel gears from 1½-inch to 24-inch pitch diameter to be readily made. The frame *F* is a brass casting reinforced by ribs not shown in the engraving. It is finished and graduated on the rim to half degrees. The rim is also grooved to receive a vernier slide *H*, which reads to minutes. This slide is retained in place by the strip *K*, allowing the vernier to slide with slight friction. The lower part of the frame is planed to receive a scale *A* running in a groove with a good sliding fit. The head *I* is fastened tightly on the end of the scale *A* and forms a slide for the scale *B*. On the end of scale *B* is a small arm, not indicated, which carries a hardened bushing receiving the taper pin *M*. This latter is driven tightly into the slide *J* and its center is exactly on the radial line from the center of the arm *C*, and the index at the arm's recording end is at the rim of frame *F*. The slide *J* is of a channel shape, sliding freely on the radial arm *C*, but can be lifted off the arm entirely. The scales were made to order by the Brown & Sharpe Mfg. Co., and are graduated to fiftieths of an inch. Each scale is provided with a vernier, reading to 0.001 inch.

Given this arrangement, it will be seen that if the scale *B* is slipped down until the zero mark on this scale is opposite the zero on the vernier at *V*, the radial arm *C* will be parallel to the scale *A*. In this position, scale *A*, scale *B*, and slide *J* can be moved as one piece in the longitudinal direction of scale *A*, the radial arm remaining at zero on the degree scale on the rim of the frame. When the scale *B* is moved from its zero, the arm *C* will register the angle accordingly. The arm *D* is called the face-angle arm, and is moved independently from arm *C*. It is provided with a hardened straight edge on a line exactly radial from the center where the arm is pivoted. This arm is used for determining the face angle and the depth of cut, as will be referred to later.

The piece shown in detail at *E* is the diameter increment gage, more commonly called the blank diameter gage. It is made to slide on scale *B* and is used only when face-angle arm *D* is moved away. At *G* is shown one of the addendum and depth of cut gages. These gages are shown in detail, so as to show more clearly the lines and figures by which they are graduated, the gage *G* being also enlarged. The addendum and depth of cut gages are hardened and ground to fit the slide across the top of slide *J*. Owing to the fact that the pitch lines would come too close together if all were marked on the same piece, there may be different blades for different pitches and depths of cut. One of these blades can be seen in place in the assembly drawing, with the corner extending beyond the center of the pin *M*. If the gear was a four-pitch gear, the amount of extension would be one-quarter inch; if a 6-pitch gear, 1/6 inch, etc. The blades are set by bringing the pitch lines opposite the zero mark on slide *J*. The gages can be used at either end of slide *J*, the point *N* becoming the working point when it is necessary to get closer to the center for small bevel gears. When the gage is set, if the arm *D* is brought up against its point, the face angle is thereby determined.



Gage facilitating Bevel Gear Calculations

As an example, we will assume that we are to make bevel gears like samples furnished us. We find in the larger bevel gear of the samples furnished 40 teeth, and in the smaller 20 teeth. The larger gear measures roughly about 10 inches pitch diameter, and we therefore decide that it must be 4-pitch. To get the correct size of the larger gear, set scale *B* to one-half the pitch diameter of the large gear, or 5 inches,

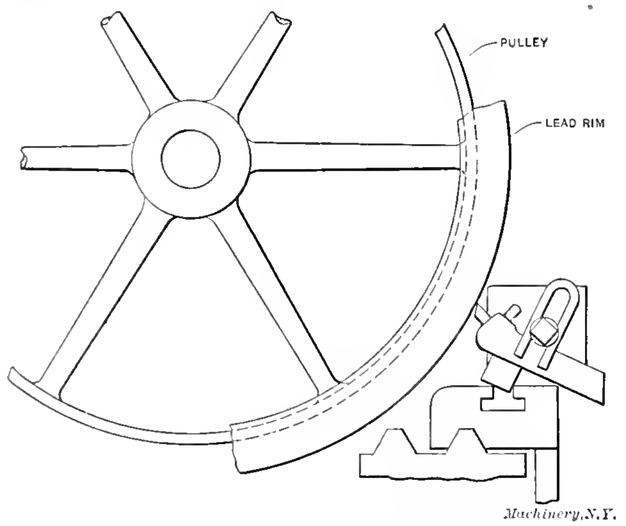
and set the scale *A* to one-half the pitch diameter of the small gear, or 2½ inches. Lock the scales by means of the wing nut on the head *I*. Take an addendum gage for 4-pitch, and set the 4-pitch mark in line with the zero on slide *J*. Bring the arm *D* up to the corner of the blade of the gage, and read off the angle to which it points on the protractor, using the vernier *H* if necessary. The angle read off the scale is the face angle of the blank. Now move the arm *D* around against the stop pin *L*, place gage *E* on scale *B* and slide it down until the extending arm touches the addendum gage on the corner. Then take the reading of the gage *E* at the vernier. Twice the amount of this reading, plus the reading at the *B* scale vernier, equals the outside diameter of the blank. This whole operation is done in less than five minutes. It simplifies the method of getting the sizes of bevel gear blanks, and particularly for the repair shop, is a great convenience.

The gage may also be used as a right angle triangle computor. Scales *A* and *B* may be considered as the sides including the right angle, and the scale on the arm *C* will give the length of the hypothenuse, registering one of the oblique angles on the protractor at the same time. By setting the slide *J* to a unit radius and the arm *C* to a known angle, the reading on scales *B* and *A* becomes the sine and cosine, respectively. By setting scale *A* to a unit length and arm *C* to a known angle, the reading on scale *B* becomes the tangent of the angle, etc.

W. A.

GRINDING WHEEL FOR LEATHER SPLITTING KNIVES.

From a mechanical standpoint, the most exacting as well as the most interesting process in the manufacture of fine leather is the cutting of the tanned hide into thin sheets or "splits," which are worked up into a multitude of products, ranging from watch fobs to automobile cushions, and varying in thickness according to their respective uses. As the allowable deviation is but a few thousandths inch, the splitting machine must be kept in perfect condition, and the cutting knife be maintained with almost a razor-like sharpness to prevent dragging or crowding the hide and leaving a thick spot. There are two types of splitting machines in general use, one of which has a cutting knife ⅜ inch thick, 4 inches wide, and about 6 feet long. This knife is sharpened at the top and bottom, with the ground edges extending back nearly 2 inches, forming as sharp an angle as is practicable. The grinding is done with fine, sharp sand applied to a lead wheel, across the face of which the knife is passed.



Machinery, N.Y.

Turning a Large Pulley with Lead Rim in a Small Lathe.

One of the "annual" jobs is the preparation of a new grinding wheel. A 24-inch pulley with a number of one-inch holes drilled in the rim is put in a sand mold and lead poured in, completely surrounding the rim. The pulley is then turned off to a diameter of 27 inches and the edges chamfered. Our largest lathe will not permit the tool-post to pass the pulley, so we used first a tool that extended out 7 inches which, though made of heavy stock, left fine chatter marks. Before the chips fell from the tool, they would also rub against the finished surface, and produce straggling grooves. The wheel as finished, though passable, did not present a neat appearance, so I decided to have it done in another way, as shown in the illustration. An angle plate was bolted to the lathe carriage, and to it was clamped the tool suitably blocked. In this position the tool is rigid, and its slant is sufficient to let gravity carry the chips away, and the completed wheel is perfect. It might be asked why such a wheel is used in place of an ordinary abrasive stone of proper grade. There are two reasons: First, in order to have the cutting edges of the knife as little concave as possible, a large grindstone wheel must be used, the cost of which does not compare favorably with the lead wheel method; second, the lead and sand method heats less, leaves less "feather," and a better edge than other wheels that have been tried for the purpose.

Middletown, N. Y. DONALD A. HAMPSON.

SPECIAL HOB FOR WORM-GEARS.

The accompanying half-tone and line engraving show a hob made by the writer several years ago for facilitating the cutting of worm-gears. It is well known that if a hob is not provided with relieved teeth, it is an unsatisfactory tool for removing stock, and can only be used for the last finishing touches on the worm-gear after it has been previously gashed. The gears which were to be cut in this case were commonly made of cast iron, and to first gash these worm-gears and then hob them was rather expensive. There were no facilities for making ordinary hobs with relieved teeth, but there was a lathe in the shop fitted with a relieving attachment whereby it was possible to relieve single cutters. In order to overcome the necessity of using hobs with relieved teeth, we proceeded to make a special form of hob, as shown in the accompanying half-tone and line engraving. On this hob, teeth were cut of the same form as the cross-section of the worm thread, but instead of giving a lead to the hob thread, the teeth are simply circular ridges around the tool, and the threads are circular grooves. The hob is then fluted in the ordinary way. When in use, the hob or cutter, as it would be more properly called, is set at an angle with the axis of the worm-wheel in order to produce the proper angle of the teeth in the latter. The outside of the hob is turned to a conical shape toward each end, the cutter being full size in the center, and the angle of the taper being equal to the angle to which the cutter is turned or rotated for cutting the worm-teeth. This angle, of course, is the same as the angle to which the saddle of the milling machine is turned when hobbing. When using this tool for hobbing, instead of indexing one tooth at a time, it is common to index around a number of teeth at a time, so as to give the cutter a chance to cut nearly an equal amount on both sides of the center. This obviates any tendency of crowding caused by a heavier cut on one side than on the other. Finally, of course, the worm-gear is finished by indexing one tooth at a time.

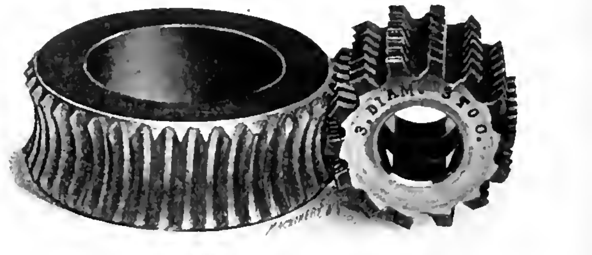
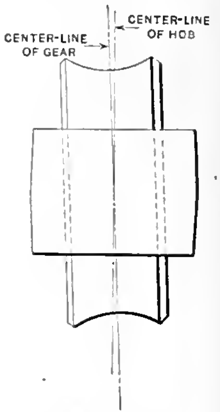


Fig. 1. Worm-gear and Special Hob by which it is Cut.



Machinery, N.Y.

Fig. 2. Diagram Illustrating the Setting of the Hob.

It should be stated here that originally there was no thought of making the gears without hobbing, but it was found that it was possible with a cutter of this form to cut

a fairly good-looking gear without hobbing. Of course, the gear will not be theoretically correct, but it will be nearly enough correct for the commercial purposes for which it is intended. It is evident that both right-hand and left-hand cutters can be cut simply by turning the table on which the index centers with the worm-wheel are mounted, in opposite directions. **Francis P. Havens.**

Waltham, Mass.

TURNING SOFT RUBBER.

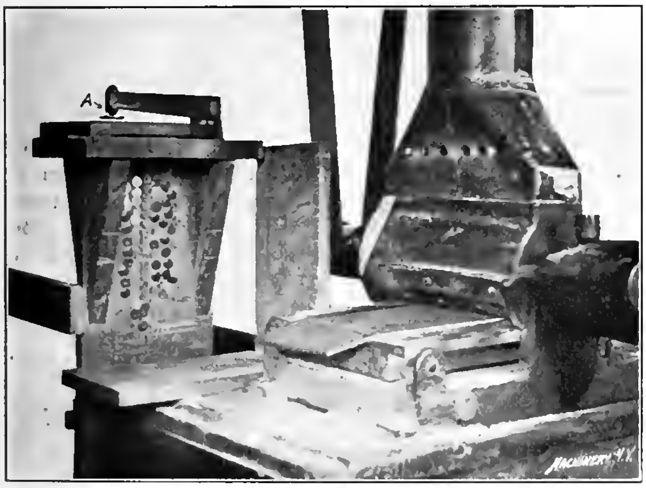
In the How and Why column of the December issue of Machinery a question regarding the turning of soft rubber was submitted. The writer has turned soft rubber with an ordinary wood-turner's gouge, about ½ inch wide, and it works very well. The gouge must be ground hollow and kept very sharp. The shavings resemble band rubber. No lubricant is used. **F. A. Ross.**

Beloit, Wis.

In regard to "L. M.'s" question as to a method of turning soft rubber in a lathe, the following procedure will be found to give good results. Rig a small grinding wheel on the tool-post, driven by a drum from overhead or by a small motor attached to the carriage. If a grinder of suitable size is available, more accurate results will be obtained. This is the method used for turning the soft rubber couch rolls used on paper machines. No lubricant is necessary.

Bay City, Mich. **H. J. Mastenbrook.**

In reply to the question submitted by "L. M." in the How and Why section of the December issue of Machinery as to the best method for turning soft rubber, the writer would suggest the use of an abrasive wheel. It would be well to write to one of the large firms making such wheels, stating plainly the kind of rubber to be turned; in this way exactly the right kind of wheel for the purpose can be obtained. The lathe should then be rigged up for exactly the speed recommended by the wheel makers. It is important that the correct speed be employed, as a difference of a few hundred revolutions per minute may cause difficulties. If a grinder is at hand, it is, of course, better to use this machine than to rig up a lathe for the purpose.



Machine for Grinding Soft Rubber Sheets to Correct Thickness.

The accompanying half-tone shows a grinder used in a rubber stamp factory for obtaining a uniform thickness of thin sheets of vulcanized soft rubber which is provided with letters on one side. Such a sheet is shown in the front of the enclosed emery wheel. The dust is carried off through a hood by the suction of a fan. A gage for showing the thickness of the sheets in thousandths of an inch is shown at *A*. While the grinder shown is not likely to be one that "L. M." could use, it illustrates the principle of the only satisfactory way of machining soft vulcanized rubber—that is, by grinding. **Ethan Viall.**

Decatur, Ill.

In the December issue of Machinery, "L. M." asks for information about turning soft rubber. The writer submits a little of his own experience which may be of service as an answer.

Provide first a tool of almost razor-like keenness; then, rubber-turning is practically a repetition of similar work on other soft materials run at a high speed. Fig. 1 shows a rubber turning tool used for feeding from right to left, with the point ahead. The noticeable feature about it, distinguishing it from other turning tools, is its lack of clearance. The elasticity of rubber renders clearance unnecessary; in fact, it is objectionable. The tool shown is set above center, and the lower side of the cutting point is flared out to give stiffness to it. A tool to cut when feeding in either direction is made with a double cutting point like the section in Fig. 2.

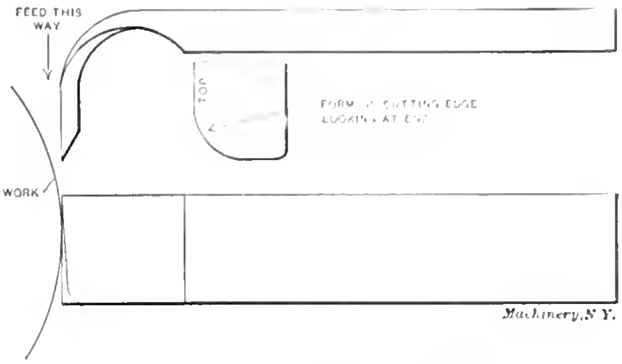


Fig. 1. Tool for Turning Soft Rubber.

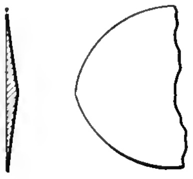


Fig.2

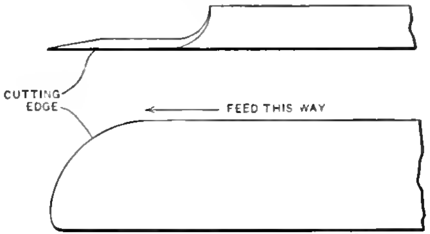


Fig.3

Fig. 2. Double-edged Tool for Turning Soft Rubber. Fig. 3. Cutting-off Tool for Soft Rubber.

On one occasion some rubber compression springs for file cutting machines were finished. The stock came in "bars," three inches in diameter, with a one-half inch core running through the center. The pieces were cut off on a bandsaw to approximate length, and then faced off in the chuck with the tool shown in Fig. 3.

For blanking out stock, round or otherwise, a bandsaw is quicker than any other method, but the operator should use great care or provide himself with suitable guides or clamps to prevent personal injury through the work catching and the latent spring in the rubber knocking the hands against the saw.

Contrary to the kink which so many know of wetting a knife before cutting rubber, the writer found it best to work it dry. The "dust" from the cut and the surfaces over which the tool passes will have a brownish hue—much darker than the stock as it regularly comes; to restore to the original gray or to remove finger marks, rub it on powdered soapstone in the lathe after the cut surfaces have been smoothed with sandpaper. **Donald A. Hampson.**

Middletown, N. Y.

SAWING CAST IRON UNDER WATER.

Regarding the question in the How and Why section of the December issue submitted by the "H. M." Co., the writer would say that if it is necessary to saw cast iron under water, a coarse-toothed saw should be used to minimize clogging, and some form of positive feed employed to force the saw into the cut. If the saw fails to cut for even one forward stroke, wet cast iron will tend to glaze, no matter whether the slip is caused by clogged teeth or insufficient pressure. Dulled or clogged teeth will soon polish the slot so that even a new saw will not cut. The same tendency to glaze is noticeable in filing or drilling wet cast iron, and it is necessary to keep the tool constantly cutting and not permit it to slip. The same condition is met with in drilling unannealed tool steel.

If the cutting of cast iron under water is undertaken with the idea of obtaining more speed, the procedure is inadvisable for obtaining the object desired. If speed in cutting is wanted, a metal-cutting bandsaw will give the best results.

Decatur, Ill. ETHAN VIALL.

DRILLING HOLES IN GLASS.

Many people think that it is a very hard job to drill holes in glass, but this is not so. It requires, of course, more time and more care than drilling in metal, because there is greater danger of breaking the glass.

The drill is made of a steel rod or an old three-cornered file. One of its ends is ground to a long tapering triangle-shaped point. It is placed in a swiftly revolving chuck (lathe or electric hand drilling machine), and the glass pressed against it very gently.

The work should be held in the hands in order to feel the pressure against the drill. As a lubricant, turpentine is used.

North Tarrytown, N. Y. JOHN INGBERG.

SLIDE RULE FOR ADDITION AND SUBTRACTION OF FRACTIONS.

The slide rule illustrated herewith, will undoubtedly meet with great favor among draftsmen and engineers in general, who have occasion to check up long lists of dimensions on drawings. This operation can be performed with speed and perfect accuracy, all chances of error are entirely eliminated, and such work becomes a pleasure instead of a task by the aid of this simple slide rule which any draftsman can make in a few hours. Of course, it is understood, in performing operations in addition or subtraction on this rule, that the operator has a pencil and pad to keep account of the units and whole numbers.

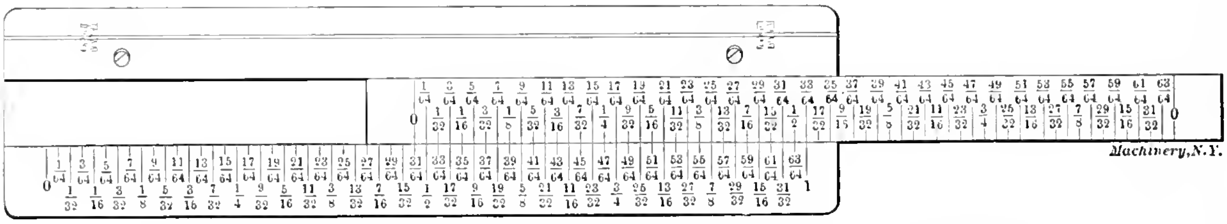


Fig. 1. Slide Rule set to add 31-64 to any of the Fractions on the Runner up to and including 33-64.

Assume that we wish to add 31/64 to 13/32: First set the left-hand zero mark of the runner to 31/64 on the lower scale, as shown in Fig. 1, and opposite 13/32 on the upper scale (or runner) read 57/64 on the lower scale for the answer. Assume that we wish to add 5 39/64 to 16 47/64: First write down 21 on the pad, then set the right-hand zero mark of the runner to 47/64 on the lower scale, and opposite 39/64 on the upper scale (or runner) read 1 11/32 on the lower scale for the answer. This added to 21 = 22 11/32 for the final answer. Assume that we wish to subtract 51/64 from 1⅝: First set the right-hand zero mark of the runner to 51/64 on the lower scale, and opposite 1⅝ on the lower scale read 53/64 on the upper scale (or runner) for the answer.

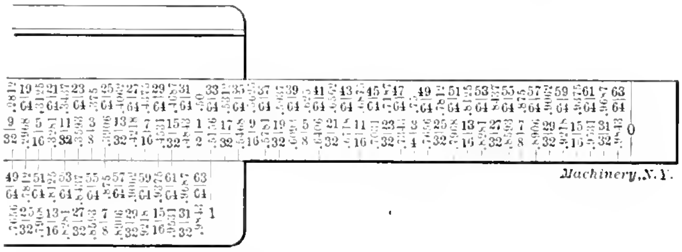


Fig. 2. Slide Rule Illustrated in Fig. 1 with Decimal Equivalents Added.

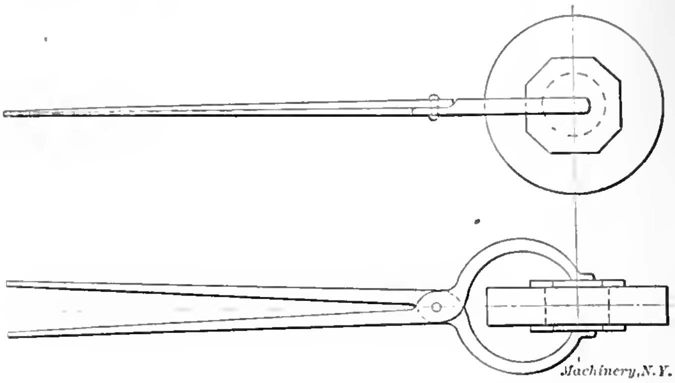
The operations for addition on this rule are identical with those for multiplication on the ordinary slide rule, only the latter employs a logarithmic scale instead of scales of equal parts. WM. C. MICHAEL.

Claremont, N. H.

[The addition of the decimal equivalents of fractions to the slide rule, as indicated in Fig. 2, would increase its value considerably, though there might be some confusion because of the multiplicity of numbers. The decimal equivalents would make it possible to add decimals and common fractions without changing the form of either, and the rule could also be used for checking drawings dimensioned with decimals.—EDITOR.]

REDUCING THE SIZE OF HOLES IN PARTLY FINISHED WORK.

In rough boring solid steel gears and similar work, it sometimes happens that the hole is made a little too large to permit a finishing cut to be taken. This may be done accidentally or through carelessness on the part of the workman, but, in any case, the bored piece is useless for the purpose for which it was intended unless the size of the hole can be reduced. The easiest way to do this is to heat the piece to an even temperature, and cover each end of the hole with a shield of some kind; sheet asbestos placed under iron plates, or two pieces of wood, one on each side, can be used.



Method of holding Protective Shield over the Center of the Heated Piece.

The covers are held in place with a pair of tongs as shown in the accompanying illustration. The work and covering is now plunged in a bath of cold water. The shields protect the center from the water. As all the cooling is done from the outside, the hot stock is forced toward the center as the outside shrinks. When fairly well cooled off, remove the piece from the bath and anneal it all over. The piece is then ready for the inside finishing cut.

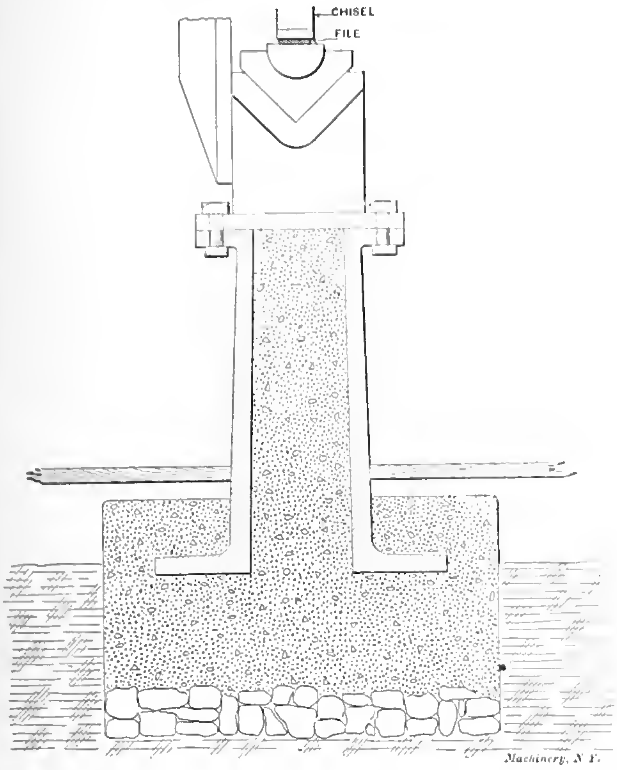
Plainfield, N. J. JAMES CRAN.

BASE AND FOUNDATION OF FILE CUTTING MACHINES.

In the manufacture of files, after the more preliminary operations, such as forging, annealing, grinding, and stripping, have been performed, the blanks go to the cutting shop where the teeth are formed on special machines. The blanks are held on a composition metal bed set in the table, which latter is driven longitudinally by a screw at a rate proportionate to the grade of the cut, and the teeth are cut thereon by rapid blows from a chisel secured in a holder or the chisel head. This chisel head or hammer, as it is commonly called, weighs, complete, from 8 to 12 pounds and makes from 2,000 to 3,000 strokes per minute. The machines for this purpose, subjected as they are to this constant jarring, should be well built and firmly mounted, not only to insure long life on their part, but also to enable the operator to turn out the best class of work; he must follow the cut with his eye so as to detect and immediately rectify any irregularity in the cut. A bench or a pedestal resting on the wood floor, found in some factories, will not answer for a foundation.

Some file cutting machines constructed by the writer were mounted as shown in the accompanying line engraving. The

foundation was built in the usual manner, the pedestal with the top perfectly level being supported from the floor until the concrete had set. In this case the pedestal was an octagonal casting, though a round or square one would have served quite as well. It will be noticed that as an aid to greater stability the inside of the pedestal is filled with concrete up to the base of the machine proper. As built, the foundations give perfect satisfaction.



Cross-section of a File Cutting Machine Concrete Foundation.

Middletown, N. Y. DONALD A. HAMPSON.

BENDING DIE.

The die herein treated was designed and made for the third and last bending operation on the piece shown at *A* in Fig. 1. The metal is 1/16 inch thick, of soft composition, and easy to bend. The first and second operations are performed in a like number of dies; the blanking or cutting from strip stock being done in one die, and the bending of the blank to a U-shape, as shown at *B*, in another. No description of these tools will be given here as they are of simple construction and readily understood by the average tool-maker who is at all familiar with die designing and die making.

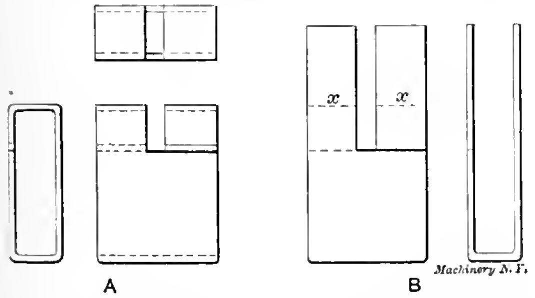


Fig. 1. Appearance of the Work when Finished and before the final Bending Operation.

The tool under consideration shown in Fig. 2, has, of necessity, several moveable parts in order to make the four bends required to complete the work. All the members are of simple outline and easy to make and assemble; therefore no detailed description of the methods of machining each part will be given. The holder *A* is of cast iron and is machined on the bottom, top, and sides to receive the several steel parts. The bending slides *B* and *B* are located in finished seats in the holder and secured in place by plates ¼ inch thick, each of which is, in turn, fastened by four 5/16-inch countersunk screws. The slides *B* have a close running fit, and are forced in to make the right and left bends by the cams *K* on the punch; their opposite or outward movements are made to take place by four compression springs *C*, located in the holder and acting against the pins *D* which are tightly driven into slides *B*. The third slide *E*, which has slotted holes to allow it to move in and out a limited distance, begins to operate after the other two have done their work; the object of this latter slide is to hold the steel form *F*, upon which the work is mounted, down, and free the formed piece from the punch on the up stroke. Springs hooked to the right-hand end of the press bolster and to pins *J*, return the slide *E* when the ram ascends. The four steel pieces *H* are adjusted, when the die is first set up in the press, to properly locate the form *F* which holds the work. The hardened rectangular steel piece *K* gives bottom to the work when in place to be formed. Hardened steel pieces *L* and *L* support the punch parts *K* and prevent their spreading when acting on the bending slides *B*.

The work having been bent U-shape previous to the finishing operation, is put on the former *F* which it pinches sufficiently to hold its own weight, and is carried to the die. On the down stroke the punch parts engage the inclined faces of the bending slides *B* and force them in, causing the right and left horizontal bends to be made at points indicated by the dotted lines *x* in Fig. 1. Further downward movement of the press ram permits these two slides to move out. The cam *L* forces the slide *E* inward until the inner ends extend over the bending form *F*, holding it down until the final bends are made by the former *M*, and the punch ascends sufficiently to free itself of the work. As the press slide continues to go up, the bending slides *B* make another in-and-out movement, thereby striking the formed piece a second time and setting the bends. The finished work is removed from the form by dropping the latter in a yoke secured to the press in a convenient position, and giving a slight pull. We have found it a good plan to taper the forms slightly from the section where the work is located, to the rear, to facilitate the removal of any material, after it is bent, that has a tendency to hug and not spring away. A suitable handle should be on the front end of the form for the comfort and convenience of the press-man, and it should extend to the front of the die sufficiently to make it absolutely unnecessary for the operator to incur any danger of accident by putting his hands between the working parts of the tool. We usually run this type of die in the press at about 100 strokes per minute, and have a slide movement of three or four inches. Several sizes have been made and all are giving good satisfaction. The tool herein described is of medium capacity. ENGINEER.

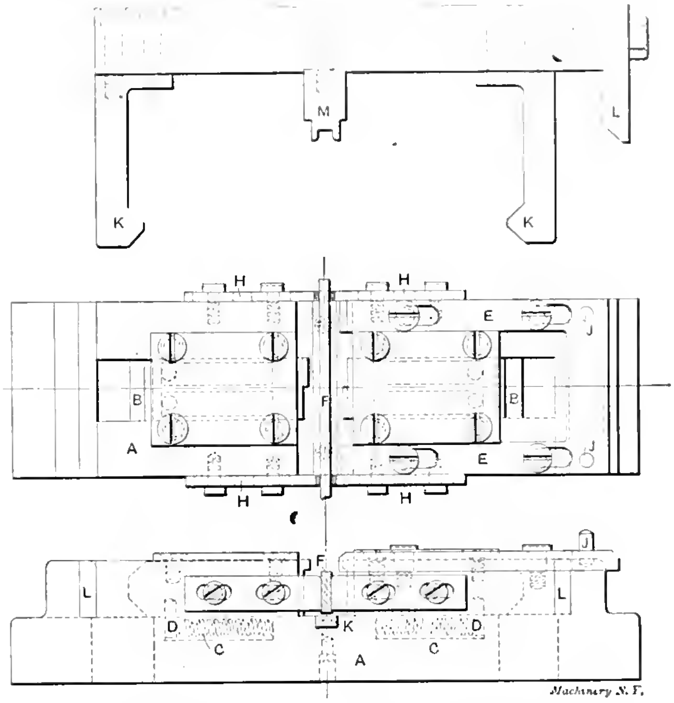


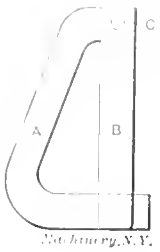
Fig. 2. Elevation and Plan of the Bending Die, end Elevation of the Punch, which form the Piece shown in Fig. 1.

SHOP KINKS.

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

ADJUSTABLE ERASING SHIELD.

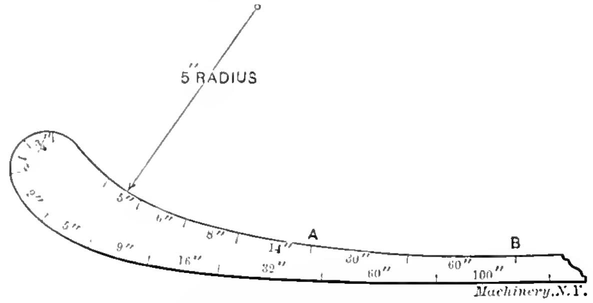


The engraving represents an adjustable erasing shield. It consists of two parts, *A* and *B*, which are hinged at *C*. By moving arm *B*, any size space can be had. Its advantage over the ordinary shield is that a very narrow space can be had at any time, while with the ordinary kind the spaces grow larger each time it is used. The shield is made of thin sheet brass.

Aurora, Ill. **JOHN B. SPERRY.**

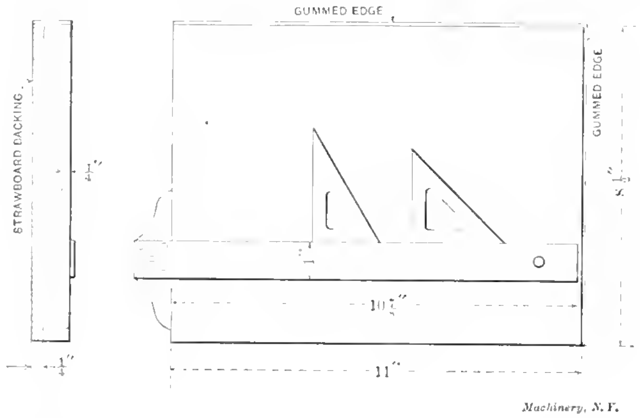
DRAFTSMAN'S GRADUATED CURVE.

The use of curves in the drafting-room has become almost as necessary as the use of the angles. While their use may facilitate the drawing and designing of shapes of irregular curves, it often puts the pattern-maker to more or less trouble in producing the exact forms in wood. A drawing without dimensions is of but little use to the workman; the same may be said of many outlines that are laid out in the manner mentioned. In most cases approximate outlines are good enough, but for particular exactness the radii should be given; and they can be obtained directly if the curve is graduated as the one shown above. **WINMAC.**



SKETCH PAD ARRANGEMENT.

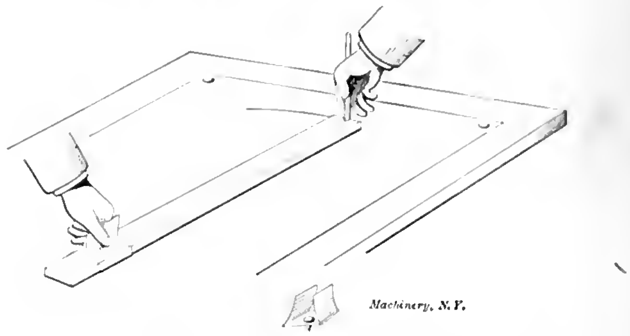
The accompanying engraving shows a very satisfactory scheme for saving time and making accurate sketches without the necessity of hunting for a drafting board and thumbtacks. Ordinary letter paper, or paper with a business heading, is blocked on an extra thick straw-board back, which should be at least 3/16 inch thick. The top and right-hand edges of the pad are gummed to hold the paper absolutely true. A small-sized T-square with a head no thicker than the straw-board backing, and the blade about 1 inch wide and slightly shorter than the length of the pad, is used. This combination gives a simple and compact means of making small sketches, and is always ready. Its great advantage lies in the fact that it can be kept on the desk or slipped into a drawer, and takes up but little room. If a carbon copy is desired, one side of the top sheet can be loosened, and the carbon paper easily placed in position.



C. C. M.

DRAFTSMAN'S TRAMMEL SUBSTITUTE.

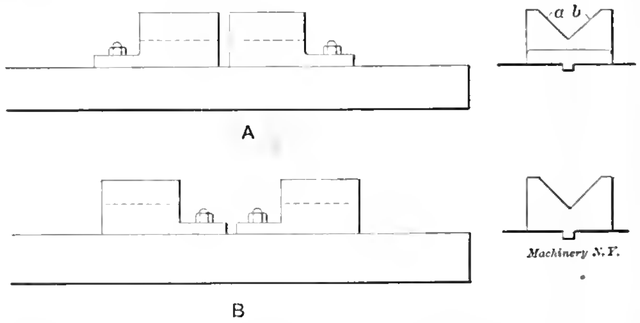
Occasionally circles or arcs of large radii are required when a trammel is not at hand. Substitutes, which are more or less clumsy and impractically contrived and which are intended to give relief in such emergencies, are, at times, described in the mechanical magazines. The accompanying engraving illustrates an arrangement which, with proper manipulation, is capable of producing results equally as good as those obtained with the most expensive instrument, and it has the added advantage that the necessary materials are always at hand with a moment's preparation. A straightedge is provided with a small notch in one end and a thumbtack, as shown by the dotted lines, inserted near it. A postal card having a thumb-tack point projecting from its center is creased over the stick; then the device is ready for use. Lay off the required radius on the paper and prick the center; insert the tack point and grasp the card flaps firmly with one hand while the other guides the pen or pencil in the notch as the curve is struck. The head of the thumb-tack which is near the notch, acts as a shoe which glides smoothly over the paper, and prevents blurring in case ink is used. A little practice makes the adjustment of the notch over the radius extremity a simple matter. **W. F. MOODY.**



Denver, Colo.

PLANING ACCURATE V-BLOCKS.

In planing a pair of V-blocks that are to be used on the planer platen for heavy keyway work, etc., the following method will be found to be a most accurate one, and the style of cast iron V-blocks, shown in the engraving, extremely well adapted for general use. First, the castings are planed on the bottom and the tongue made to fit the slot in the platen on which they are to be used, and, as there are various sizes of slots in planer platens, it is necessary that the succeeding operations be done upon the planer that the V-blocks are being made for.



After being drilled for the bolts, the blocks are placed on the platen as shown at *A*, and the tool-head is set to an angle of 45 degrees. A roughing cut is taken down side *a*, then the blocks are reversed as shown at *B*, and another roughing cut taken down the opposite side *b*. The foregoing operations are then repeated for the finishing cut, without disturbing the angular setting of the tool-head.

If this method is adopted for planing V-blocks, the user will find that the V is always in the center of the slot, regardless of the position of the blocks; but if they are planed by the old method of setting the tool-head first to one side and then the other, the V-blocks are only in line when set in slots as originally planed, and the workman, especially if he is a new one, is liable to get them placed the wrong way about, resulting in error and delay. **R. S. F.**

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

WHITCOMB-BLAISDELL SINGLE-SPEED PULLEY, GEAR-DRIVEN LATHE.

We present herewith a complete description with illustrations of a new 18-inch lathe, built by the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. This lathe is of the single-speed pulley type with speed changes obtained through geared connections. The principal feature of the design is the new form of clutch used in making the speed changes. This is of very ingenious construction, and involves a principle on which the builders have obtained a basic patent, though the idea is so simple that it is strange no one has previously patented it. Besides this one particularly novel feature, there are so many other points of originality in the design that the amount of space we have allowed for describing it is fully justified.

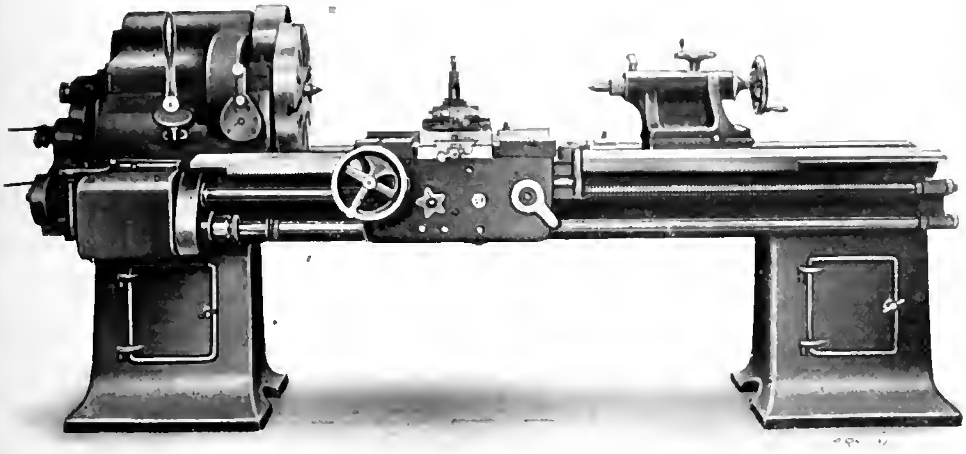


Fig. 1. The Whitcomb-Blaisdell Single-speed Pulley, Gear-driven Lathe, 18-inch Swing.

Driving Mechanism.

The geared head-stock is shown in elevation and detail in Figs. 1, 2, 3 and 5. Power is received at the driving pulley *A* (see Fig. 3), which is keyed to shaft *B*. This shaft revolves in fixed bearings in the head-stock and carries pinions C_1 C_2 and C_3 keyed to it, and has pinion teeth cut on it at C_4. These four pinions mesh with corresponding gears D_1, D_2, D_3, D_4, which normally revolve loosely on friction shaft *E*. Either one of clutch bodies F_1, F_2 and F_3, and gear *H*, may, however, be engaged with the corresponding gear D_1, etc., by means of clutches G_1, etc., whose construction will be described later. It is thus seen that four rates of speed may be given to shaft *E* when pulley *A* is running at constant speed.

Shaft *E* carries gear *H* keyed to it, and has pinion teeth cut in it at *J*. *H* and *J* mesh with gears *K* and *L*; *K* is keyed to clutch member *M*. *L* and *M* may be connected by clutches N_1 and N_2 respectively, with clutch bodies O_1 and O_2, which are keyed to the spindle *P*. The four speeds, which may be given shaft *E* are thus doubled, giving eight speeds for the spindle.

The construction of clutches *G* and *N*—the main point of interest in this drive—is best seen in the detailed views at the right of Fig. 3. The peculiarity of this form of clutch may be expressed by saying that it is a positive friction clutch —that is to say, its engagement takes a measurable amount of time and allows some slipping of the engagement surfaces, thus obviating the severe shock met with at high speeds in positive clutches. On the other hand, it avoids the uncertain driving power and excessive slippage met with in friction clutches, and obviates as well, the necessity for frequent or even occasional adjustment.

In the upper clutch, the expansion ring Q_1 is hung on a pin R_1, which is, in turn, fast to the revolving gear D_1. This ring is thus always rotating when the driving pulley is in motion. The open end of ring Q_1 has pivoted to it a lever S_1, which through the medium of strut T_1 may be made to spread the ring open, engaging the inner diameter of F_1, and thus connecting D_1 and *E*. The movement of the lever for thus operating the clutch is effected by the sliding spline V, which has keyed to it a series of cams U_1, U_2, etc. When this spline is shifted axially on shaft *E* to bring cam U_1 in the path of the revolving lever S_1 (the direction of revolution being immaterial), the latter, as soon as it strikes U_1, is forced outward, spreading ring Q_1 and engaging the clutch. Supposing, for instance, that clutch ring Q_1 and lever S_1 are revolving in the direction of the arrow, and that shaft *E* is being started from a state of rest; it is evident that the rotation of the ring and lever will cause the latter to ride up on the cam until the clutch is fully engaged, when, since *E* is rotating at the same rate as Q_1, the relative movement of S_1 and U_1 will cease so that the clutch will not be tightened more than is necessary to carry the load. If slippage occurs at any time, this will simply cause lever S_1 to ride still further over the cam, tightening the clutch still further. Any slippage thus tightens the clutch the exact amount required to carry the extra strain.

One of the interesting points in the design of this clutch relates to the matter of relieving the face of the clutch ring for the oil, where the driving surfaces come together. As is well known, clutch surfaces which run in oil must be grooved so as to allow the parts to come quickly to a bearing. In the case of this clutch, it was found necessary to groove the periphery of rings Q_1, etc., to such an extent that the bearing area was divided into about ¼-inch squares, separated by oil channels. This permits the lubricant to be squeezed out almost instantly. If larger undrained areas had been permitted, the squeezing out of the oil would have taken some time, and as long as it remained, the full driving force would have come from the engagement of lever S_1 and cam U_1; as these parts, with the acute contact surface between them, could not have been made strong enough to stand the strain of the full driving power, this complete grooving is necessary for the operation of the clutch. The builders advise the use of a thin free-flowing oil for the headstock mechanism.

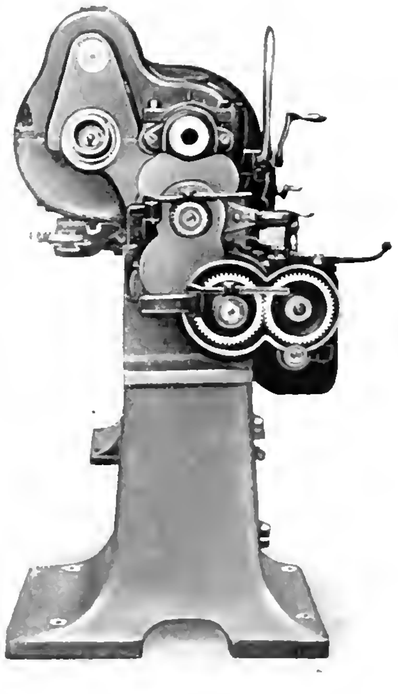


Fig. 2. End View of Lathe showing Feed Gearing Connections.

It will be noted that no adjustment is required, the clutch adjusting itself, each time it is used, to the amount required by the load. It may also be seen that the amount of slippage that takes place before the clutch is engaged is predetermined by the shape of the acting surfaces of the lever and cam, as there is no possibility of the parts ever slipping for more than the merest fraction of a revolution. The wearing surfaces are far more durable than in the ordinary type of friction clutch. This durability is still further enhanced by the

method of mounting rings O_1, etc. These, it will be seen, are provided with circular tongues at a, entering corresponding grooves in members D_1, etc. In their open positions, these tongues closely fit the small diameter of the grooves, thus centering the rings in members F_1, etc., and holding them entirely free from these members, so that there is no rubbing of parts not in action. When the rings are spread open to engage their respective members, the free fit on the outside diameter of tongue a permits them to engage freely and without restraint.

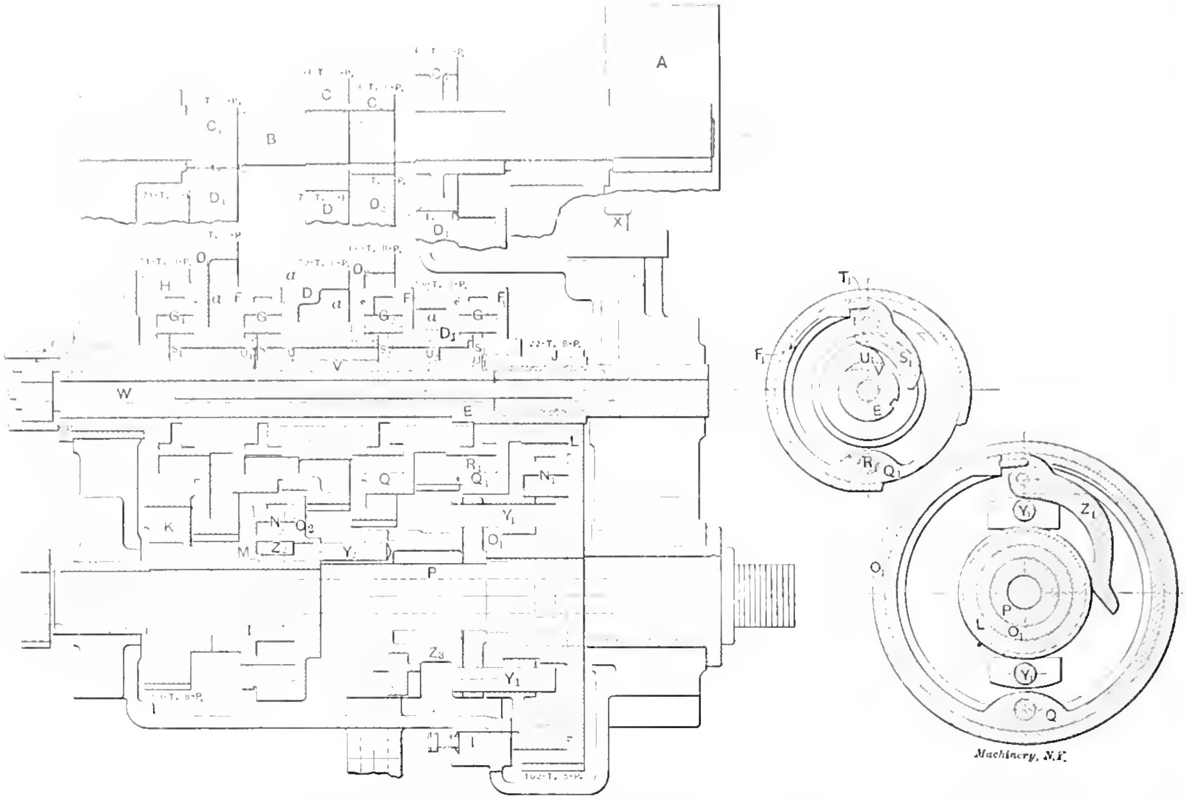


Fig. 3. Head-stock Spindle for Whitcomb-Blaisdell Lathe showing the Gearing, and the Positive-action Friction Clutches which control the Speed Changes.

Spline V carries four cams U_1, U_2 etc., which engage corresponding arms S_1, etc. In the position shown, a movement of spline V to the left will bring U_1 out from under lever S_1, allowing it to drop and thus releasing the clutch. Continued movement brings cam U_3 under lever S_3, thus engaging this clutch. A further movement to the left carries U_3 beyond S_3 and engages U_2 with S_2. The position farthest toward the left brings U_4 and S_4 in engagement. In the reversed motion, the same sequence is gone through in reverse order. This movement of spline V is effected by its connection at the left-hand end with sliding rod W, which passes through shaft E. This rod has pinion teeth cut on its extreme right end, engaging a pinion on stud X, which is in turn connected by gearing with the crank shown at the front of the main bearing of the head-stock in Figs. 1 and 5. The four positions of the spline and the four corresponding speeds are indicated by the dial pointer shown.

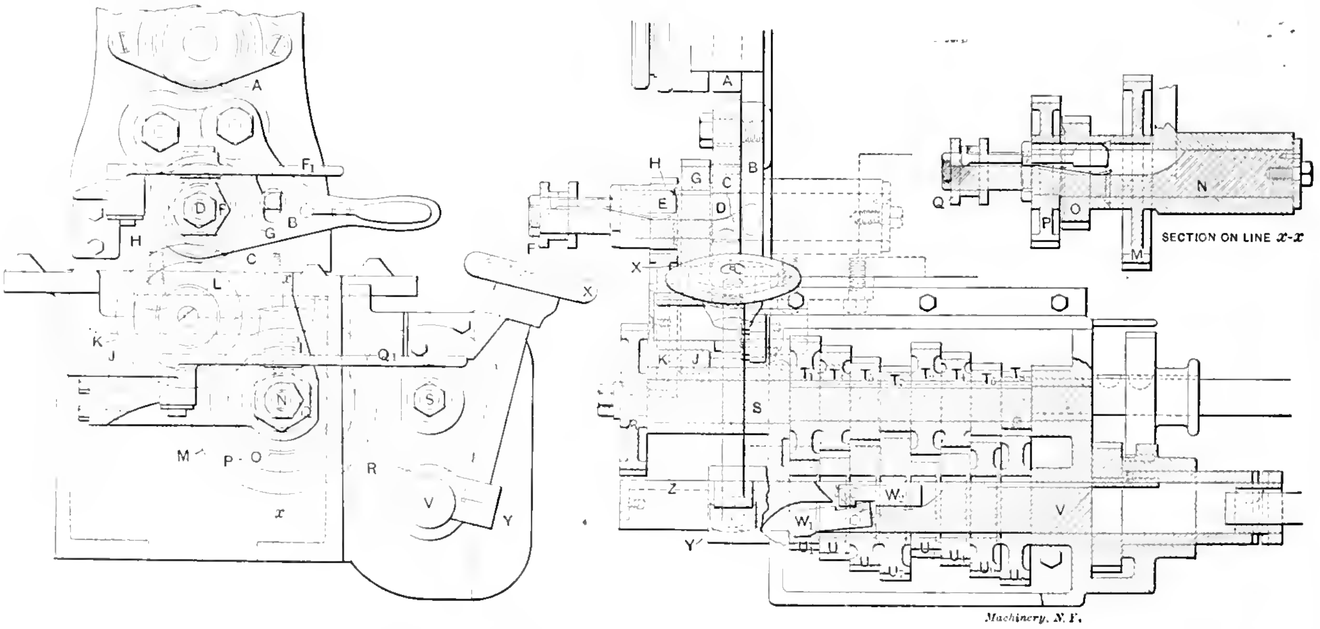


Fig. 4. The Feed Change Mechanism; note the Double Sliding Key for the Gear Box.

Clutches N_1 and N_2 are identical in principle with clutches G_1, G_2, etc., though they differ slightly in construction, as shown in the lower face view at the right of Fig. 3. In these clutches cams U_1, etc., are replaced by pins Y_1 and Y_2, which engage levers Z_1 and Z_2. These pins are fast in the sliding collar Z_3, which is shifted by means of the vertical lever shown at the front of the head-stock in Figs. 1 and 5. Owing to the comparatively slow motion of gear L, two pins Y_1 are provided, while but one pin Y_2 is used. This insures rapid action in the clutch even at slow speeds.

The only criticism that came to the writer's mind in examining and operating these clutches related to the possibility of trouble from a faulty engagement of cams U_1, etc., with their corresponding levers. Such a faulty engagement might take place, if U were brought under S at just the time the

latter came around, so that the engagement took place on the corner. It appears that this sometimes happens, without ill effects, however. If the corners of the engaging surfaces are new and sharp, *U* may easily be pressed into complete engagement. If the corners of these surfaces should be rounded from long usage, they disengage themselves and the operator throws them in again immediately.

A detail in the construction of the head may be noticed at *I*; this is a spring plunger which may be pressed into engagement with corresponding notches in the face of member O_1 which is keyed to the spindle. It is thus possible to lock the spindle for unscrewing chucks, faceplates, etc., from the nose.

The Feed Changes.

Provision is made in this lathe for thirty-two changes of feed for turning or threading, without removing or changing the gearing. Figs. 2, 4 and 5 show how this is effected. The feed driving gear *A* on the spindle is connected through the usual reversing tumbler gearing on sector *B*. Gear *C* is keyed to shaft *D*; this shaft is slotted for sliding key *E*, operated through collar *F* by horizontal lever F_1. Key *E* may be set to drive either of gears *G* and *H*; these are separated by the hardened internal collar shown, which withdraws the key from one before it engages with the other. Gears *G* and *H* mesh with corresponding gears *J* and *K* keyed to the hub of pinion *L*, which thus may be given either of two rates of speed. *L* and *K* engage gears *M* and *O* on shaft *N* (seen best in the detail at the upper right-hand of Fig. 4) through a sliding key arrangement exactly similar to that in the shaft *D*. Either of gears *O* and *M* may be engaged to *N* by the shifting of collar *Q*, and the horizontal handle Q_1 attached to it. Shaft *N* thus has four rates of speed, which are transmitted through gears *P* and *R* to shaft *S*, in the feed box proper.

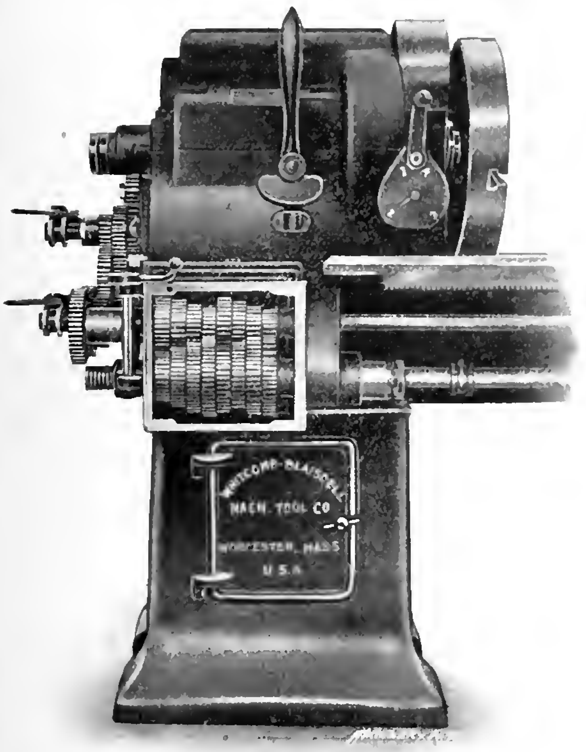


Fig. 5. View of Head-stock End of Lathe, with Gear Covering Removed.

This feed box is of the sliding key variety, but differs radically from the usual type in the details of its construction. This will be inferred from the arrangement of the gears, as shown in Fig. 5, where it will be seen that they are disposed in the form of a double cone on each axis. The reason for this will be apparent in the line drawing, Fig. 4. Gears T_1, T_2, T_3, etc., are keyed to shaft *S*, which, as explained, can be connected with the spindle in four different ratios. These gears mesh with mating gears U_1, U_2, U_3, etc., on sliding shaft *V*. These gears are engaged with *V*, in turn, by keys W_1 and W_2, which are pivoted to *V*, and are connected with each other by the spring and interlocking surface shown, so that when one moves into engagement the other drops out, and vice versa. This alternate movement in and out of engagement is effected by the hardened washers placed between each of the gears. As *V* in Fig. 4 is shifted to the right, the washer between U_1 and U_3 throws key W_1 out of engagement and puts a tension on the spring connecting W_1 and W_2, so that the latter is thrown into engagement with the spline in gear U_2, as soon as it comes into position to do so. A further movement of *V* disengages W_2 and throws W_1 into engagement with U_3. The order of engagement as *V* is shifted to the right is thus, U_1, U_2, U_3, U_4, etc.

V is shifted by means of a sleeve *Z* attached to its outer end, which has rack teeth cut in it meshing with pinion *Y*, at the lower end of the vertical rock shaft shown in Figs. 2, 4 and 5. This shaft has a handle or knob *X*, and carries a dial with figures corresponding with the pair of gears engaged. Referring to the feed and thread plate at the front of the head-stock, the operator may find the number of threads per inch given by each of these eight positions, in combination with the four changes effected by the horizontal levers. The feeds are five times as fine as the threads.

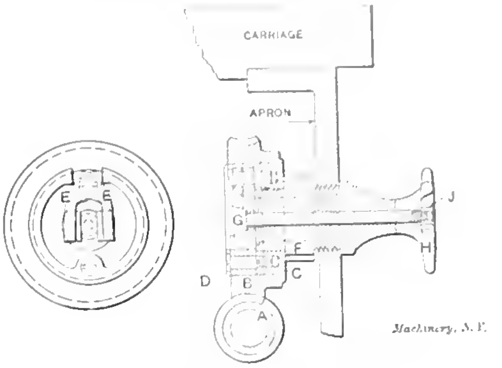


Fig. 6. Adjustable Friction Drive for Apron Feeds.

The advantages of this form of gear box lie in the short axial movement required for the sliding keys, and the correspondingly compact arrangement of the controlling mechanism for the eight changes. It should be noted also, that, owing to the fact that when one of the keys is in engagement the other is withdrawn, there is little wear on the hardened washers separating the gears. A much better selection of threads has been provided in this box than usual, owing to the fact that the gears have not been limited to even pitches. Where it was necessary in the gear box, in obtaining a desired ratio, to employ fractional pitches, this has been done without hesitation, so that the pitches of different gears vary, though they are most of them about nine diametral. Each of gears U_1 and U_2 has six splines in its bore, so that they engage quickly. Provision is made for disconnecting either the feed rod or the lead-screw from the feeding mechanism, by means of the sliding gear and sliding clutch shown at the right of Fig. 4.

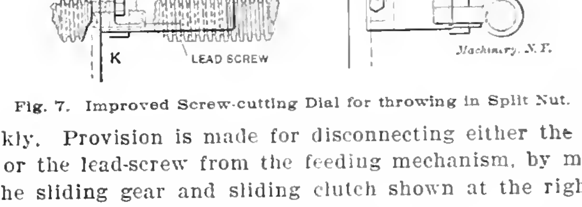


Fig. 7. Improved Screw-cutting Dial for throwing in Split Nut.

The Carriage and Apron.

The details of the carriage construction follow the standard practice of the builders in most particulars. There are, however, two points of improvement which are worth mentioning. One of them relates to the friction drive for the feed. This is shown in section and plan in Fig. 6. The worm *A*, keyed to the feed rod, engages a wormwheel *B* which normally revolves

loosely on clutch body *C*. Split friction ring *D*, pinned to *C*, may be spread apart by the double levers *E*, so that the worm-wheel drives *C* and the pinion *F*, to which, in turn, *C* is pinned. Levers *E* are spread apart by turning bolt *G* so that the circular portion of its head, instead of the flat portion, is brought around between the ends of the levers. Bolt *G* is turned by knob *H* on the outside of the carriage. The improvement in its construction lies particularly in the method of adjusting the clutch from the outside. This is done by nut *J*, which draws in bolt *G* against the pressure of the spring under its head. Owing to the conical shape of the round portion of the head of *G*, the axial movement operates to spread the levers further part, and thus adjustment is made for wear.

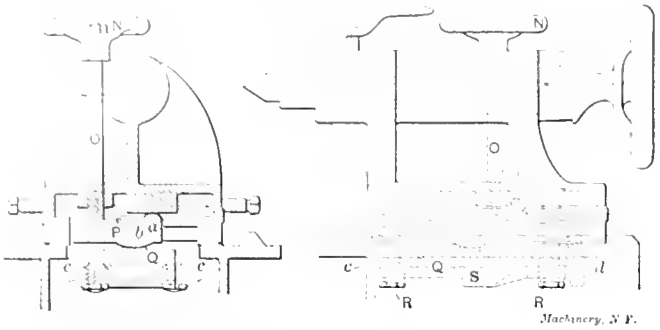


Fig. 8. Tail-stock, showing Method of Clamping at the Four Corners with Single Hand-wheel.

Another improvement in the construction of the carriage relates to a threading device which has been provided. This is shown in Fig. 7. The principle of the arrangement, it will be observed, is the same as that employed on other makes of lathes for indicating the points at which to throw in the half-nut to "catch the thread" when running the carriage back by hand for a new cut in threading. Worm-wheel *K* meshes with the lead-screw and is always in engagement with it. This is connected by gearing in the ratio of 2 to 1 with the vertical shaft *L*, which carries at its upper end a revolving dial having graduations indicated by a stationary pointer. The improvement consists in providing three concentric circles for these graduations, one for even pitches, one for odd pitches, and a third for half pitches. This provision makes it possible to catch the thread much quicker on even pitches than would otherwise be the case, while the cutting of half pitches is provided for. This is not usually done. The pointer is moved toward or away from the center to agree with the circle of graduations it is desired to read. It is evident from the dial that the wormwheel *K* has a pitch circumference of 4 inches.

The Tail-stock, Taper Attachment, Etc.

The tail-stock clamping arrangement is original with this lathe. It is shown in Fig. 8. The tail-stock is clamped to the bed at the four corners by means of hand-wheel *N*. This is keyed to the threaded stud *O*, which may thus be screwed down against the hardened plate bearing in lever *P*. This latter is fulcrumed at *a* against the under side of the tail-stock, and has a spherical boss at *b*, which bears against a hardened plate on clamping lever *Q*. This latter is hung from spherically seated nuts on studs *R*, which form a fulcrum for it. The outside ends at *c* bear on the under side of the ways of the bed, clamping the tail-stock at the front end. Pressure is also transmitted from lever *P* through lever *Q* to the outer end of lever *S*, which in a similar way through similar bearing points *d*, clamps the rear end of the tail-stock. Springs near bearing points *c* and *d* throw the clamping surfaces out of engagement when hand-wheel *N* is screwed back to relieve the pressure.

The advantages of this arrangement lie in the very firm clamping which can be obtained, and in the handiness of the operation, it being necessary to make but one movement to clamp the tail-stock. Ordinarily there are at least two, and sometimes four nuts to be tightened. The workman is often careless about this, tightening only one. With this arrangement, the clamping action is simultaneous at the four corners with but one movement. Of course in adjusting the tail-stock, it is necessary to so set the nuts or studs *R* that the clamping action is evenly distributed.

Among the advantages of this lathe is that common to all lathes of the single pulley constant speed type, namely, that of delivering the same horse-power through all the changes of spindle speeds. In addition, this lathe never has to be slowed down to make any change in speeds or feeds, all of which may be effected by an unskilled operator, at full speed, or under the heaviest cuts. All the gearing in the head runs in oil, and it has been found to require no attention after many months of continuous operation, and then the only requirement was that of refilling with oil. The construction will thus be seen to possess marked advantages from the standpoints of both operation and maintenance.

DIAMOND MACHINE CO.'S FACE GRINDER.

The accompanying engravings show the general features of a large face grinder which has been designed by the Diamond Machine Co., of Providence, R. I. While this machine was planned with reference to the particular work of grinding locomotive guide bars, its construction is such that it will be found useful for the general run of surfacing operations in the ordinary machine shop.

The machine consists, as may be seen, of a reciprocating work-table, sliding on a long bed, which carries the work back and forth before the face of a large ring emery wheel, held in a steel-bound adjustable chuck, which so supports the wheel as to make it entirely safe at any reasonable speed. The bearings are of ample area, and are lined with a high grade of babbitt; they are ring oiled, and protected from dust. The end pressure is taken by a ball thrust bearing. The longitudinal table movement is obtained by an open and cross belt reversing mechanism, connected to the table rack by heavy gearing. The mechanism used is similar to that found on the planer. It is regulated for any desired length of stroke by the shifting of adjustable dogs. When it is desired to operate the table by hand, the clutch is thrown in to connect, with the table gearing, the hand-wheel shown at the front of the bed. The cross feed is effected by adjusting the spindle head axially along the rearward extension of the bed on which it is

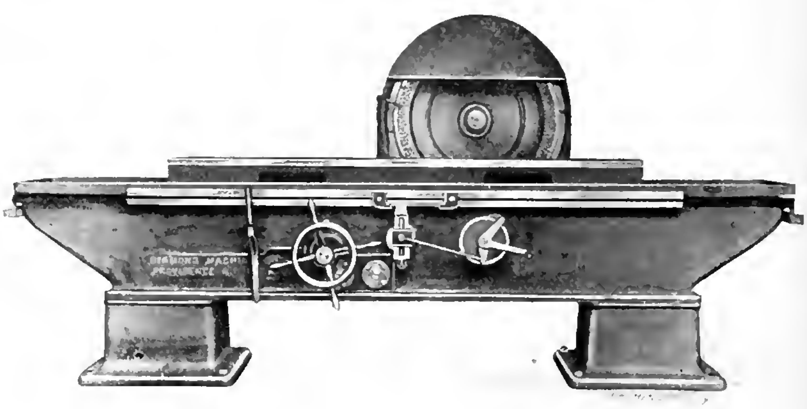


Fig. 1. Face Grinder for Finishing Guide Bars and General Work.

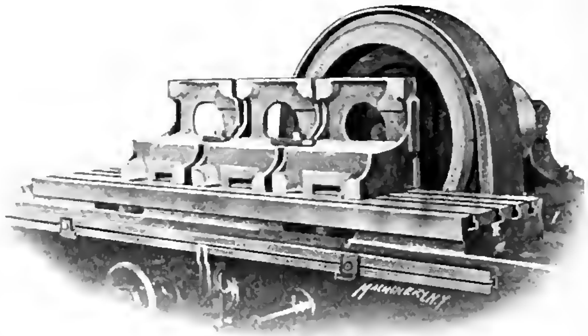


Fig. 2. Facing Machine Parts on the Grinder.

mounted. This cross feed is shown connected for automatic control in Fig. 1. It is capable of very fine adjustment.

One of the advantages claimed for this machine in the work of finishing flat surfaces, is the fact that it works with equal facility on hard or soft iron, or may even be used for hardened steel. The work does not need to be so rigidly fastened as on a planer or milling machine. The movements of the mechanism are of great rapidity, as compared with those of other machines for this class of work. It has been profitably applied to such miscellaneous operations as the finishing of machine columns, water meter cases, water pipe flanges, lathe legs, floor plates, etc. It is shown in Fig. 2 grinding a casting of a form often met with in machine shop work.

This machine is built in either 7-foot or 9½-foot lengths, and for belt or motor drive. Longer machines can be made if desired. On the 7-foot machine the clamping surface of the platen is 7 feet long and 17½ inches wide. The table travel is at the rate of 20 feet per minute. The wheel is 30 inches in diameter and runs from 350 to 700 revolutions per minute, depending on the nature of the work. The wheel spindle bearing is 3½ inches in diameter and 10 inches long. The floor space required for operating is 18 feet 4 inches long by 7 feet wide. The weight complete, with counter-shafts, is about 8,000 pounds; with a motor drive which is self-contained, the weight is about 10,000 pounds. An automatic pump with suitable attachments for wet grinding is furnished on all machines.

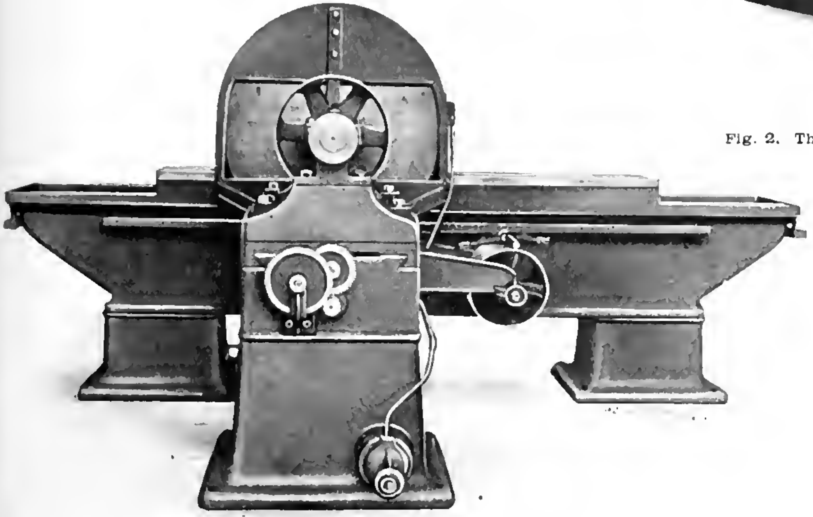


Fig. 3. Rear View of Diamond Face Grinder.

SCHELLENBACH-HUNT UNIVERSAL MICROMETER AND SURFACE GAGE.

The four half-tone engravings published herewith give a very good idea of the range of usefulness offered by a new micrometer measuring instrument, made by the Schellenbach-Hunt Tool Co., Cincinnati, Ohio. It is intended to be used as a widge-range micrometer caliper in either of the two positions shown in Fig. 1 or Fig. 2, as a height gage (see Fig. 3), or as a micrometer scratch gage for laying out work as shown in Fig. 4. All these various applications are possible with very little change in the instrument itself.

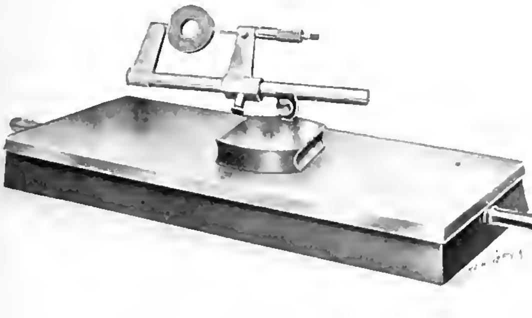


Fig. 1. Schellenbach-Hunt Measuring Instrument arranged as a Bench Micrometer.

As may be seen in Fig. 1, where the instrument is arranged as a bench measuring instrument, the micrometer head is carried by a sliding jaw, which is adjustable to eight different positions on the bar or beam of the caliper. The bar can be shifted endwise to any desired position in the base clamp, and by a quarter turn backward, the instrument can be lifted out of the clamp and be placed inside or outside of the jaw, as may be necessary to permit it to be moved to the desired location as indicated by the graduation on the bar. These locations, of course, are for even inches. The length of the jaws is such that round work up to 4 inches in diameter, and flat work up to 7 inches in length, can be calipered to thousandths of an inch.

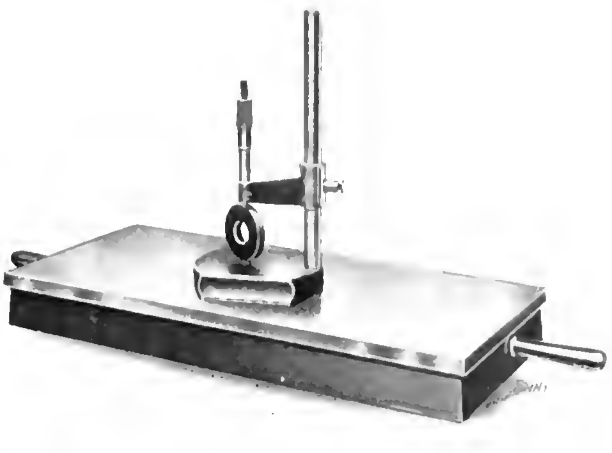


Fig. 2. The Same Instrument used as a Micrometer on an Anvil Base.

The location of the sliding jaw on the bar is determined by conical holes in the center of the flattened side of the latter. To set the jaw, it is only necessary to slide it to approximately the desired position and then screw the locating pin down until its conical end seats itself in the bar. This both positions and clamps the jaw rigidly at the same time. The bar, as well as the locating pin and the bushing which guides it, are hardened, ground and lapped.

In Fig. 2 the instrument is seen with its fixed jaw or anvil head removed, and with the bar clamped in position on the base, with the point of the measuring screw over an anvil point in the latter. A 2-inch reference disk is shown held between the measuring points, as in Fig. 1. The capacity of the tool when used in this way is the same as before. The bar is drawn to its seat in the base by the same screw used in connection with the anvil head.

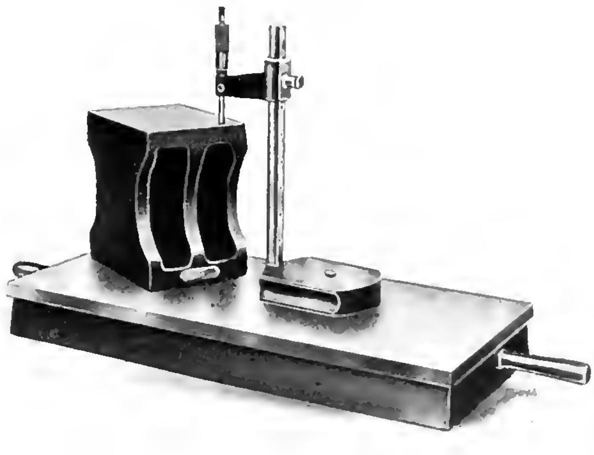


Fig. 3. Arranged as a Height Gage, whose Capacity may be Increased by Height Blocks such as shown.

In Fig. 3 the instrument is arranged for use as a micrometer height or surface gage. The change from Fig. 2 is merely that of turning the bar half way around. In this position any distance from 0 to 8 inches in height can be measured. By the use of cast iron height blocks, such as shown in place under the measuring screw, the range can be extended. The makers

furnish these blocks 6 and 12 inches high; with them, the instrument has a range of from 0 to 26 inches by thousandths of an inch. They are useful in setting the tables of milling and boring machines to exact position in relation to the centers of their spindles, and in connection with measuring the various heights of planed and milled surfaces, the location of jig bushings, etc.

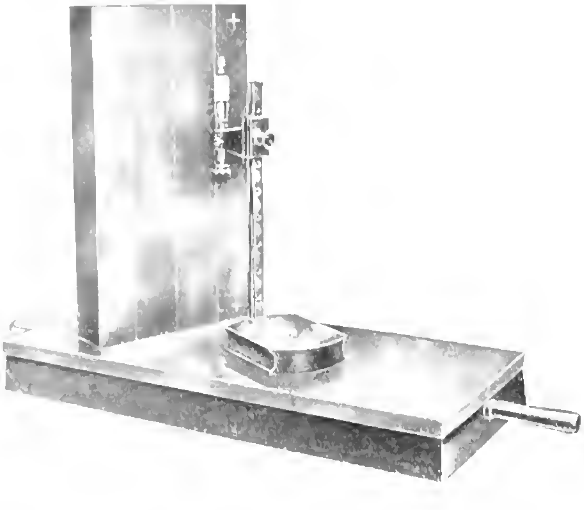


Fig. 4. The Tool arranged as a Micrometer Scratch Gage—laying out Centers for Boring.

In Fig. 4 the instrument is shown with a special circular scribing tool attached to the end of the measuring spindle. When so arranged, it becomes a precision scratch gage—a tool which should be appreciated by any one having to do with the laying out of holes and machined surfaces in work requiring fine measurement. The lower face of the scribing disk is ground at right angles to its bore, while the upper side is ground at a slight angle and to a sharp edge, which is notched. The points formed by the notches are the scribing elements. The lower side of the disk is drilled and tapped for a screw, the head of which projects over the edge of the bore, and locates the scribing lines in the plane of the end of the measuring spindle. The disk is slotted, and is clamped to the spindle by means of a tightening screw. The cutting points are kept sharp by grinding, in the same way that a formed gear cutter is ground. As the face of the disk is a plane surface, grinding the notches to keep the scribing points sharp can be continued indefinitely, without destroying the accuracy of the cutter.

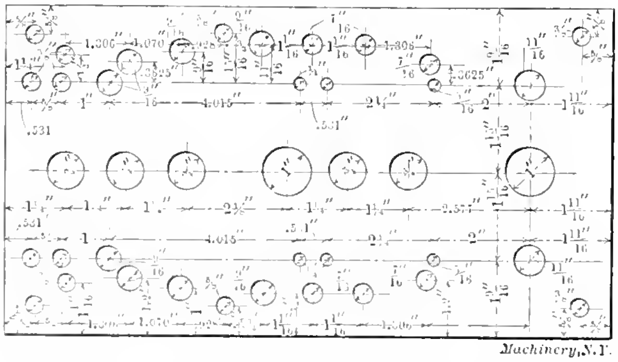


Fig. 5. Diagram of Work being Laid Out in Fig 4.

The particular piece of work which is being laid out in Fig. 4 is shown in Fig. 5, with the measurements of the various holes which are to be drilled in it. The locating of these, it will be seen, involves the taking of a great many measurements, which are made with facility and accuracy when this instrument is used. The measurements from one edge are first made and then the work is placed on its other face and lines scribed for measurements at right angles to the first. The intersections locate the various holes. When used in connection with the height blocks, such as the one shown in Fig. 3, lines may be drawn on work from within 1/16 inch of the base surface to the full range of the instrument, which is 26 inches, as described. It is, of course, understood that the micrometer spindle should be locked before the scribing is done. The provision of a scratch gage which can be set to thousandths of an inch should materially assist the workman in producing good work, in the many operations for which the tool is adapted.

SPECIAL SKINNER CHUCK FOR HOLDING GAS ENGINE CYLINDERS.

The two engravings shown herewith illustrate a special chuck made by the Skinner Chuck Co., 94 N. Stanley St., New Britain, Conn. It is designed for holding gas engine cylinders, and is especially adapted to the work of automobile factories. In the operation for which it is used, the cylinders are bored and faced, and practically finished at one chucking.

The chuck is of the two-jawed universal type. The jaws work together when operated by either screw, being connected by rack and pinion gears which are completely enclosed. Special jaws are used to fit the exterior of the casting which is to be machined. To prevent the possibility of the work's loosening and chattering in jaws at the extreme outer end of the work, they are connected at this point, as shown, by two swing bolts, one on each side. This ties the work and the chuck together, making it practically a solid piece, and permitting heavy cuts to be taken, with the special tools usually provided for such work.

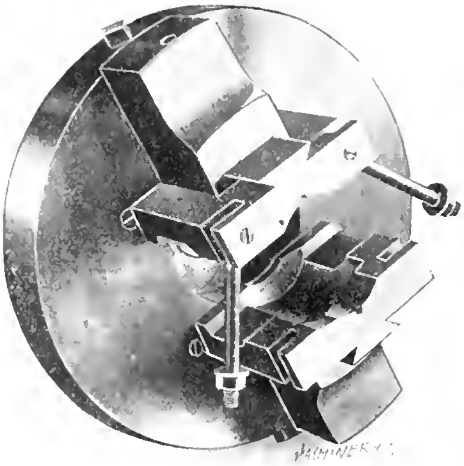


Fig. 1. Special Chuck, provided with Jaws for Holding Gas Engine Cylinders.

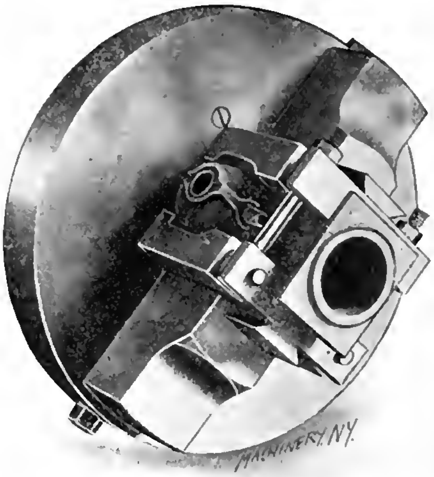


Fig. 2. Work in Place in Chuck. Note the Swing Bolts at Outer End of Jaws.

The chuck is of particular interest on account of its size. The diameter of the body is 24 inches, and the width of the adjustable jaws is 6 inches; the adjusting screw nuts are 1¼ inch square, and the net weight of the device is 490 pounds.

OSTER PIPE THREADING DIE-STOCK.

The Oster Mfg. Co., of Cleveland, O., has added a die-stock for threading pipe from 1 to 2 inches diameter, to its line of pipe-threading tools. This die-stock is so designed that the chasers automatically recede from the work while cutting, thereby forming a standard taper thread; the chasers are controlled by a cam for this purpose. On the face-plate of the die, graduations are provided by means of which special guide posts are set so as to obtain the exact size required to be cut; these guide posts, in turn, drive the cam which operates the chasers or dies. When the die has been set for cutting a certain size, the guide posts are locked by a nut at the bottom of the posts, and the setting remains unaltered as long as threads of a given size are cut. One feature of this die-stock is the universal

gripping chuck which can be adjusted to all sizes by revolving it by means of a handle. This takes the place of all bushings, and makes the die-stock entirely self-contained. The gripping jaws of the chuck are made of hardened tool steel, and consequently will not wear appreciably even after a long period of use.

AMERICAN 36-INCH TRIPLE-GEARED LATHE WITH TURRET ON SHEARS.

The unusually heavy turret lathe shown in Figs. 1 and 2, is built by the American Tool Works Co., Cincinnati, O. It is provided with the regular carriage, tail-stock, center and follow rests, etc., being in this respect identical with their 36-inch heavy pattern engine lathe. The chief point of novelty lies in the turret slide itself, and in the separate feed mechanism provided for controlling it.

The hexagonal turret is indexed by a bolt located at the front of the slide, which brings the locking point very near the tool. This is superior to the usual construction, which locks it at the back, in which case slight wear of the turret locating surfaces is multiplied several times at the tool point. The turret can be indexed automatically, or by hand, or the mechanism can be set so as to be operated, if desired, to run the slide back to the extreme limit without withdrawing the locking pin and revolving the turret. This is done by the small lever shown near the large pilot wheel in Fig. 1.

A unique construction of the turret slide itself, gives it support at the outer end by a gibbed bracket, which travels along the ways of the lathe. This support eliminates any tendency to spring at the extreme travel of the slide. For work which requires the turret slide to pass over the carriage, this bracket can be removed. The turret slide base is moved along the bed by the small pilot wheel shown in Fig. 1. This base is clamped to the lathe bed by two eccentrics, one at each end. It is further secured from slipping under severe end thrust by a bolt which engages a ratchet toothed rack which is cast in the center of the lathe bed, and is used in the same manner, also, for supporting the tail-stock.

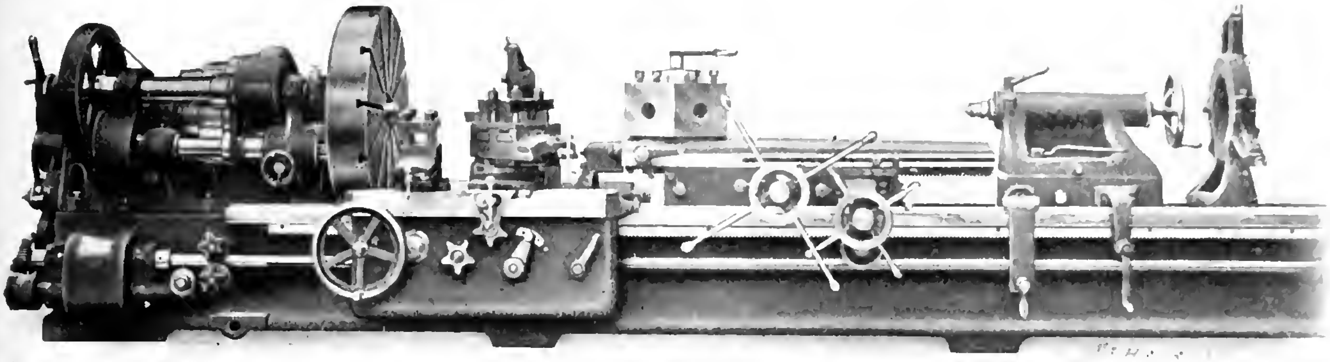


Fig. 1. Front View of Heavy "American" Lathe, with Turret mounted on Independent Slide on Shears.

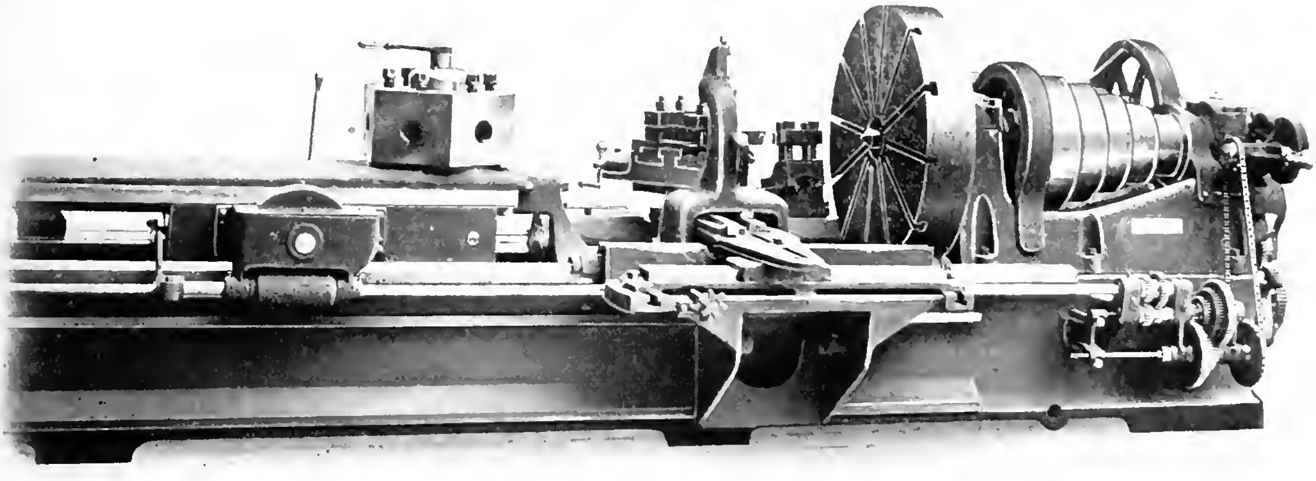


Fig. 2. Rear View of Lathe, showing Special Feed Mechanism for Turret Lathe.

Fig. 2, taken from the rear side of the lathe, shows the supplementary feed mechanism provided for the turret slide. This is driven through reverse gearing, sprockets and chain, from the rear end of the spindle, as may be seen. By means of a sliding key arrangement, eight changes of feed are provided, operated by the knobs shown at the front of the bed, beneath the head-stock. These feeds range from 0.005 to 0.162 inch per revolution, and are entirely independent of the regular carriage and apron feeds. This feed mechanism is provided with a protecting cover which is shown removed in the engraving. The reversing of the turret feeds is a convenient feature in such operations as back-facing and back-counterboring.

Provision is made for attaching the turret slide on the regular tool slide of the carriage, if desired, in work in which it is advantageous to employ the carriage feeds for the turret. This occurs in large tapping operations, for instance, where it is advantageous to give the taps a positive feed through the regular screw cutting mechanism. This arrangement is also of value in the ordinary work of chasing internal threads with the tool.

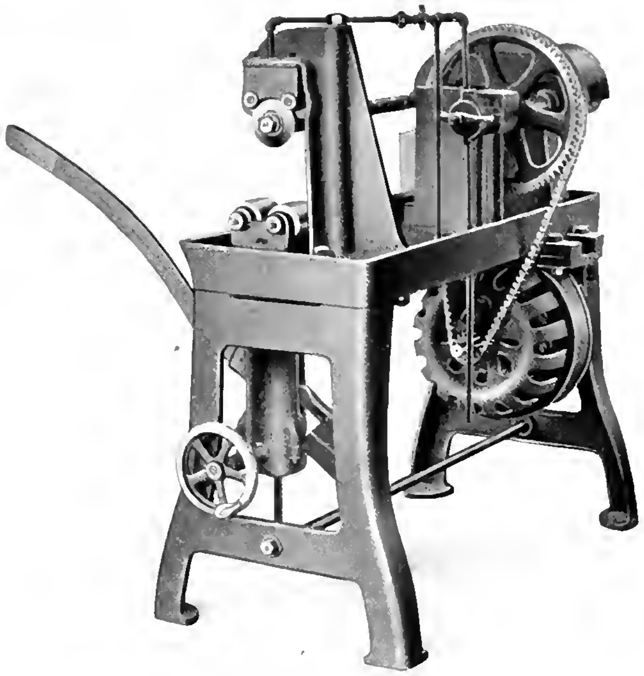
The taper attachment, shown plainly in Fig. 2, is of heavy and substantial construction, and is designed to eliminate all cramping tendencies of the moving parts. It is supported on the bed, though the entire attachment is bolted to and travels with the carriage. It may be quickly engaged or disengaged without disturbing the taper setting. For setting the taper, a vernier arrangement is provided, with a very fine adjustment.

The general features of the lathe are well known. The head-stock is triple back-geared, the regular back-gearing being automatically disengaged when slipping the pinion into mesh with the face-plate gear, and *vice versa*. Three changes of feed or lead are provided for turning and threading, with

each setting of gears. The compound rest is provided with a tool-holder of the four stud type; a serrated base is provided for the tool. The apron is tongued and gibbed firmly to the carriage, extending its entire length. It is double, giving all the shafts a double bearing. Both the longitudinal and cross feeds are reversed from the front of the apron. All the gears and pinions are of steel of wide face and coarse pitch, cut from the solid with special cutters; they are bronze bushed where they run loose. The studs are of crucible steel, hardened and ground, and provided with convenient means for lubrication from the front. The tail-stock is strongly proportioned, with large continuous bearings on the ways; and it can be adjusted rapidly by crank and gear. It is secured against movement by a pawl engaging a rack cast in the center of the bed. The regular equipment of this lathe consists of steady, follow and full-swing rests, counter-shaft and wrenches.

MOTOR-DRIVEN PIPE AND TUBE CUTTER.

In the accompanying illustration is shown a No. 6 Fox pipe or tube cutter equipped with a No. 3 Westinghouse motor, the machine being manufactured by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich. The motor is applied to the machine in a manner permitting of a very compact arrangement, and is mounted on the machine in such a way that practically no change from the standard design is required, except that the bed is provided with two pads onto which the motor is bolted. Instead of the regular tight and loose pulley, a large sprocket is placed on the driving shaft, power being transmitted from the motor to this shaft by a Morse silent chain. From the driving shaft power is transmitted to the cutter shaft by a train of gears. The action of the machine itself is simple. The flue to be cut off rests on two rollers shown in the foreground of the engraving, directly under the cutting disk. The position of the rollers is adjustable for different sizes of pipe, the adjustment being obtained by the hand-wheel shown. The cutting-off operation is accomplished by pressing down on the lever at the left which raises the rollers and brings the flue against the cutting disk. As an example of the capacity of the machine, it may be mentioned that a $1\frac{1}{2}$-inch standard wrought iron pipe can be cut off in about three seconds, and a 4-inch boiler flue in about eight seconds. The machine is regularly equipped with an oil pump and tank for supplying lubricant to the cutting disk.



Fox No. 6 Motor-driven Pipe and Tube Cutter.

As it is often required to place machines for cutting off pipe or boiler flues in places where a line shaft is not available, a motor driven flue cutter should be of especial advantage, and will undoubtedly prove of interest to those requiring machines of this character.

NICHOLSON INSERTED BLADE PIPE TAP.

In Fig. 1 is shown an inserted blade gas pipe tap made by W. H. Nicholson & Co., Wilkes-Barre, Pa. These taps are made regularly in sizes from 1 inch to 12 inches in diameter—an example of the latter size being the one shown. The blades are made of a special grade of tool steel, which is machined with a gib on the lower edge, fitting into a corresponding groove in the body of the tap. The tap body and shank is made of steel accurately finished. After the blades have become worn, the tap can be returned to the makers, who will fit it with new blades at a small cost, making practically a new tool.

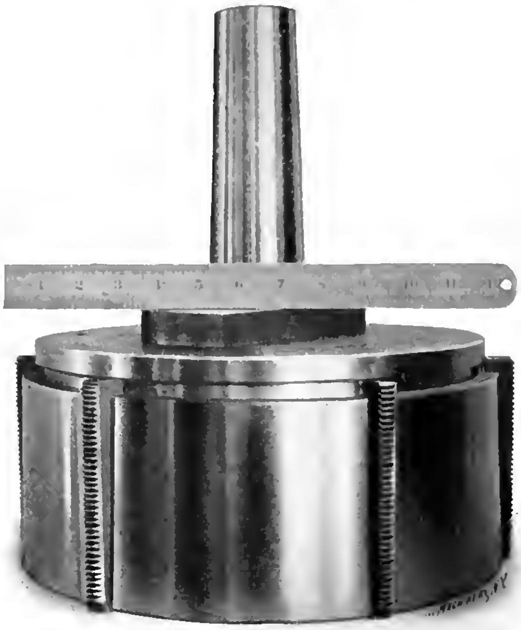


Fig. 1. A 12-Inch Nicholson Inserted Blade Pipe Tap.

This tap is made with shanks of different forms for use in different machines. The example shown in Fig. 1 is intended to be used in a tapping machine, being provided with a taper shank and a driving tongue or tenon, to fit a corresponding slot milled in the face of the machine spindle. These tools may also be conveniently used in the lathe or turret machine. For use in the lathe, the end of the holder is enlarged and bored out to fit the outer end of the tail-stock spindle, thus giving much greater holding power than is ordinarily obtained

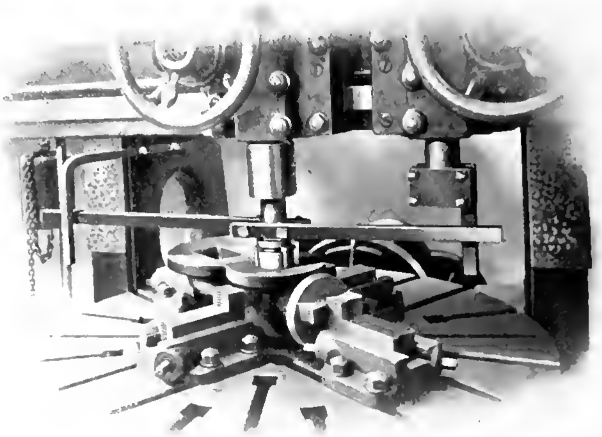


Fig. 2. Using the Tap in a Boring Mill.

for tapping in the lathe. When used in the boring machine or in turret machines, the tap is provided with a cylindrical shank, as usual.

Fig. 2 shows the tap in use on the boring machine. For this work and for the lathe, a squared section is provided on the shank, to which a holding clamp or wrench is attached to prevent it from turning.

HART'S "BUCKEYE" DIE-STOCK OF LARGE DIMENSIONS.

In the April 1908, issue of MACHINERY, an extended description of the design and operation of the Buckeye die-stock manufactured by the Hart Mfg. Co., 10 Wood St., Cleveland, Ohio, was given. The principal feature of this construction of die-stock is that the chasers which cut the tapered thread on the pipe, and which are inserted into the die body, are not as wide as the length of the thread; but by a mechanism which permits the chasers to recede from the work as they progress along the pipe, a full length thread of correct taper is cut. Another of the features of the die is that the chasers release automatically when the full length of tapered thread has been cut. A third feature, wherein this die differs from the ordinary die-stocks for pipe threading is in the adjustment of the dies. A wide range of sizes may be cut with the same chasers by simply loosening a screw and setting a stop to the required graduations. For a more extended description of how these features are accomplished mechanically, the description in the April, 1908, issue of MACHINERY, mentioned above, may be referred to. In adapting the Buckeye die-stock to the threading of pipe as large as 4 inches in diameter, it was found advantageous to provide the outside of the body with a large spur gear which meshes with a small pinion placed on the shaft squared on one end and which can be easily turned by a ratchet wrench of special design which is also supplied with the die-stock. The die-stock can also be operated by the ordinary die-stock handles as shown in Fig. 2. When the gear drive is used, the pinion has a planetary movement about the large gear, and its teeth are held in mesh with the gear when the body slides in and out of the frame by a member fastened to the pinion and engaging in the groove at the inside edge of the gear, this member at the same time acting as a guard for the pinion.

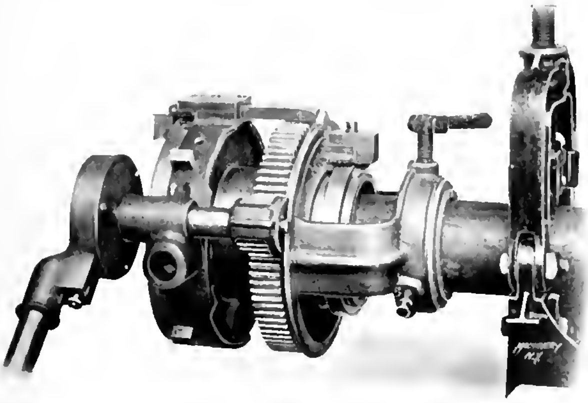


Fig. 1. Buckeye Die-stock for Cutting Taper Pipe Threads up to 4 Inches in Diameter.

The ratchet wrench furnished with the die-stock can be adapted to both right-hand and left-hand threading, by removing the latch pin shown in the engraving Fig. 1 and turning it. In Fig. 2 the cutting-off attachment provided with these die-stocks is shown in operation. The cutting-off tool is fed inward by the knob on the feed screw at the outside end, while the die-stock is turned around in the same way as when cutting threads. Back rests are provided, shaped in the same way as the chasers, but having blank end surfaces. These rests support the die on the pipe during the cutting-off operation.

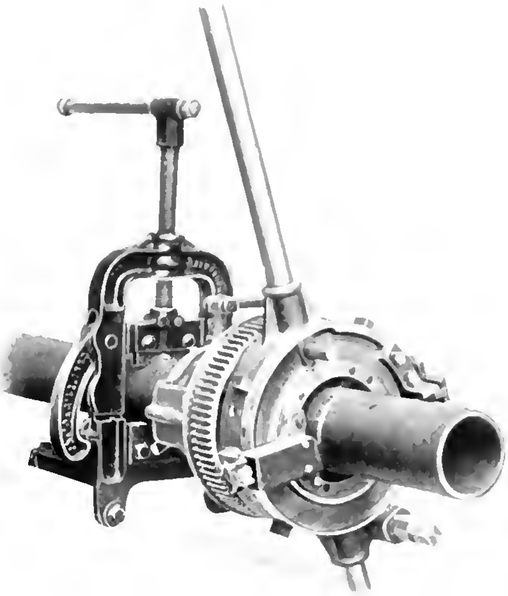
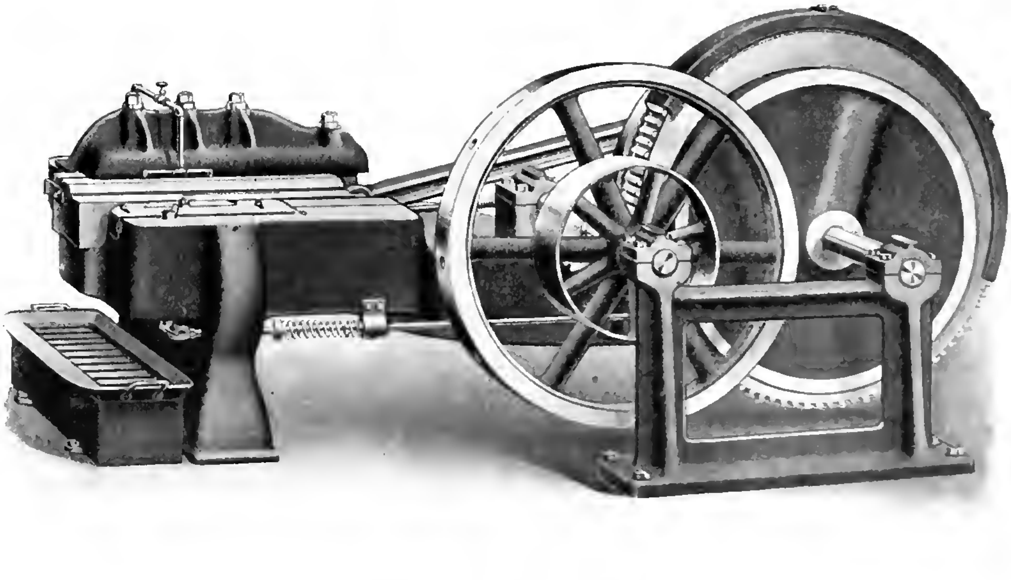


Fig. 2. Cutting-off Attachment mounted on Large Size Buckeye Die-stock.

NATIONAL MACHINERY CO.'S THREAD ROLLING MACHINE.

The National Machinery Co., Tiffin, Ohio, has recently placed on the market an improved thread rolling machine, of which we show an illustration herewith. The machine is of the reciprocating type, in which the blank is started at the commencement of the stroke between flat reciprocating dies, grooved to agree with the thread it is desired to form on the bolt or screw. The movement of the die, on the forward stroke, rolls the blank through it between the grooved plates, forming the desired thread. Aside from having been redesigned throughout from the standpoints of greater power and durability, this machine has incorporated in it specific improvements in construction. One of these relates to making the slide which carries the reciprocating die, of unusual length, and backing it by a bank of hardened steel rollers, which greatly



Improved Thread Rolling Machine.

reduce the wear and the power required to operate the machine. This slide is operated by a crank having a quick return movement, so that the machine can be operated at a high rate of speed, and still allow the operator the maximum time for feeding.

The machine has a capacity for bolt and screw threads of all sizes up to 1 inch in diameter. It operates at a speed of 35 strokes per minute, and its net weight is 18,000 pounds.

IMPROVED ADJUSTABLE REAMER.

An improved reamer with inserted adjustable blades has been brought out by R. M. Clough, Tolland, Conn., this reamer being known as the Style B adjustable reamer. The improvement over previous designs consists in the shortening of the reamer as compared with adjustable reamers as commonly made. On sizes over 2 inches diameter the bodies of the reamers have been made one-half, and on sizes under 2 inches, one-third the total length. The advantages gained by doing this, outside of the decreased cost, are, in the first place, that on large reamers the shortening of the body decreases the weight so that when they are used in a horizontal position the weight does not cause the reamer to run out of true; in the second place, the shorter bodies permit the bottom of the slots for the blades to be given a greater amount of taper so that practically double the amount of adjustment as compared with ordinary inserted blade reamers can be obtained. The blades are fitted in dove-tail shaped slots and adjustment for wear can be made without regrinding the blades, which is necessary when the blades are clamped by screws or nuts. These reamers are regularly made in sizes from 3/4 inch to 6 inches diameter, and provided either with a straight or taper hole for a shell reamer arbor, or with a solid, straight or tapered shank.

COATES POWER ERASER, DRAWING CLEANER AND PENCIL SHARPENER.

The Coates Clipper Mfg. Co., Worcester, Mass., has brought out an electrically-driven flexible shaft device for drawing-room use which can be applied for many different classes of work. As shown in the accompanying illustrations, Figs. 1 to 4, a small motor, which receives its power directly from a lamp socket, is fitted on a pedestal with an independent switch. The motor is provided with a 3-foot long No. 11 Coates flexible shaft and is provided at the end with a clamp for holding circular erasers. It is a very handy instrument to use for extensive erasing on drawings or tracings, and there is less liability of injuring the surface of the paper or cloth than is the case when erasing by hand.

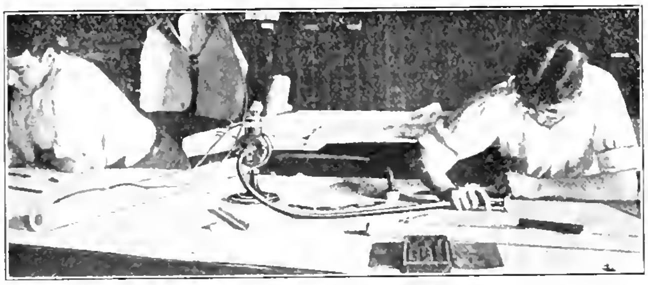


Fig. 1. Coates Electrically-driven Flexible Shaft Device for Drafting-room use, fitted with Ink or Pencil Eraser.

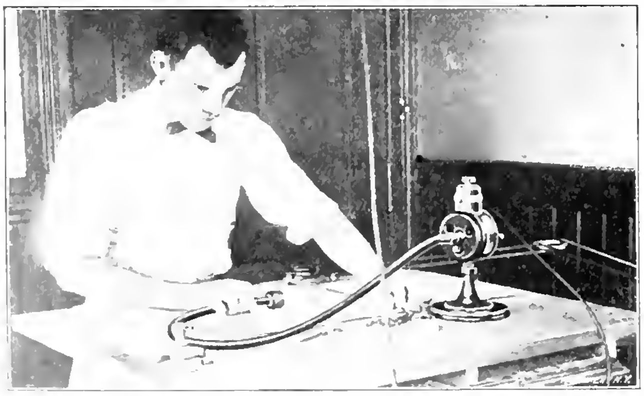


Fig. 2. Soft Rubber Roll fitted to End of Flexible Shaft for Cleaning Tracings.

The end of the flexible shaft can also be fitted with a small soft rubber roll for cleaning drawings when completed. In this way the right pressure can easily be applied to the soft rubber and the drawing is quickly cleaned without affecting the ink lines. A sandpaper disk for sharpening pencils can also be mounted on the end of the flexible shaft. This attachment is very satisfactory for the sharpening of pencils, because as soon as the sandpaper is worn out it can easily be replaced and the pencil sharpener thus always kept in first-class condition.

Fig. 3. Sharpening Lead Pencils on Sand Paper Disk mounted on End of Flexible Shaft.

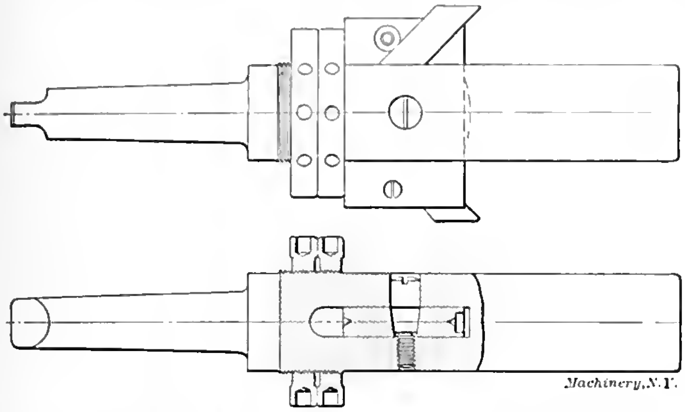

Fig. 4. Polishing Drawing Instruments on the Coates Flexible Shaft Device.

If it is required to polish or burnish drawing instruments, a small crocus cloth wheel can be mounted on the end of the flexible shaft. When ink spots have been left on drawing instruments and allowed to harden, or when rust spots have commenced to form, they can be easily and quickly removed by polishing with such a wheel. The needle points can be sharpened and the tools, in general, kept in good condition. These various erasers, sandpaper disks, crocus wheels, etc., are furnished with the device.

KELLY CYLINDER REAMER.

In the July, 1908, issue of MACHINERY three applications of the Kelly adjustable reamer were illustrated and described. The accompanying illustration shows a new cylinder reamer brought out by the Kelly Tool Co., of Cleveland, Ohio, known as the type C reamer. Referring to the engraving, it will be seen that the reamer is mounted in a heavy boring bar, a slot being milled through this bar into which the reamer is inserted; it is held in place by a screw passing through the bar and the reamer body, the hole in the latter being tapered in order to get a proper clamping action. By tightening the screw, a solid boring tool is obtained. In finishing reamers the screw is slightly loosened, thereby allowing the reamer body to "float" sidewise in the slot provided in the boring bar, so as to compensate for any discrepancy in the alignment of the machine. A few thousandths inch, or in extreme cases 1/64 inch, is sufficient "float" to enable both blades of the reamer to locate themselves centrally with the bore, and each blade will have an equal amount of work to do, a uni-

form diameter of the hole throughout being ensured. It will be noted that the cutter or reamer body itself is made of one sold flat piece of steel and is hardened, and into this the cutters are tightly fitted, being ground to fit 10 degree dove-tailed slots in the body. Hardened gib-bushings with a 10 degree taper, supply pressure on the outer side of the blade and force it against the inner wall of the dove-tailed slot. At the back of the tool is placed a hardened adjusting screw of fine pitch, which insures that the reamer will cut its exact calipered size.



Kelly Adjustable Reamer mounted in Boring-bar for Cylinder Boring.

For more detailed description of the reamer itself we refer to the article published in the July, 1908, issue of MACHINERY, mentioned above, the present illustration showing merely an interesting arrangement of the tool for boring cylinders and similar heavy work.

ALFRED BOX & CO.'S MULTIPLE DIE, BOLT AND PIPE THREADING MACHINE.

Alfred Box & Co., Philadelphia, Pa., have recently devised a bolt cutter of unusually convenient construction, being so arranged that it carries a number of dies ready in place to be used. The machine shown provides for eighteen of such dies, which may be for pipe threads, United States standard threads, or special straight or taper threads. The machine may thus be equipped for all of the regular run of work in a shop, making it possible to do odd jobs or manufacturing operations with equal facility.

The separate dies are mounted at the front ends of short quills, carried in bearings in the large face turret. This face turret is locked by a projection on a steel spring handle, shown at the left of Fig. 1, which engages notches in its periphery. The quills are driven by clutch members at the inner end, which are given the form of gears, as is shown in Fig. 2. The gears form clutch teeth, which engage with similar internal projections at the front end of the hollow spindle of the machine. This spindle is driven by a large gear, meshing with a pinion on the cone pulley shaft, as shown.

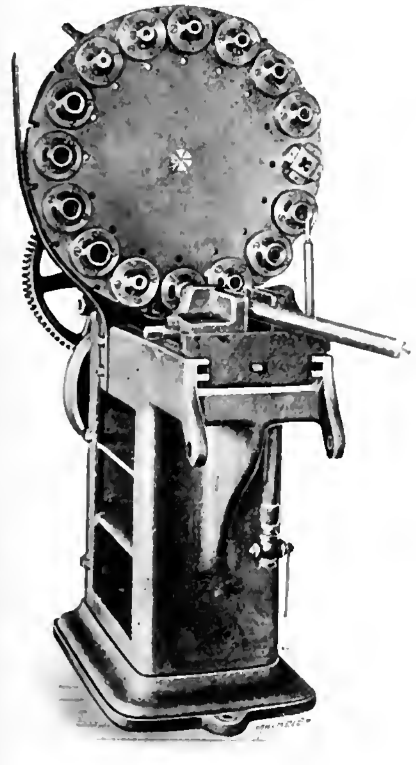


Fig. 1. A Bolt or Pipe Threader, with a Variety of Dies ready for Use.

In indexing to change from one die to another, the lever in back of the turret head in Fig. 2 is raised, bringing the turret forward until the clutch driving the die is disengaged The turret may then be rotated until the locking handle drops in the proper notch to agree with the die it is desired to use. The lowering again of the handle at the back of the turret connects that die with the driving spindle.

Provision is made for using dies of various forms. In the engravings, these dies are shown provided with guiding collars, for leading the work into the cutting edges, exactly central with the threads, thus insuring accurate results. The fact that the die quills and the driving spindle are hollow, makes it possible to work on bars of any length. The work is held from revolving by a vise, as shown.

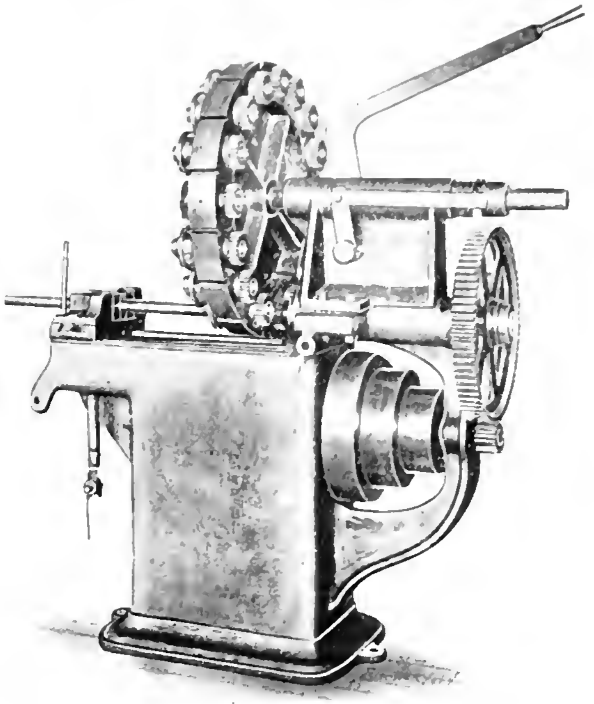


Fig. 2. Rear View of the Multiple Die, Threading Machine.

This machine should save much time in threading bars, pipes, rods, etc., especially in shops where there is much of this work to do in small lots of varying sizes.

HIGH-SPEED UNIVERSAL ATTACHMENT FOR WHITNEY MILLING MACHINE.

Figs. 1 and 2 show a high-speed universal milling attachment designed for use with the well-known milling machine made by the Whitney Mfg. Co., Hartford, Conn. The purpose of this attachment is to provide for the presenting of cutters to the work at any required angle in two planes; and to drive the cutter at a high speed for use with comparatively small cutters and end mills. This high-speed drive, however, is stiffly driven, and will bring out the full capacity of any tool likely to be used with it.

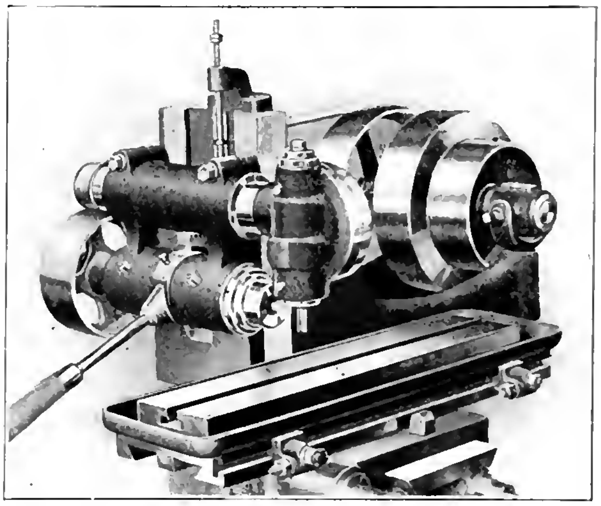


Fig. 1. Vertical Attachment for Whitney Hand Milling Machine.

The attachment, it will be seen, is mounted in the seat provided for the overhanging arm in the cutter slide. It may be revolved in this seat for swiveling the cutter about a horizontal axis. It carries on its outer end a cutter spindle, mounted in a head, which is itself adjustable about a bearing on the arm, on an axis at right angles to that of the latter. This gives the universal adjustment mentioned. The drive is by belt, from the regular driving pulley, over a small pulley at the end of the shaft passing through the center of the arm. At the spindle head, the motion is transmitted from this shaft to the spindle through a train of bevel gears, which permits the universal adjustment. Fig. 1 shows the cutter spindle vertical, while Fig. 2 shows it set at an angle with the horizontal.

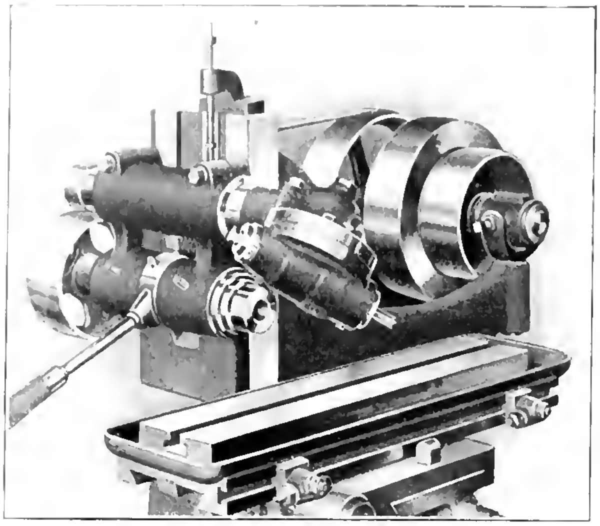
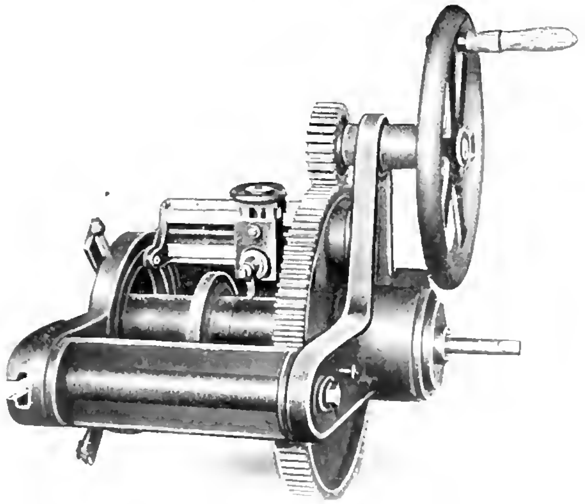


Fig. 2. Spindle of Attachment set for Angular Milling.

This tool was originally designed by a customer of the builders of this machine, the Porter-Cable Machine Co., of Syracuse, N. Y. The Whitney Mfg. Co. was so pleased with its usefulness in adding to the wide range of work to which the machine is adapted, that they have made arrangements to place it on the market.

STOW CRANK-PIN TURNING TOOL.

We show herewith an improved design of the crank-pin turner made by the Stow Flexible Shaft Co., Philadelphia, Pa. This device is of the type which permits the re-turning of a crank-pin while it is in place on the engine. It is supported at the back end by four jaws which center the tool against the flange of the pin. At the front end, a center is provided, which is screwed into the center hole of the crank pin, thus locating the device by the axis of the pin. When located in this way it is held firmly in place by any suitable clamping device.

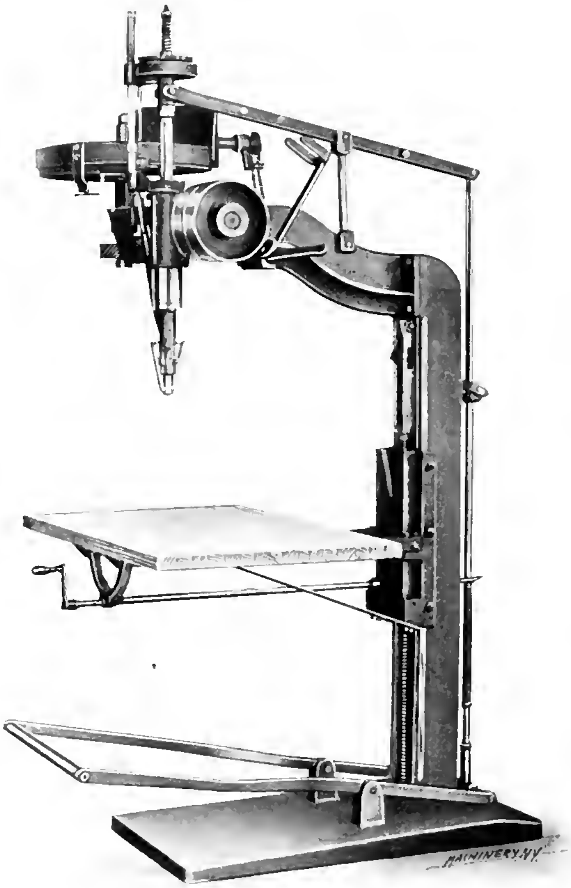


Portable Crank-pin Turning Machine, with rigidly supported Tool Slide.

A particular feature of this tool consists in an improved method of supporting the outer, or free end of the tool slide. This tool slide, it will be seen, is carried by a large gear, driven by the small pinion and hand-wheel shown. The free end of this slide is clamped to a ring, which is a running fit in a seat at the inner end of the frame. The tool slide bracket is thus supported at both ends, and is capable of doing much more rapid work than is possible with the usual unsupported construction. The various adjustments and movements of the tool can be readily understood from the engraving.

REYNOLDS AUTOMATIC SCREW DRIVING MACHINE.

A new design of power driven automatic screw driver has been added to the line built by the Reynolds Machine Co., Rock Island, Ill. In this line of machines the screws to be driven are dumped into a hopper or magazine, from which they are taken by a feeding mechanism which brings them into position for driving, at the end of the vertical spindle. There they are held by a pair of jaws, until the driver descends and engages the slot in the head of the screw, and forces it down into the work. The spindle, which is friction driven, runs as high as 1,000 or 1,500 revolutions per minute on the smallest sizes, so that the screws are driven in a fraction of a second. The capacity of these machines is limited only by the ability of the operator to get the work under the spindle, and he has both hands free to do this. Owing to the fact that the spindle is friction driven, the tightness of the drive may be limited to any desired amount.



An Automatic Screw Driving Machine for Large Work.

The particular form of the machine here shown is of larger capacity than anything previously made by the builders. It will set screws to the center of a 48-inch circle, and the table has sufficient vertical adjustment to take in work 30 inches high. The table is automatically raised, just as the screw is started, by means of a cam connection with the foot treadle and spindle operating lever at the top of the machine. The treadle is so arranged that the operator can reach it from any position about the table.

In addition to the usual features of magazine feed, adjustable friction drive for the spindle, etc., the machine has a positive stop which allows screws to be merely started, or set so that the head projects any uniform height desired.

This is effected by providing a braking device for the spindle and a release for the friction drive, which become operative at any desired point in the travel. The first machine of this type was built for the U. S. Arsenal at Rock Island.

NEWTON HEAVY FOUR-SPINDLE MILLING MACHINE.

A four-spindle milling machine of unusally massive construction is shown in the accompanying engravings. It was built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., for the Altoona Shops of the Pennsylvania R. R. The machine is of the planer type, with two side horizontal spindle heads on the face of the housings, and two vertical spindles on the cross-rail.

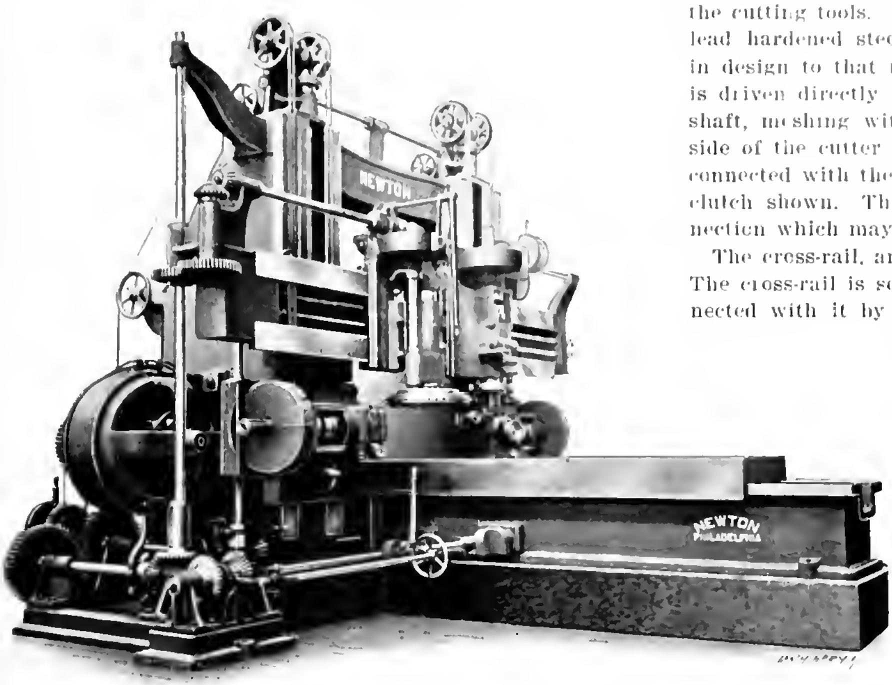


Fig. 1. Heavy Four-spindle Milling Machine, built for the Altoona Shops of the Pensylvania Railroad.

The machine is driven by a 50-horse-power General Electric motor, having a variable speed range from 560 to 1,120 revolutions per minute. As may be seen best in Fig. 2, this is connected through a rawhide idler pinion and idler gear to a cross shaft, from which is taken the motion for the feed and fast traverse of the two vertical heads. As is better seen in Fig. 1, from a smaller pinion on the hub of the second idler, motion is taken through a back gear drive for the vertical shafts driving the two side heads. Motion for the fast traverse and feeds is transmitted through to the working side of the machine, where it is connected with a feed box of the builders' standard design, giving nine changes. The arrangement of feeds and speeds provided makes available individual drive or simultaneous drive for the heads and feed; and fast traverse for the table, for raising and lowering of the cross rail, and for the cross adjustment of the heads on the rail.

The construction of the two side heads and of the right-hand cross rail head is similar. The spindles are 5⅜ inches in diameter and have a bronze bushed bearing 17 inches in length, with a double taper bearing 8¾ inches long at the end of the adjusting sleeve. The ends of the spindle have an external thread, on which face cutters can be fitted; they are provided, as well, with a No. 5 taper for holding end mills. The spindles are provided with through holes for retaining bolts. In addition there is a broad slot milled across the end of the spindle to fit the tenoned drive of large mills and arbors. All the spindle wormwheels are approximately 26½ inches in diameter, and are provided with hardened steel worms having roller thrust bearings. These parts are all encased and run continuously in oil. The rack sleeves in which the spindles are mounted have sufficient length to permit an independent adjustment of 12 inches for the spindle on the saddle by means of the rack and pinion and worm gear mechanism shown.

The left-hand cross-rail head is of somewhat different construction. The spindle is mounted in a slide which has an independent vertical adjustment The spindle carries a solid cast steel rotary planing head 26 inches in diameter over the cutting tools. This cutter head is driven through a steep lead hardened steel worm and a bronze worm-wheel similar in design to that used on the other heads. The cutter head is driven directly by a pinion on the end of the worm-wheel shaft, meshing with an internal gear fastened to the upper side of the cutter disk. This head may be connected or disconnected with the driving mechanism by the hand lever and clutch shown. The right-hand head has a back geared connection which may be thrown in or out, as required.

The cross-rail, and side heads as well, are counterweighted The cross-rail is so arranged that the side heads may be connected with it by swing bolts, and thus elevated or lowered by power when so attached. The elevating screws have roller thrust bearings both at top and bottom, to permit pulling the cutters into the work when sinking in to depth, without putting the screws in compression. The table feed is by a spiral gear and rack, similar in design to the well-known Sellers drive for planers.

The table of this machine is 42 inches wide and 18 feet long, and the feed movement permits the taking of cuts 16 feet in length. The maximum distance between the ends of the horizontal spindles is 60 inches and the minimum distance is 36 inches. The maximum distance between the end of the horizontal spindle and the top of the work table is 66 inches. The minimum distance between the centers of the vertical spindles is 32 inches. The table feeds available at the high speed of the motor range from 0.789 to 8.150 inches per minute. At the slow speed of the motor, these feeds are cut in half. A quick return of about 22 feet per minute is available

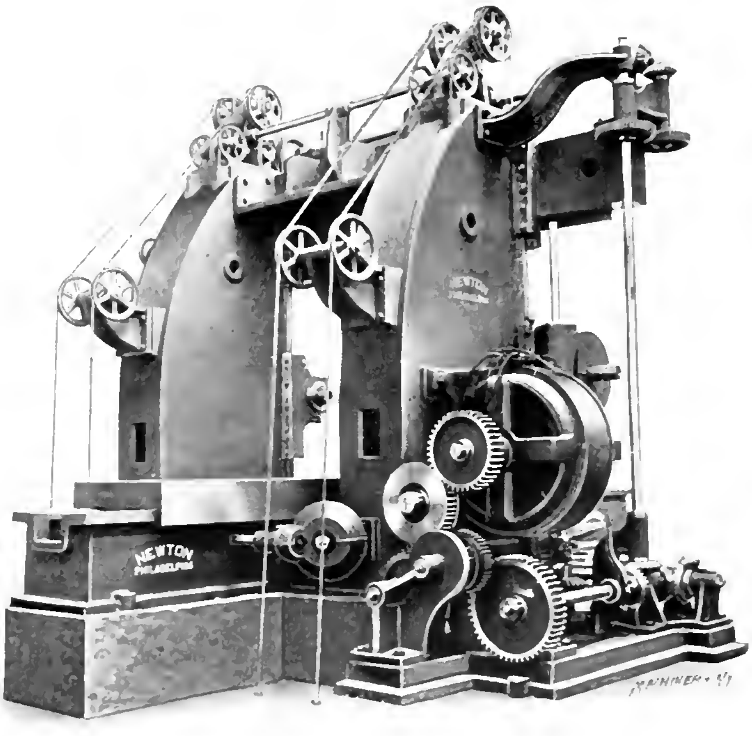


Fig. 2. Rear View of Four-spindle Milling Machine, showing Driving Gearing.

in both directions. The maximum feed of the rail vertically and the saddles on the rail is 1½ inches per minute, with the motor on the high speed.

"STAYIN" POSITIVE DRILL SOCKET.

The G. R. Lang Co., of Meadville, Pa., is placing on the market a drill socket which is intended to obviate the difficulties arising in high-speed drilling from the insufficient driving power of the ordinary taper shank drill with a tang. Under modern conditions this tang is much given to twisting off, rendering an otherwise good drill practically useless. Various appliances have been devised for using such broken drills effectively. The device here shown is intended not only for using such broken drills, but for preventing them from breaking in the first place.

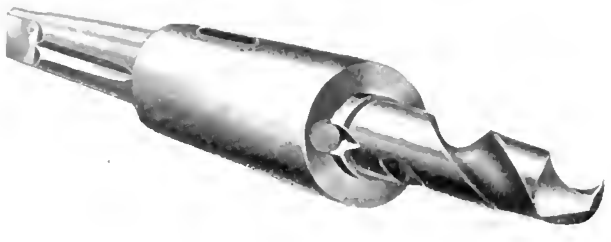


Fig. 1. A Drill Socket which relieves the Tang of all Stress

Fig. 2. An Old Drill Ground for use in the "Stayin" Socket.

Fig. 1 shows a socket of this design which has, as may be seen, a round driving key set in the taper hole. This driving key engages a V-groove milled in the taper shank of the drill. The driving is done by the frictional contact of the taper surfaces, and by the positive action of the round key mentioned. The tang is thus relieved of all strain, and is of use only in driving the drill from the socket. To provide, however, for drills that have had their tangs twisted off, the key slot is made unusually deep. In fixing up old drills to be used in this socket, the shank is ground flat, as is shown in Fig. 2, to give a driving surface for the key. A new and an old drill are shown separately in Fig. 3.

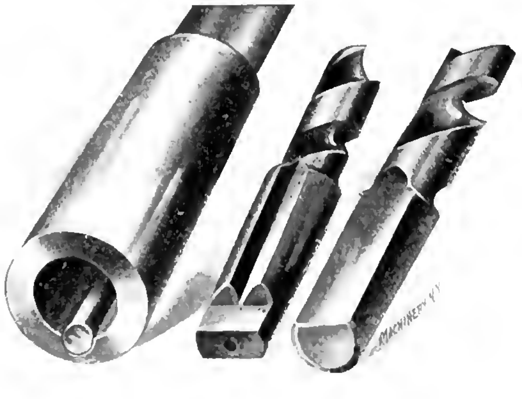
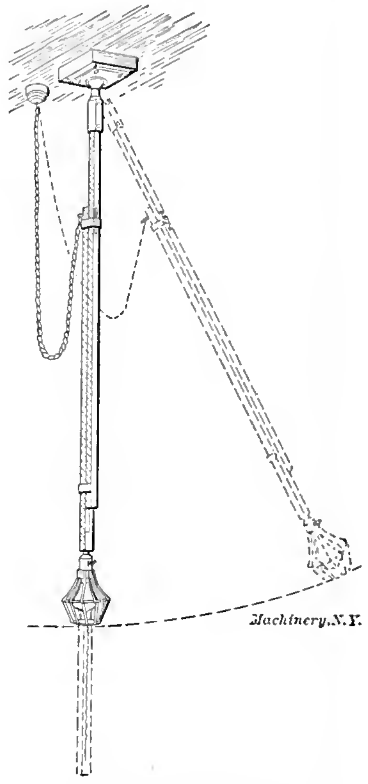


Fig. 3. The Socket and the Drills.

An advantage of this socket as compared with others for the same purpose lies in the fact that it not only holds the drill in the socket but holds the socket in the drill press, as well. The makers will furnish the jig for drilling a keyway in the drill press spindle for inserting the hardened steel rods which are furnished for the purpose. The sockets are made slightly heavier than the standard type, and the key is pressed in. They are all drilled by special jigs, which bring the keys parallel with the axis and central with the drift pin hole. Being accurately finished in the lathe, the taper fit is of the highest order. The makers keep all sizes in stock at practically the same price as the old style sockets.

ADJUSTABLE ELECTRIC LIGHT HOLDER

The Harley Machine Co., 92 Hayden Ave., Springfield, Mass., has brought out an adjustable electric light holder suspended from the ceiling and intended particularly for shop use. As shown in the accompanying line engraving, the holder consists of a ball and socket joint, the socket being fastened in the ceiling, and two wooden bars having a sliding adjustment. The lamp is fixed to the lower end of one of the bars. The socket consists of a steel plate pressed out in the center to fit the ball and fastened at the extreme corners so as to obtain a spring action. The upper end of the ball works in a wooden block fastened to the ceiling, and ample friction is thus provided so that the holder with the light at the lower end will stay in any position radially in which it may be placed, even though there be considerable vibration. The two sliding rods, being made of wood, provide sufficient friction so that the light can be pushed up or pulled down and still remain stationary in any position desired longitudinally. It will be seen that by this combination of movements it is possible to bring the holder to any position in a large circle about its socket and also to raise or lower the light according to the requirements. The difficulties of obtaining light in various positions, as required in machine work, recommend the use of an adjustable holder for the light, and any device providing adjustment will undoubtedly be of interest to mechanics in general.



Adjustable Electric Light Holder made by the Harley Machine Co.

TWO WILLEY ELECTRICALLY-DRIVEN GRINDERS.

Figs. 1 and 2 show two new designs of the Willey grinder as made by James Clark, Jr., & Co., Louisville, Ky. These machines are of the regular construction of this well-known line of tools, in having the motor built into the machine itself, making an unusually neat and satisfactory arrangement.

Fig. 1 is a floor grinder for general purpose work. The motor frame and pedestal are one casting, and the starter is contained in the frame, where it is out of the way and well protected. This starter is made for this particular machine, and is not a commercial product. The armature shaft, which is also the wheel spindle, is very stiff. The motor is especially designed for grinder service, being completely enclosed from emery dust. The tool rests are so supported that they can be adjusted to any desired position. The surface grinding attachment shown over the left-hand wheel is furnished when desired at extra cost.

The addition of a self-contained wet grinding attachment makes of the machine shown in Fig. 1, the combined wet and

dry grinder shown in Fig. 2. With this arrangement, the left-hand wheel is used for dry grinding, and the right-hand for either wet or dry. The attachment consists of a hood, splashing plate for the wheel, a water reservoir, and a settling chamber fitted with a centrifugal pump. The whole is bolted to the bottom of the pedestal, and is steadied at the top by a second bolted connection with the frame. The pump is so made that the bearings are above water, and it has no stuffing box. It is driven from a pulley on the end of the wheel spindle, as shown.

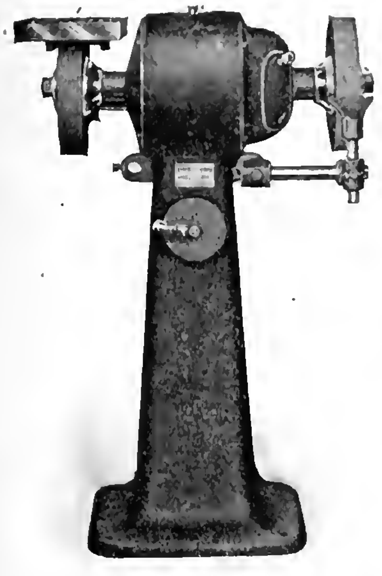


Fig. 1. Willey Electrically-driven Dry Grinder.

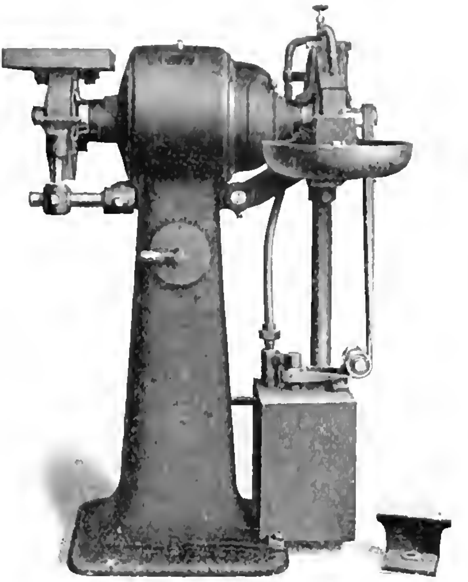
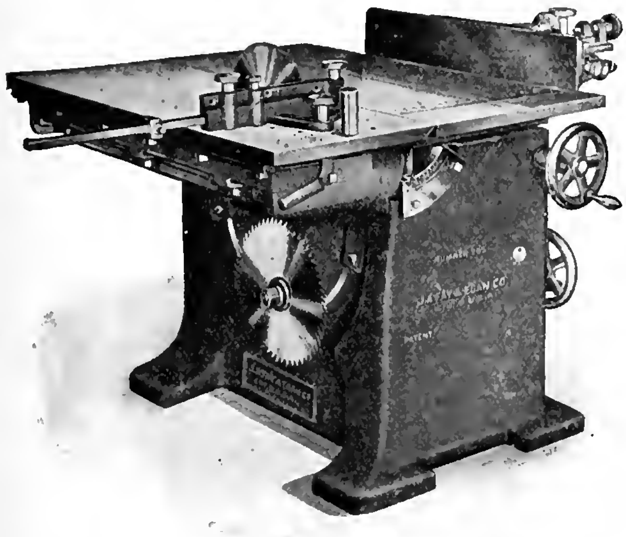


Fig. 2. The Grinder in Fig 1, with Pump and Reservoir Attachment.

The height of this machine over all is 48 inches. The wheels used are 12 inches in diameter by 2 inches face, and they usually run at about 1,600 revolutions per minute. The net weight of the machine in Fig. 1 is 475 pounds. With the water attachment, as in Fig. 2, it is 670 pounds.

FAY & EGAN DOUBLE CIRCULAR PATTERN-SHOP SAW.

The J. A. Fay & Egan Co., West Front St., Cincinnati, Ohio, is building the improved saw table shown herewith. It is of the type in which cross cut and rip saws are both permanently mounted in the machine, and either may be brought into use as required. In addition to this, the machine is provided with such a variety of adjustments, attachments, gages, etc., as to make it specially adapted to the work of the pattern-shop.



A Combination Cross-cut and Rip Sawing Machine, especially adapted to Pattern Work.

The mechanism for changing the saws and adjusting them for height is distinctly different from other machines of the kind. Both saw arbors are carried in a revolving frame. This overhangs at the front of the machine so that it is a simple matter to take off or put on the saw without disarranging the table. Two saws up to 16 inches in diameter can be used at the same time; if only one saw is used, it may be as large as 20 inches in diameter.

The table is made in two sections; a moving section 44 x 16 inches mounted on anti-friction rollers, and a stationary section 44 x 20½ inches, provided with an extension so that material up to 20 inches in width can be rip-sawed. The moving section of the table has sufficient travel to edge or cut off stock up to 35 inches in length, and it will open to permit the use of a 2-inch grooving head. The whole table can be tilted by a hand-wheel to an angle of 45 degrees with the saw face. This angle is indicated by graduations.

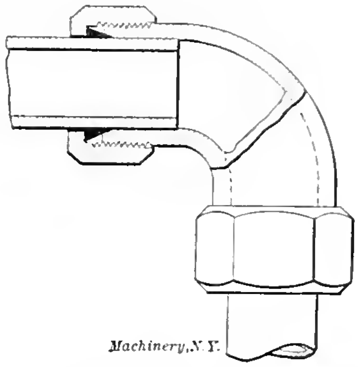
The ripping fence may be set to take stock up to 20 inches wide and be used on either the right or left section of the table. Micrometer adjustment is provided for setting it. The miter cutting-off fence is used on the sliding table, and covers a range from 45 degrees up to 60 degrees. On the front, as shown in the illustration, it is provided with a stop rod to be used for beveling stock to accurate lengths.

The builders will send full illustrations and descriptions of this machine and its mechanism on request.

UNION-CINCH PIPE FITTINGS.

The line engraving shown herewith illustrates the construction of a very ingenious line of fittings, made by the Sight Feed Oil Pump Co., Milwaukee, Wis. The particular feature of this line of fittings is the fact that by their use it is possible to do a complicated job of piping, with nothing more in the way of tools than a hack-saw, a file and a pair of monkey wrenches. The simplicity of this outfit is made possible by the fact that no threading has to be done, the joints being made tight against high pressure on the smooth ends of the pipes.

In the engraving it will be seen that first a gland nut is put on over the end of the pipe. This is followed by a tapered bushing of soft metal. The pipe is then inserted in the fitting, and the nut is screwed down tightly on it, thus compressing the bushing in the tapered space between the outside of the pipe and the flared opening of the fitting. This may be tightened down so firmly as to resist leakage of pressures up to 1,000 pounds per square inch.



An Example from the "Union Cinch" Line of Pipe Fittings, which require no Threading

The advantages of this method of piping are obvious. The connections are made without soldering, flaring, hacking, or using cement of any kind. The usual pipe vise and bench, with a full set of taps and dies and an assortment of pipe wrenches, is dispensed with. Every joint is a union, so that the pipe system may be taken apart at any point and reassembled. A neat looking job at a small expense may be made of steel or brass tubing conforming to the outside diameter of standard pipe sizes. This tubing, which will be furnished by the makers of the fittings, is inexpensive and is carefully annealed, so that it can be readily bent to any desired form.

Fittings are furnished for all required purposes. They are furnished in the form of L's, adaptors for changing from threaded to Union-Cinch pipe systems, T's, couplings, relief valves, etc. They are recommended by the makers for such work as piping up oil pumps, gravity oiling devices, gages,

and drop pipes especially on work of this character around ammonia handling machinery, where the steel tubing and steel fittings are well adapted to keeping the system perfectly free from leakage of the ammonia gas.

IMPROVED SPINDLE ADJUSTING DEVICE FOR MULTIPLE SPINDLE DRILLS.

The accompanying line engravings illustrate an improvement for the adjustment of the tools in metal working machines, recently patented by Mr. F. E. Bocorselski, superintendent of the Baush Machine Tool Co., Springfield, Mass. The illustrations show the device as specifically provided for a multiple spindle drill, and intended for rapid and independent adjustment of the various drill spindles both as regards their location relatively to one another in the horizontal plane as in the vertical direction.

In order to illustrate more plainly the application of the device, the head of a multiple spindle drill press is shown in Fig. 1 and the adjusting device itself is shown in detail in Fig. 2. In Figs. 1 and 2, *A* is the frame of the head of the drill press, *D* is a block attached to the frame by means of the projecting stud *B*, and *E* is a bracket containing a bushing *C* which guides the drill spindle. The object of the design is to provide a simple means by which the spindle guiding bracket *E* may be moved for considerable distance in relation to the head *A* without resorting to a slow screw adjustment. When the head has been placed approximately in the correct position, the minute adjustment may be accomplished by a screw engaging with a half-nut. The device also provides for independent adjustment of the various spindles in a vertical direction, so that any one of a number of drill spindles can be so adjusted that the working end of its drill will be in a horizontal plane with the working ends of the drills in the other spindles, irrespective of the length of the drills. The object desired is accomplished in the following manner.

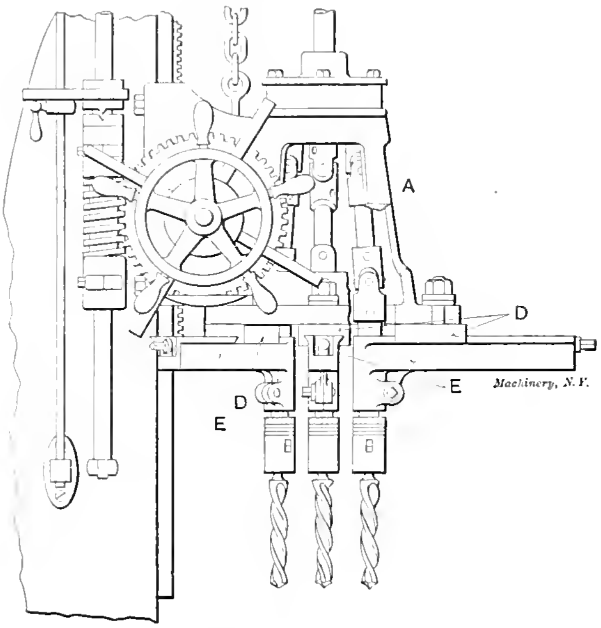


Fig. 1. Multiple-spindle Drill provided with Improved Facilities for Adjusting the Drill Spindles.

The block *D* having a swivel action in relation to the frame *A* permits the spindle *F* to be located in any position radially about the stud *B*. In the lower face of the block *D* a dove-tail slide is cut, into which a slide of the bracket *E* fits. The bracket is provided with a feed-screw *G* which is capable of a swiveling motion downward about the ball point at its further end, and which can by this means be thrown out of engagement with the half nut *H* attached to the block *D*. It is evident that when the feed-screw is out of engagement with the half-nut, bracket *E* can be pushed along by hand until the spindle *F* is approximately in the desired position. The feed screw is then again brought into engagement with the half-nut, and the final adjustment made by the screw. The arrangement of the screw and the half-nut is shown more clearly in the enlarged sectional view in Fig. 3. It will be seen here that the half-nut *H* is connected by studs to a block *K* which is cut out at its upper side to fit the outside of the screw, but which is not threaded. On the lower side of block *K*, the holes for the studs which connect the block with the half-nut are recessed, and springs interposed between the heads of the screws and the bottom of the recesses of the block. The springs keep the screw *G* ordinarily in engagement with the half-nut, but when pressure is applied downward on the end of the screw, the springs will permit it to be brought out of engagement with the nut.

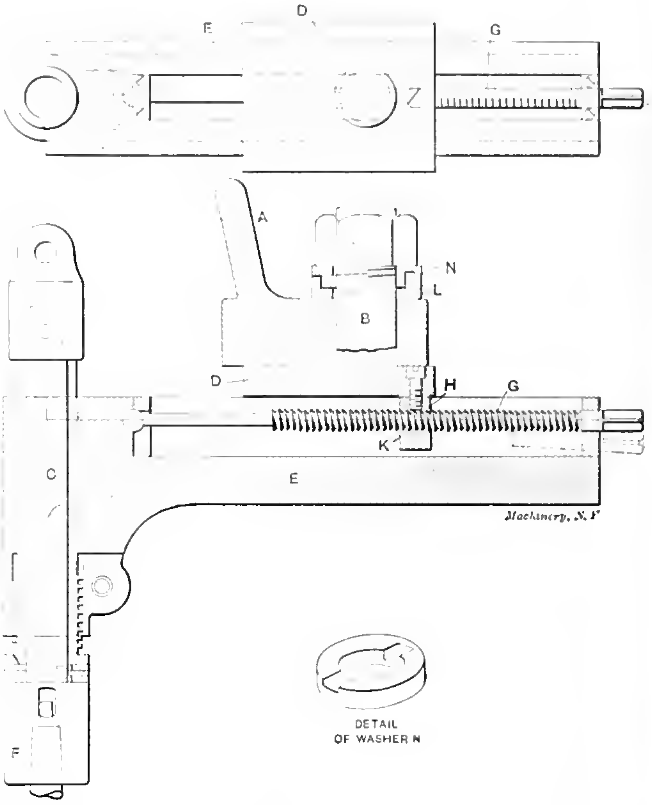


Fig. 2. Details of Bocorselski's Device for Rapid Adjustment of Multiple Drill Spindles.

Another interesting feature is introduced in the washer between the nut on stud *B* and the head *A*. In order to prevent the block *D* and bracket *E* from falling when the nut on the stud is unscrewed, a key is put through a slot in the stud; the ends of this key rest on the washer *L* as shown. On top of the key another washer, provided with a groove to accommodate the key, is placed. The key is tapered and at the large end the slot in the upper washer is not carried completely through, in order to prevent the key from slipping out of its seat accidentally.

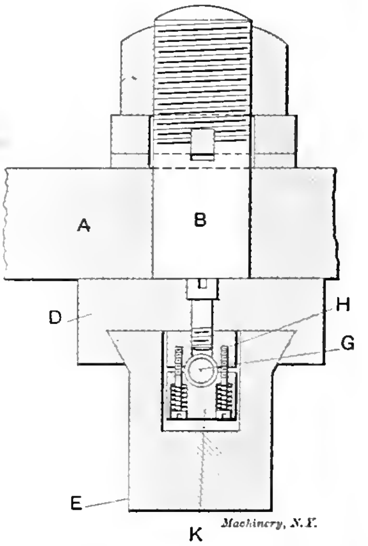


Fig. 3. Section through Half-nut, Screw and Spindle Guiding Bracket.

The vertical adjustment of the spindles is accomplished by means of threading the outside of the sleeve *C* and having it engage with a thread in the vertical hole for the bushing in block *E*. The drill spindle *F* is held firmly by shoulders to the bushing *C* in the longitudinal direction, but, of course, is free to rotate in the sleeve. When the sleeve is adjusted in the bracket, the spindle consequently follows, and thus an independent vertical adjustment is obtained.

While reference has been made especially to the application of this device to a multiple spindle drill press, it is evi-

dent that this is only one example of the utilization of the device, and that it is not limited to the type of machine here shown.

THE "RADICAL" ANGULAR DRILL.

The Radical Angular Drill Co. of 114-118 Liberty St., New York City, is introducing in America a tool for drilling square, triangular and other polygonal holes. It has been used for some time in Germany and other European countries. While this tool resembles all the others of its class, in its general construction, it has some special features which the inventor claims are original and have never before been employed. The most important of these features is the provision made for cutting holes with absolutely flat sides and sharp corners. The device is at least theoretically capable of doing this, and the only theoretical considerations in the way are the matter of accuracy of workmanship, and sharpness and correct form of cutting tools.

Fig. 1. A Device for Machining Square Holes, with Sharp or Round Corners.

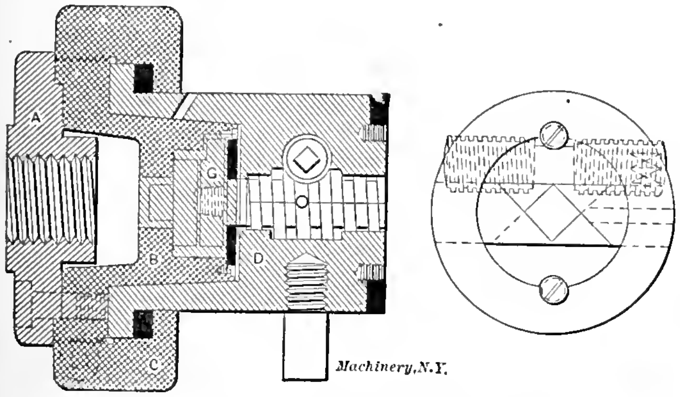
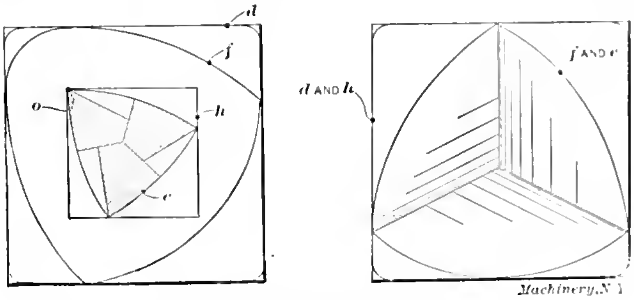


Fig. 2. Construction of the Angular Drilling Attachment.

Fig. 1 shows the device with one of the cutting tools in place, and others lying beside it. An axial section through the attachment is shown in Fig. 2. Flange or face plate *A* is screwed onto the nose of the machine in which the work is to be done. This may be either a lathe, drill press, milling machine (see Fig. 6) or any other tool having the necessary rotary spindle and means for holding the work. To flange *A* is screwed the driving member *B*. Over this is fitted the chuck *D* which is held in place on *B* by nut *C*. This chuck is similar to the common design used for drilling chucks, and is provided with jaws operated by right and left-hand screws which give a square opening, as shown in the end view. This member is stationary, being fastened in some way to keep it from revolving. The size of the square opening, in connection with the tool used, determines the size of the square hole to be drilled. If a triangular hole is to be drilled, special jaws which give a triangular opening are provided. The tool itself, seen better in Fig. 3, is composed of the three-lipped cutting blade and a holder. The latter is screwed into the dog *G* which is driven from *B* in such a way that the tool is positively rotated, but allowed to float as required by the peculiar contour of the holder, in connection with the square opening in the jaws of the chuck. These jaws are tightened down so as to just fit the holder or shank, and still allow it to rotate.

The action in cutting a square hole will be understood from Fig. 4. The line marked *d* represents the square opening in the chuck jaws. The line marked *f* is the outline of the shank of the cutting tool. The hole being cut is shown at *h*, and *c* is the cutting blade. It will be seen that the action of *f* in *d* is identical with that of a familiar form of cam sometimes called a "3-cornered box cam." The particular construction which makes it possible to cut geometrically square corners lies in placing the center of the rounded one of the three corners of *f*, at *o*, which is exactly in line with one of the cutting edges of the tool *c*. This means that this one of the three cutting edges of the tool finishes the periphery of the square hole. It is led in straight lines, parallel with the sides of *d*, and at each corner is pivoted about itself, leading out at right angles to its entering direction.

Fig. 3. The Cutting Tool and Shank used for Sharp Corners or Round Holes



Figs. 4 and 5. Sketches showing the Principles of Drilling Square Holes with Sharp and Round Corners.

A construction previously used for cutting a square hole (see Fig. 5) involves the use of a shank *f* working in opening *d*, and guiding a cutting tool of exactly the same size and outline as *f*. In this case, while the sides of the hole produced (which is the same as *d*) are thus straight, the cutting edge of the tool does not cut clear in to the sharp corner, and slight fillets are left as shown. When it is desired with this attachment to cut square holes with small fillets, the

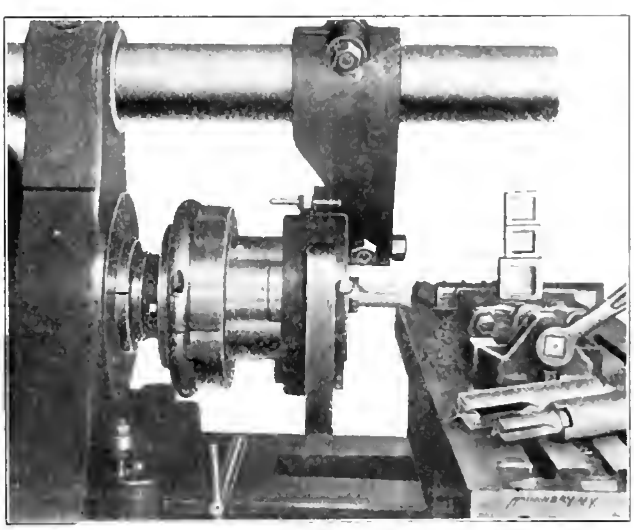


Fig. 6. The Attachment in use on the Milling Machine.

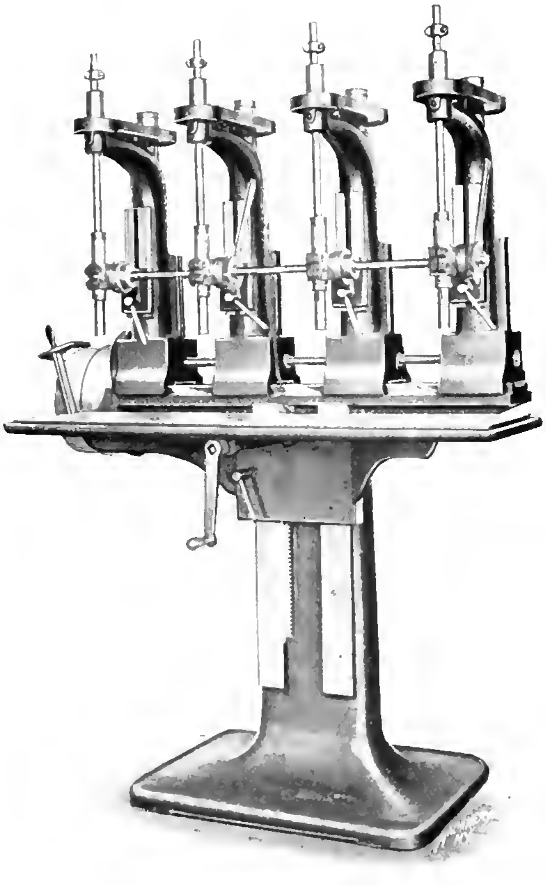
shank and tool are made of the same size and the shank is given the form shown at *f* in Fig. 5. The cutting of three-cornered and six-sided holes is effected by tool shanks and cutting tools of suitable outline working in special chucks. These have slight fillets, though it is almost impossible to discern them in the case of the hexagonal hole.

The grinding of the tools may be effectively done by means of a simple attachment provided by the makers. This attachment locates the tool by the corners of the shank in a V-block, which is set at such an angle as to present the cutting edge properly to the grinding wheel in a surface grinder, cutter and reamer grinder, or other similar machine.

In using this device in a machine spindle, a stop bar may be screwed into the chuck *D*, and rested against some stationary point, such as the frame of the machine. The angular position of the stop bar about the axis of rotation, of course, determines the angular location of the outline of the hole. Fig. 6 shows the tool in use in a milling machine. Here, the chuck is kept from revolving by a clamp ring which encircles it, and is attached to the overhanging arm. Samples of the work done by the tool, and samples of the tools themselves, both for sharp-cornered and round-cornered square holes, are shown on the machine table.

IMPROVEMENT IN SENSITIVE MULTIPLE SPINDLE DRILL PRESS.

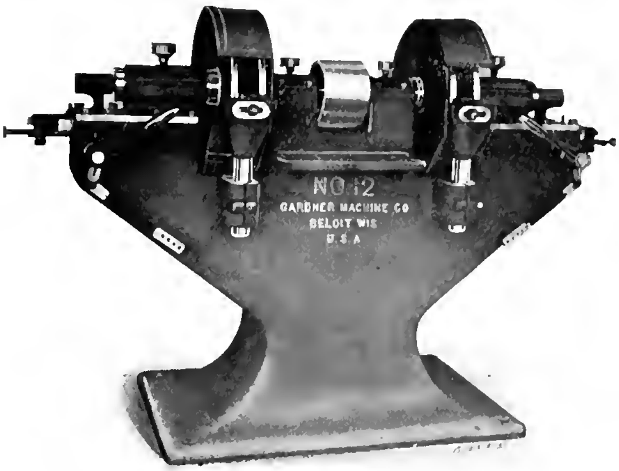
The accompanying half-tone illustrates an improvement added to the regular line of sensitive multiple spindle drill presses manufactured by the Taylor & Fenn Co., Hartford, Conn. The feature of the improvement is that all the spindles can be fed simultaneously to the work by operating a single handle, the feed pinions having been connected with one another by means of a splined shaft running through to all the spindles. Of course, a feed lever may be applied at every spindle, and any feed lever may be operated for feeding all the spindles towards the work. This arrangement does not interfere with the adjustable feature of the various spindles. By simply releasing the keys in the hubs of the feed pinions, the connecting shaft may be disconnected at any time so that the spindles may be used independently.


Taylor & Fenn Sensitive Drill Press arranged to Feed all the Spindles by Operating One Feed Handle.

This type of machine is built with any number of spindles up to six. As shown in the photograph the top columns are placed at equal distances apart, but they can be adjusted to any distance from one another, whether evenly or irregularly spaced. It is evident that for drilling a large number of duplicate parts, the arrangement permitting the feeding of all the spindles by one handle, is of great advantage, and that the rapidity with which the work can be performed is much greater than in the ordinary form of this machine, where each spindle must be fed to the work independently of the others. In all other respects, the machine is of the same design as those regularly manufactured by the Taylor & Fenn Co.

NO. 12 GARDNER IMPROVED DUPLEX DISK GRINDER.

In the July, 1908, issue of MACHINERY, a double disk grinder manufactured by the Gardner Machine Co., Beloit, Wis., was illustrated and described. The accompanying half-tone shows what is practically the same machine, but built in a double pattern, so that there are, in fact, two machines mounted on the same frame. It may either be used by two men simultaneously or by one operator rough grinding with the one pair of wheels and finishing with the other set. The same principle of driving by a single pulley as described in the July issue, is employed in the present machine. The outer disk wheels are mounted on hollow spindles supported on sliding heads; and driving shafts, coupled to the main spindle, drive the hollow spindles, the former being splined to engage with keys fastened in the latter. The lubricating arrangement is particularly well adapted to the purpose of the machine, and dust caps and other provisions for excluding dust from all wearing surfaces are provided. Disk wheels from 15 to 18 inches diameter may be used. The maximum distance between the wheels is 4½ inches, and the weight of the machine as illustrated is 1,900 pounds. With all accessories, including setting up press for the wheels, countershaft, splines, etc., and crated for domestic shipment the weight is 2,500 pounds.



No. 12 Gardner Improved Duplex Disk Grinder.

HOEFER CONE PULLEY POLISHING MACHINE.

The machine shown herewith is one of a number of special machines which were originally developed by the builders in the manufacture of drill presses and metal power saws. The particular purpose of this machine is the polishing of cone and driving pulleys. It is intended to take the place of the more tedious and costly hand methods of polishing these parts. As shown, the machine consists essentially of a power-driven head-stock and a tail-stock, mounted in a way somewhat resembling the speed lathe. At the back of the lathe is mounted a round horizontal bar on which loosely revolve two pulleys, the smaller of which is connected with the counter-shaft, while the larger one is belted to an emery wheel. This wheel is carried on a swinging arm, also pivoted about the rod at the back of the machine. The arm has a sliding

motion on the rod, which is controlled by the lever at the right. The emery wheel is beveled, and swivels about an axis at right angles to the sliding bar, so that it may be set to agree with any taper for the crowning of the pulley.

In order to dispense with the time lost in putting pulleys on an arbor, a very satisfactory substitute for this method of holding them was designed. A conical plug is used, supported in the end of the spindle, instead of the regular center. It is made of such size that it will take care of two or three different diameters of holes. This centers the pulley properly. To drive the pulley, a dog is placed on the face-plate, engaging one of the spokes in the work. In the tail-stock an auxiliary conical bushing, revolving on the regular center, gives proper bearing for the rear end of the hub. This tool has greatly reduced the time of polishing pulleys over the old methods, in the shops of the builders, the Hoefer Mfg. Co., Freeport, Ill.

A Machine for Finish Grinding Cone and other Pulleys.

FOOTE-BURT NO. 24 HIGH-DUTY DRILL.

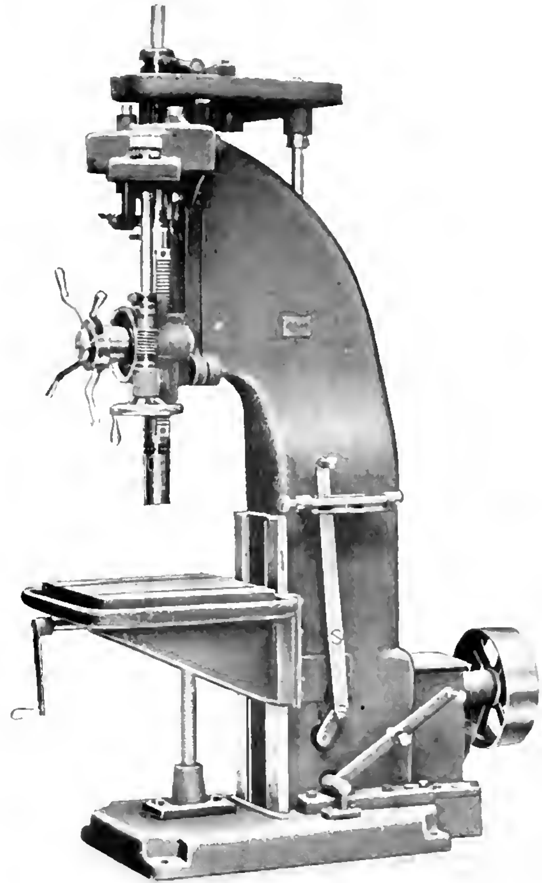
The accompanying illustration shows a drill of the heavy, box column, high-duty type, built by the Foote-Burt Co., St. Clair Ave. and 41st St., N. E., Cleveland, Ohio. This size of machine was designed to use a 1¾-inch high-speed drill to the full limit of its capacity in the hardest materials. An improvement over the usual construction of this type of machine relates to the provision of a single speed pulley drive, all the speed changes being obtained by the manipulation of the handles shown at the side of the column, which are within easy reach of the operator at all times. Spur gears are used throughout, except for one pair of slow running 2 to 1 bevel gears at the driving end, and one worm and worm-wheel for the feed.

The spindle is of forged high-carbon steel, fitted with ball thrust bearings made by the builders of the machine, and guaranteed not to crush under severe duty. Three changes of geared feed are provided for this spindle, any one of which is instantly available by the simple shifting of a lever at the front of the machine. This feed change can be made without stopping the spindle. An adjustable automatic stop and a hand throwout is provided. The hand feed is through the worm gearing shown; the quick traverse in either direction is accomplished through the spider hand-wheel at the front of the machine, which engages or disengages the feed connection by an in or out movement of any of the handles. The table is of the knee type, with a large square locked bearing surface on the vertical ways of the column, to which it is securely gibbed. It is adjustable vertically by a square thread screw, located just back of the center of the table, to permit boring a hole through the latter for passing boring bars or other tools, if desired. The work is clamped to it by means of the two T-slots provided, and it is surrounded with a liberal oil groove.

The driving and speed change gearing is mounted at the base of the column. The nine spindle speeds are obtained through a double train of spur gearing, which is always in mesh and runs in a bath of oil. There are two sets of three gears, any one of which in each of the two trains may be thrown into action by a sliding lock bolt or key. The three speeds obtained in each of these trains give nine speeds in all, any one of which are instantly available. The power is transmitted from the horizontal shaft of this speed mechanism, through bevel gears inside the column, to a vertical driving shaft, which is connected with the spindle by an idler spur gear, thus avoiding the necessity of more than one pair of bevels in the entire machine.

A tapping attachment will be furnished, operated by a positive steel clutch located on the idler gear at the top of the machine, thus obviating the necessity for driving the spindle through the keyed member of a clutch. This attachment reverses in the ratio of 2 to 1.

This machine has the following dimensions: The distance from the center of the spindle to the face of the column is 12 inches. The maximum distance from the nose of the spindle to the top of the table is 28 inches; the length of power feed is 16 inches; the spindle has a diameter of 3 inches at the nose, and is provided with a No. 4 Morse taper. The spindle driving gear is 8⅞ inches in diameter with a 1½-inch face. The table has a vertical adjustment of 20 inches. The nine spindle speeds range between 71 and 306 revolutions per minute. The three feeds are 0.007, 0.016, and 0.033 inch respectively. The net weight of the machine is 2,450 pounds.



High-duty Drilling Machine with Single Speed Pulley Drive.

As an extra attachment, a compound table will be furnished, with a knee specially built for supporting it. This compound table has a longitudinal adjustment of 14 inches, and a cross adjustment of 8 inches. The working surface is 16½ x 30 inches. When the compound table is furnished, the maximum distance from the nose of the spindle to the top of the table is decreased by 3¾ inches.

LODGE & SHIPLEY HEAVY AXLE LATHE.

The axle lathe illustrated herewith is built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. The machine is of the standard construction, so far as its general plan is concerned. That is, the axle is driven by equalizing dogs from a hollow revolving driving gear at the center of the bed, the work being supported on two dead centers. Both journals may thus be turned simultaneously. Power is transmitted to the driving gear by a shaft lying in the center of the bed.

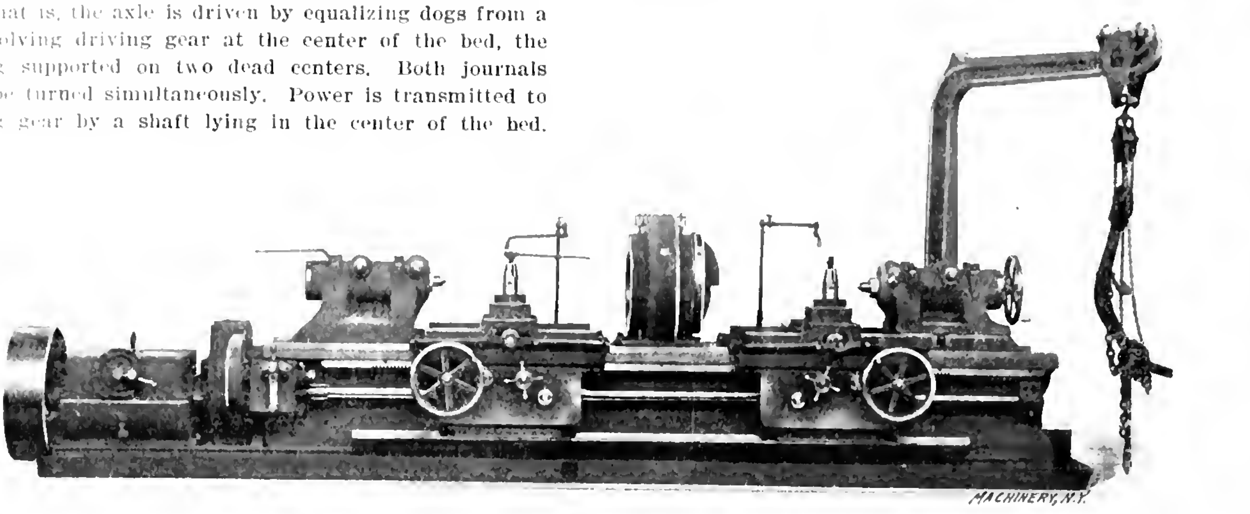


Fig. 1. Lodge & Shipley Single Pulley Drive Axle Lathe.

In the details of its design, this lathe is original throughout and is intended to mark a new step in the development of special machinery for this class of work. Essentially this tool is another evidence of the growing tendency to provide the heaviest machinery with all possible facilities for rapid manipulation. This tendency has, of course, been brought about by the remarkable shortening in cutting time made possible by modern high-speed steels.

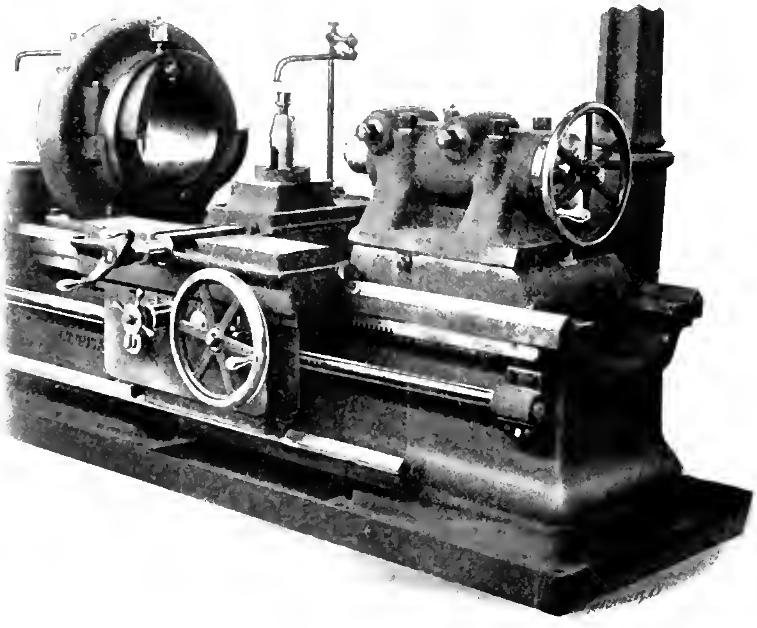


Fig. 2 Driving Head, Carriage and Tail-stock.

The bed is deep and heavy, as may be seen. It is provided with frequent cross braces of box section, and has, as well, a longitudinal stiffening member, also of box section, cast in the center of the bed for its full length. The ends of the bed are cut away so as to facilitate the removal of the tail-stocks, or to permit them to over-hang for a reasonable amount, on work of unusual length.

An especially important feature of this machine is the drive. This is best seen in Fig. 3, which shows the gearing in the speed box exposed, with the cover removed. Power is applied to the constant speed pulley of large diameter and wide face, running at high velocity. The three speeds are obtained by sliding gears, running in a bath of oil; this number is sufficient to cover the range required for the work of turning axles. All the shafts are carried in bushed, ring oiling bearings, and all the gearing is of steel. The driving shaft is of large diameter and is amply supported by journal blocks in the bed. There is no over-hanging on the pinion which engages with the main driving gear, as the shaft is supported at each end in long bearings; the driving gear is also provided with a double bearing. The compensating driver, secured to the gear in the head, is provided with steel faced driving dogs.

All the feed gearing is of steel. The rate of feed is changed by the gear box shown, attached to the left-hand end of the bed; this gives three rates, which may be changed while the lathe is in operation. The two carriages are of unusually interesting construction, as is shown in Fig. 4. It will be seen that they are of the double walled type, this construction being more completely carried out than in any lathe apron that has ever come to our notice. The apron itself is of box form, entirely enclosing the mechanism, front and back, except for the necessary openings. This gives great power and durability to the feed mechanism, and should enable it to withstand the rough service to which lathes of this type are inevitably subjected.

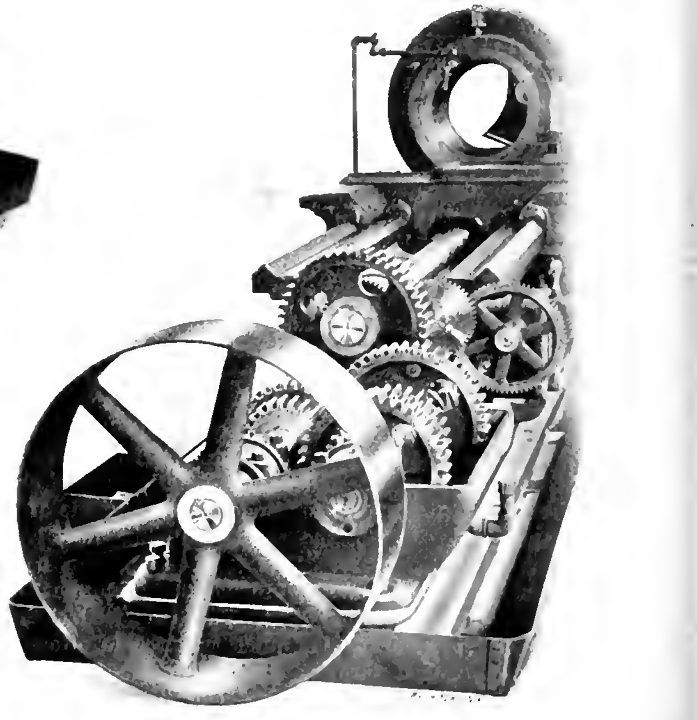


Fig. 3. Driving Gearing with Cover Removed.

The particular point of interest in the design of the carriage relates to its support by a third V, cast in the bed directly under the apron. This is best shown in Fig. 2. A tapered gib is provided for this bearing, which may be set so that the carriage is supported evenly on all three V's. The purpose of this construction is to support the apron at the bottom for both vertical and transverse stresses. The spring of the apron due to the thrust from the rack and pinion is thus effectively overcome. The carriage itself has a bearing on the flat way at the front side of the bed, on which the tail-stock slides, as well as on the V's at the front and rear. This bearing is carried over the 45-degree surface on the inner edge (seen at the end of the bed in Fig. 2). This, with the V's, furnishes sufficient provision against the heavy thrust that results not only from the cutting, but from the operation of burnishing as well.

Water troughs are provided around the tool slide and the wings of the carriage. The tool-posts are arranged with hardened toothed plates interlocking with the tool, and effectually preventing the possibility of its swinging or slipping under the heaviest cuts. The tool slide itself is of steel.

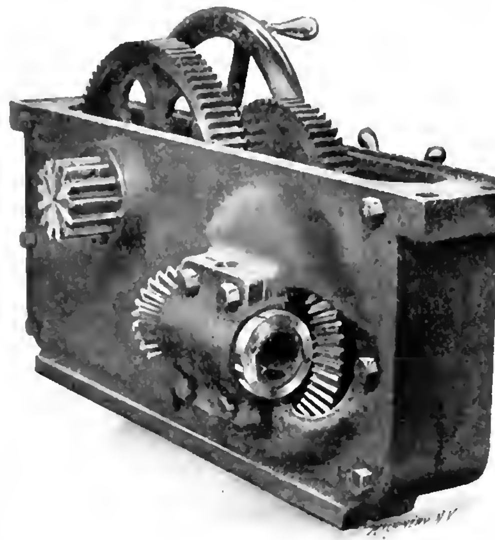


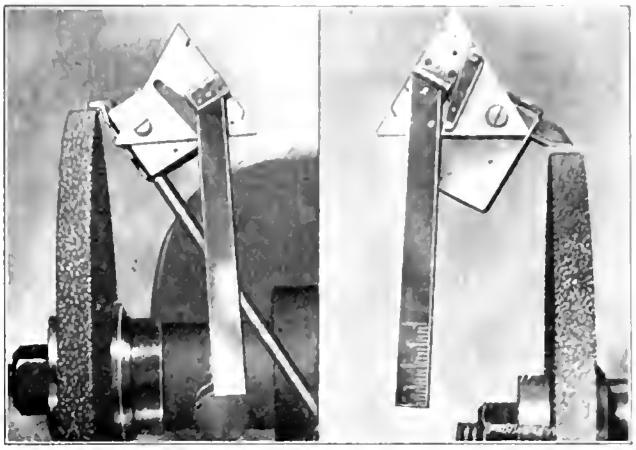
Fig. 4. An Apron that is really "Double Walled."

The tail-stocks are of heavy construction, clamped to the bed by four bolts as shown. These are brought to the top of the spindle barrel, where they can be easily operated from the working position at the front of the machine. The common arrangement, found on heavy lathes, of a pawl for the tail-stock engaging a rack cast in the bed is provided in this case. This arrangement tends to relieve the strain on the clamping bolts, and makes the locking of the tail-stocks positive against the strain of the heaviest cut. The tail-stock at the driving end has no cross adjustment. That at the right-hand end may be adjusted for aligning the centers to parallelism, or for turning tapers. The spindles of each tail-stock are clamped by two plug clamps of improved design. They are placed on top of the spindle barrel where they can be easily manipulated.

Altogether this lathe gives the impression of being a very creditable piece of design.

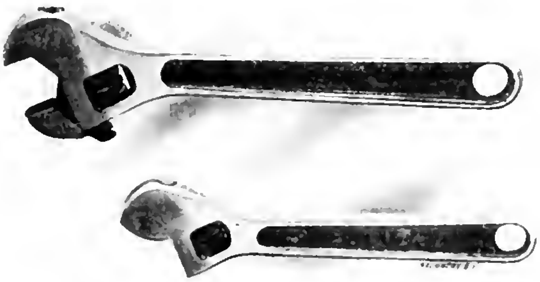
KRIEGER GRINDING GAGE FOR THREAD TOOLS.

The accompanying half-tone illustrations show the use of a 60-degree inside and outside thread tool gage brought out by the Krieger Tool & Mfg. Co., 83-91 Randolph St., Chicago, Ill. This gage is intended to guide the operator in sharpening threading tools made from flat stock or in grinding the point of forged inside thread tools. It is well known that it is difficult to grind a 60-degree thread tool with any degree of accuracy when one is simply guided by the eye for judging the angles of the tool itself. By the use of this grinding gage it is possible with little experience to get a 60-degree angle so nearly perfect at the first grinding that no regrinding to a more correct angle will be necessary. This lengthens the life of the tool and saves time. The gage is also provided with a center gage so that the angle of the thread tool may be tested directly in the gage. The lever or arm extending from the gage and by means of which the operator gages the angle at which he holds the gage, is graduated with ordinary rule graduations, and the tool consequently makes a handy combination tool. Spring clamps are provided by means of which any tool is easily attached to the gage. In the illustrations, Fig. 1 shows the grinding of an internal thread tool, and Fig. 2 the grinding of a 60-degree external thread tool from flat stock. These illustrations indicate the manner in which the operator is guided by the arm of the device so as to see that he holds the tool in approximately the correct position when grinding, the arm then being parallel with the wheel.


Figs. 1 and 2. Grinding Internal and External Thread Tools, using Krieger Grinding Gage to obtain Correct Angles

CRESCENT ADJUSTABLE WRENCH.

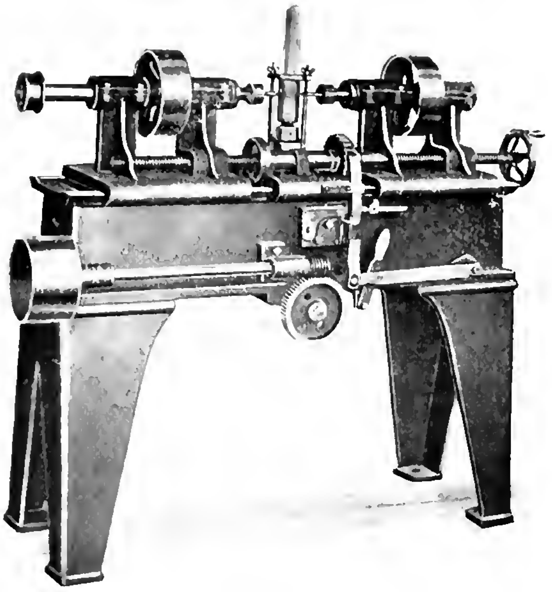
The accompanying half-tone engraving illustrates the Crescent adjustable wrench made by the Crescent Tool Co., Jamestown, N. Y. In the designing of this wrench the outlines of the ordinary 22½-degree engineer's wrench, which is acknowledged to be the most serviceable of all solid wrenches for practical use, has been followed. The design is such that the wrench can be used in practically every opening where a solid wrench can enter, but one size of this adjustable wrench takes the place of a great number of solid wrenches; thus, the 10-inch wrench, which is the larger of the two shown in the engraving, replaces nine sizes of solid wrenches. The wrench consists of five pieces: the handle with one of the jaws forged solid with it, the adjustable jaw, the thumb screw by which this jaw is adjusted, a pin or stud, and a spring. The movable or adjustable jaw is provided with ample bearing surface in the handle and when in use locks itself against the handle, thereby relieving the thumb screw of the working stress. A small spring washer is placed between the thumb screw and the handle at the upper end of the former. This acts as a friction and prevents the thumb screw from moving too easily and changing the adjustment of the jaws, if the wrench should be laid carelessly on the bench or floor. It will be noted that the opening between the jaws is easily adjusted to fit the nut, with the thumb of the same hand that holds the


Two Sizes of Crescent Adjustable Wrenches, the Closed and Opened Wrenches are 8 and 10 inches, respectively.

wrench. The handle is made from drop forged carbon steel and the movable jaw from special alloy steel. At the upper end of the handle a hole is provided by which the wrench may be hung on a nail.

HOEFER SPLINING MACHINE FOR CROSS SLOTS IN SPINDLES.

Like the Hoefer cone pulley polishing machine described in this issue, this machine for milling cross slots in the ends of spindles, is the result of the needs of the Hoefer Mfg. Co., of Freeport, Ill., in its work of building vertical drill presses and power metal saws. This tool is entirely automatic in its action, and is extremely rapid, it being unnecessary to pay any attention to it except to change spindles when the work is completed.



Machine for Automatically Cutting Drift Pin Slots, etc.

The machine consists of a bed on whose upper surface are mounted heads carrying the cutter spindles, between which is vertically reciprocated a work spindle on which the part to be machined is mounted. The heads are strongly made, and are rigidly gibbed to the ways on the top of the bed, and are connected by right- and left-hand feed screws journalled in the work spindle head at the center of the machine. The rotation of this screw simultaneously feeds the cutters in toward or away from the work. The connection between the two ends of the lead-screw is by friction couplings, which allow the two heads to be adjusted independently for depth.

The cutter spindle at the left carries a pulley, belted to another on the shaft at the front of the bed, by means of which the feeding and operating movements of the machine are controlled. This shaft, through worm gearing, drives an adjustable crank, which reciprocates the plunger spindle on which the work is mounted. By means of the adjustment of the crank-pin, drift holes of various lengths can be obtained. The spindle to be milled is held firmly and solidly by means of the clamps shown, on a taper plug fast in the plunger. This provides the means for holding the work and reciprocating it vertically to agree with the length of slot to be milled.

The feeding of the heads inward at the end of each stroke of the work, is effected by means of cams on the inner face of the worm-wheel. These operate on the lever shown, which is in turn connected with the vertical pawl, engaging a ratchet wheel on the right- and left-hand feed-screw. This ratchet feed is automatically thrown out when the proper depth has been reached, by the striking of a pin on the left-hand head against an adjustable release dog controlling the movements of the pawl. It may also be thrown out by hand, by operating the short lever seen at the bottom of the bed, which raises the mechanism beyond the reach of the operating cams. A very thin shell is left between the cutters at the conclusion of the action. To remove this shell the two ends of the feed-screw can be separated as described, and one head alone used in cutting it out.

The accuracy of the work is insured by the alignment of the heads on the bed, and by the firm support given the fish tail cutters. The bed carries an oil tank and an oil pump, which furnish a steady stream of oil to the cutter.

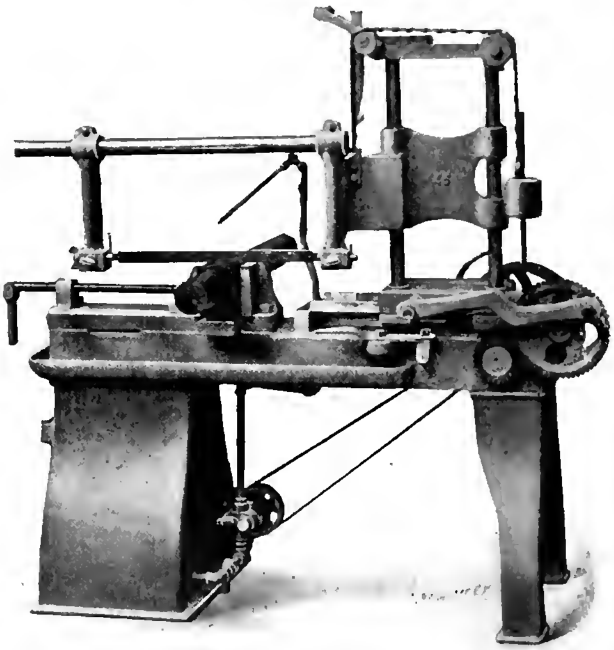
HIGH-SPEED "STERLING" HACK-SAW MACHINE.

The Diamond Saw & Stamping Works of Buffalo, N. Y., has recently placed on the market two new power hack-saw machines, known as No. 3 and No. 4 high-speed "Sterling" power hack-saws. The No. 3 machine is illustrated in the accompanying engraving. These machines take blades from 17 to 21 inches in length and can be run at a speed of from 80 to 100 strokes per minute.

The main driving shaft on which the pinion driving the gear for the saw frame motion is fastened, is 1 7/16 inch in diameter, and the large gear shaft is 1 3/16 inch. The bearings are thus large in diameter, and have also been given sufficient length so as to eliminate rapid wear. The area of the working surfaces of the main bearings, in fact, is 8 square inches. All bearings are provided with means for taking up lost motion with the exception of the main driving shaft bearings, where this has not been considered necessary. The drive is by means of tight and loose pulleys, and a pump for lubrication is provided so that oil or other lubricant can be used on the saw when running at high speed. The front leg of the machine is made with a cabinet frame and a tank for the lubricant is provided inside of the leg.

The construction of the saw frame and the means for counter-balancing are plainly shown in the engraving. The vise for holding the work is provided with a swivel base so that work can be cut off at any angle up to 45 degrees. The limiting capacity of the machine is 8 x 12 inches.

The No. 4 machine is identical with the No. 3 machine excepting that instead of the solid vise provided in the machine just described, the No. 4 machine is made with a centralizing vise and provided with adjustable stroke which enables the operator to use every part of the blade. When much small work is cut off, a certain portion of the blade only is utilized if the stroke is not adjustable, and therefore in shops where there is a large amount of cutting off to be done and the machine is almost continuously in operation, the saving in cost of blades due to the use of an adjustable stroke will soon amount to a considerable figure. It is estimated that from one-third to one-half of the amount of saw blades used can be saved when small work is being cut off by an



High-speed Hack-saw Machine made by the Diamond Saw and Stamping Works.

arrangement which permits using every part of the blade, and the value of this improvement is therefore apparent.

PRENTICE BROS. 16-INCH SHAFT TURNING LATHE.

Prentice Bros. Co., Worcester, Mass., is placing on the market a lathe of the type adapted to the turning of shafting, and especially for work having several diameters and shoulders. For this work, it is arranged with a carriage carrying a number of tool-holders, each of which is provided with a follower rest; and the construction of the tail-stock is such that these can be run back beyond it, so that various diameters can be turned at one single passage of the carriage, without adjusting or shifting any of the tools.

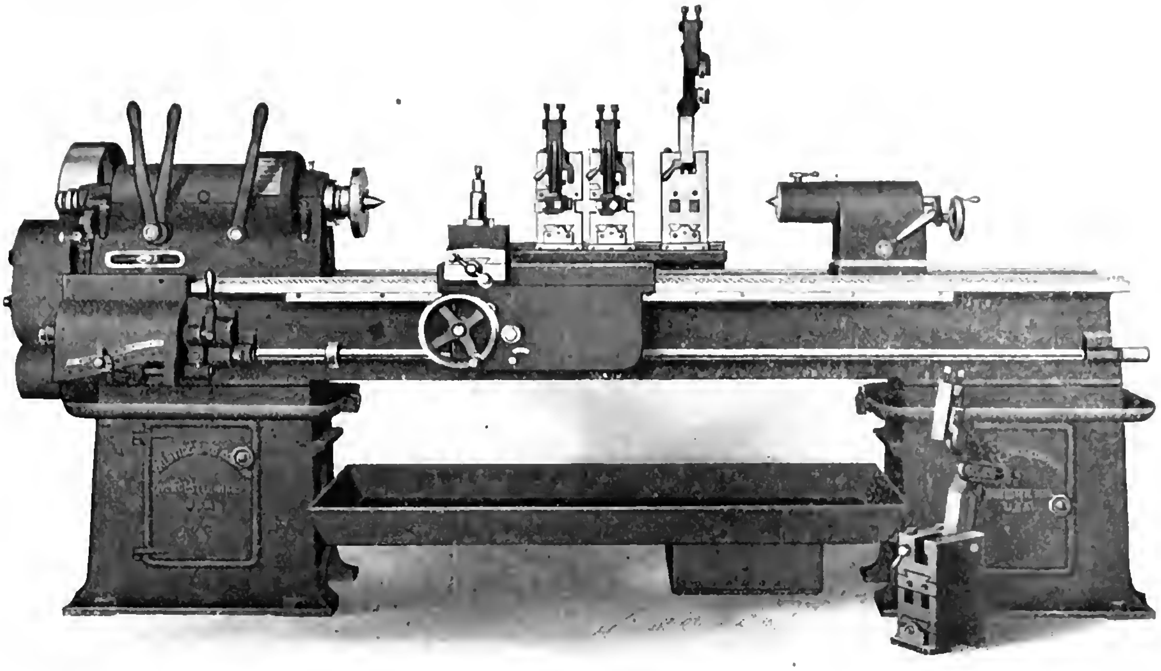


Fig. 1. New Design of Prentice Lathe, especially adapted to turning Studs, Shafts, etc.

The head-stock of this lathe (see Fig. 1) is the same as is used on the builders' regular high-speed geared-head lathes. The three levers at the front of the head-stock give eight changes of speed. These changes are obtained simply and conveniently, and with no possibility of error or mis-manipulation on the part of even the most careless workman. The use of a head-stock of this type gives the operator no excuse for not running the spindle at the proper speed for the diameter of work he is turning. The quick change gear mechanism is also the same as used on the makers' standard lathe, where it has proved itself to be entirely satisfactory. It is simple in construction and operation. As in the case of the head-stock it is impossible to lock any conflicting ratios of gears. The index plates accompanying the lathe clearly explain the operation of the levers.

The main point of interest is the carriage, which is shown in Fig. 2 with two tool blocks in place. It differs radically from the usual construction, in having, for one thing, the bridge at the left-hand end, with the bearing extending toward the right. This construction allows the tool blocks to pass back beyond the tail-stock. Another conspicuous departure from the usual construction will be noted in the fact that the tool blocks are at the rear of the lathe, so that (as the tools themselves, as shown in Fig. 2, are right side up) it is evident that the spindle runs backwards. The tool carriers or blocks are securely bound to the dove-tail on the rear bearing of the carriage, by means of three backing screws, which are reached from the front, and which hold it firmly in position. The cutting tools are held in slots in these blocks, by means of hardened steel taper wedges, which are brought into action by square end adjusting screws projecting from the block in front over each slot. For adjusting these tools for diameter, the same wrench as for tightening them is used on the cross adjustment screws, which shift the tool blocks on their dove-tail bases.

Each tool block is provided with a roller follower rest, whose use is largely responsible for the success of the machine. In Fig. 2, the left-hand tool block has the follower rest lifted up out of the way. To bring it into working position it is lowered, as shown for the other block, and is then pressed toward the right and forced under a ledge, which securely binds it in position. The fitting of these parts is so close that particles of dirt or chips will prevent the entrance of the rest under the ledge. The roll carriers may be fastened on either side of the follow rest, so that the rolls may be brought to bear on the work directly following the tool cut. The right-hand block in Fig. 2 shows clearly that this construction virtually makes a box tool of each tool-holder. Each of these tool-holders is provided with a separate supply of oil, from piping at the back of the carriage.

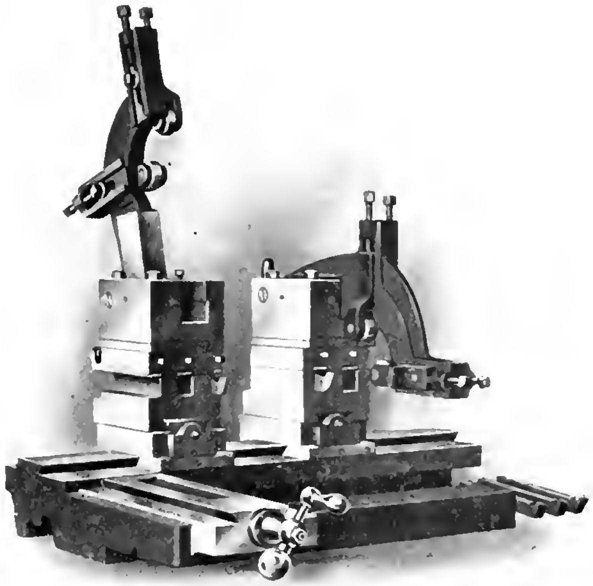


Fig. 2. The Carriage and Tool-blocks, with Follow Rests.

The tail-stock is shown plainly in Fig. 3. It is reversed from the usual construction, since the tool rests are required to pass it at the back instead of at the front. The clearance provided for the tools is unusually close, it being possible to set the latter for cutting down to 13/16 in diameter, and still pass them back of the tail-stock spindle for their

entire length. As may be seen, the spindle itself is of small diameter, and is grooved to permit the passage of the tool. When work is to be placed between the centers preparatory to turning, the tool carriage is run back toward the tail-end of the bed, so that the first tool will start in to cut at the end of the shaft. It is at this position that the tools must clear the tail-stock especially when turning small diameters.

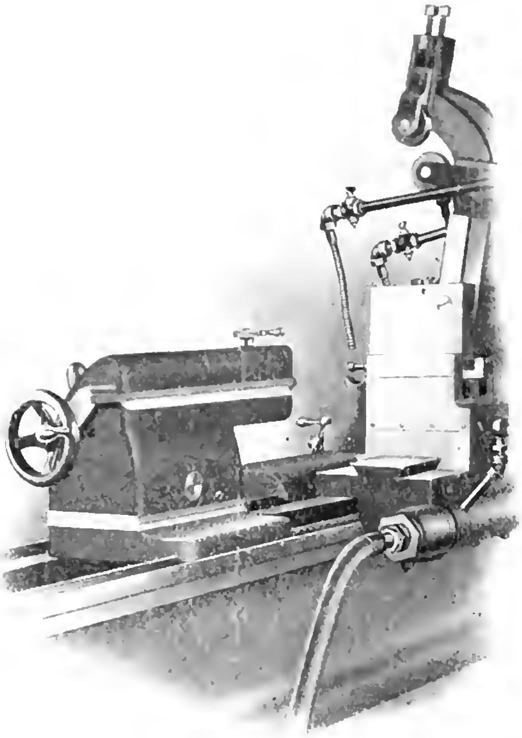


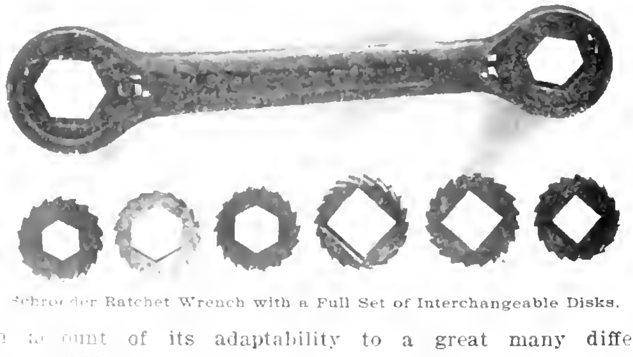
Fig. 3. Tail-stock cut away to clear the Tools.

The work for which this lathe is especially adapted is the turning of shafts and studs of all kinds, in the sizes found in the ordinary run of work in the average machine shop. Its field is thus seen to be a broad one. It is not intended ordinarily to be used for screw cutting, but at a small extra expense a lead-screw will be furnished; in this case the work of the ordinary engine lathe can be done on the machine, using the regular tool-post shown at the left-hand side of the carriage in Fig. 1. This tool-post is intended ordinarily to be used for squaring down shoulders, if the work requires this.

The lathe swings 17½ inches over the ways and takes 62 inches between the centers on a 9-foot bed. The largest diameter the follow rests will take is 5 inches. The net weight of the machine, with a 9-foot bed, is 3,300 pounds.

SCHROEDER RATCHET WRENCH.

The Bullard Automatic Wrench Co., Providence, R. I., has brought out a ratchet wrench provided with interchangeable disks to take square and hexagon standard size nuts, which

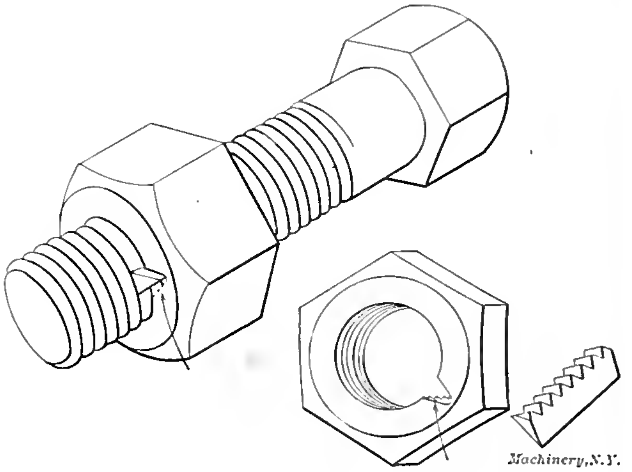


Schroeder Ratchet Wrench with a Full Set of Interchangeable Disks.

on account of its adaptability to a great many different conditions will undoubtedly be of interest to the trade. The main advantage is that one wrench handle will serve for seven or eight different sizes, and the change of disks, permitting this wide range, can be made in less than one-half minute. The accompanying engraving shows the general design of the wrench and also a series of disks which can be placed in the wrench in place of those shown in position. The construction of the wrench is very simple. A pawl is provided with a spring behind its plunger so that it will be constantly in contact with the disks when in use. In the center of this pawl a thin key is provided which enters into a groove in the disks, thus holding them in place when once inserted. When it is required to change the disks, all that is necessary is to pull the pawl back as far as it will go and the disk will fall out. When in use, the pawl is forced over against the step on the side of the slot provided for it, and the wrench acts practically as a solid tool. The frame or handle is made double ended, as shown, of high quality steel, drop forged and case-hardened. The interchangeable disks are made of soft steel and all the holes are made to fit standard hexagon nuts, or a set of disks may be provided for five hexagon sizes and three square nut sizes. Besides these disks there is an extension piece provided with the sets, one end of which fits the half-inch disk of the wrench, and the other end taking any of the disks in the set. With this combination the wrench may be used in many otherwise inaccessible places.

VIBRATION LOCK-NUT.

A self-locking nut has recently been brought out by the L. S. Brach Supply Co., 143 Liberty St., New York. It is the invention of Mr. W. L. Clark, vice-president of the Niles-Bement-Pond Co. In view of its simplicity it will undoubtedly be of interest to practical men and appreciated in mechanical work. The principle of the nut, which is termed by its makers the vibration lock-nut, is shown in the accompanying line engraving. The nut is made like an ordinary hexagon nut, and has a V-shaped slot cut longitudinally on the inside of the hole, with a threaded wedge or key fitting into the slot, so as to form a part of the nut. This wedge is so shaped that it does not interfere with the running of the nut onto the bolt; but when the nut is reversed for removal, the key is carried over against the opposite side of the slot, its teeth being forced against the bolt so as to firmly grip it. This prevents accidental loosening of the nut. When it is required to remove the nut, however, this can easily be done by inserting a pointed wire, or any pointed object, in the larger opening on the side of the key before starting to turn backwards. This will prevent the key from getting into position to act as a binding wedge, and the nut is removed as easily as an ordinary nut.



Self-locking Nut brought out by the L. S. Brach Supply Co.

It is clear from a study of the construction that the nut will lock itself securely at any point on the bolt without distorting or damaging the thread. It should be valuable wherever lost motion of the parts held is likely to occur, as it will hold firmly and indefinitely the parts it is required to secure. In fact, it is not only self-locking, but where the parts vibrate it is also self-tightening, inasmuch as the vibrations will move the nut onto the bolt, but the key or wedge

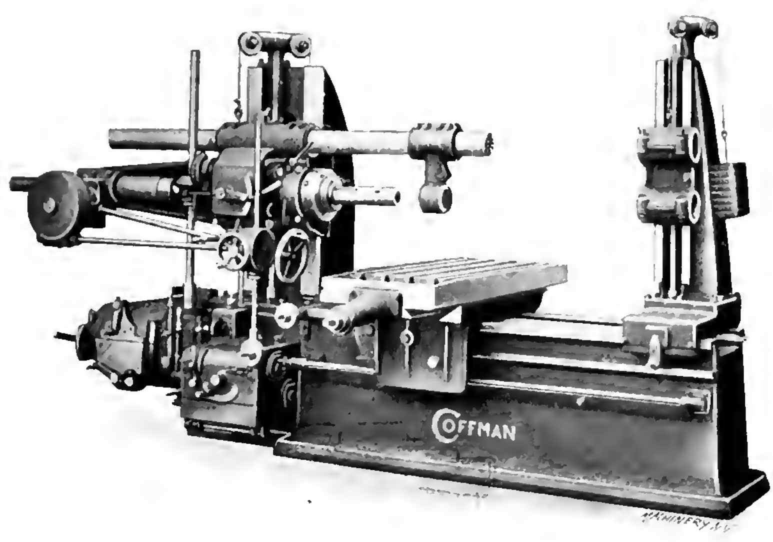
prevents the vibrations from moving it back to its original position. It is especially applicable for railway service on car trucks, fish plates, etc., dispensing with a large amount of inspection now necessary, and insuring safety at all times.

COFFMAN UNIVERSAL BORING, DRILLING AND MILLING MACHINE.

The horizontal boring, drilling and milling machine shown herewith is built by J. P. Coffman, Franklin, Pa. This tool is unusually complete in the adjustments and movements furnished, and would appear to warrant the use of the word "universal," which is applied to it by the builders. An inspection of the two engravings will indicate some of the improvements incorporated in the machine. Note, for instance, the provision of an overhanging arm, and the bringing of both the fine feed and the quick traverse hand-wheels for the boring bar, close to the operator's position. Other features will be noted in the course of the following description.

General Construction.

The main bed is of the box type of design, and is heavily ribbed and cross-braced. The stiff form of the column will be appreciated from an examination of Figs. 1 and 2. The spindle head or saddle is counterbalanced, as is also the outboard support for the boring bar. The saddle and support are adjusted vertically by accurately cut screws, geared together, so that they always move in unison.



Coffman Universal Boring, Drilling and Milling Machine.

Mention has been made of the overhanging arm, furnished for supporting the boring bar. This is not only useful in an obvious way in milling, but in boring it makes it possible to use bars in work where a number of holes are to be bored in line; supporting the bar in the center overcomes the danger of chattering, which is likely to occur in such work. It will thus oftentimes avoid the necessity for a special fixture. It should be noted that the outboard support for the boring bar is also provided with a support for the overhanging arm. The outboard bearings are especially wide. This permits the use of double bushings for supporting the boring bars, thus materially stiffening them.

Main and supplementary work-tables are provided, the former having automatic power cross feed, and the latter having cross slide ways which permit the work to be clamped to it, and still follow the movements of the main table. The main table is provided with oil channels for carrying off oil and cutting compounds. A reservoir for these is provided in the base.

The Spindle and Driving Mechanism.

The machine is built on the unit plan of construction, with the speed box, feed box, spindle drive gearing and feed drive gearing as the principal members. The machine shown has a speed box for constant drive. This, however, may be replaced. If desired by the customer, however, a cone drive or variable speed motor will be furnished instead. If a constant speed motor drive is to be used, the speed box is retained, and the driving shaft is directly connected by gearing or chain and sprocket with the constant speed motor. The speed change mechanism gives 12 rates of speed, there being four changes by a cone gear device, which is, in turn, multiplied by three positive change clutches. A reverse is also provided for in this box. In Fig. 2, handles *A* and *B* operate the cone gear change, while handle *C* operates the clutches. The reverse is effected by handle *D*, which controls a bevel gear and clutch directly on the vertical drive shaft of the spindle.

The lever *E* on the front of the spindle-head gives two rates of speed, and in the central position disconnects the spindle from the driving mechanism. The two rates of speed here obtained are in the proper ratio for the operations of boring and facing, and make it unnecessary to change the regular speed mechanism in performing these operations on a given-sized hole.

The nose of the spindle itself is provided with an internal split taper sleeve which, by means of a screw and socket wrench, may be forced in to clamp the boring bar for facing operations and similar work. When the bar is being fed through the spindle, it is tightened up just enough to give a firm bearing, thus obviating the looseness often resulting from wear at this point after long use. This clamping device also comes into play when holding milling cutters in the spindle. The spindle has a threaded steel nose-plate with a slotted face, adapted for holding the design of face mill that is screwed on with a spanner wrench and driven with a key. This permits running mills or facing heads positively in either direction.

The boring bar is of hammered crucible steel, ground and lapped true. The spindle is of semi-steel, provided with a long key or feather for driving the bar. The front sleeve bearing is taper and the rear one straight. Both are ground true and lapped, and run in bearings of "genuine babbitt" in which is set a spiral groove filled with rolled blocks of compressed graphite. Lubrication for these parts is effected from a reservoir in the bottom of the head.

The Feed Mechanism.

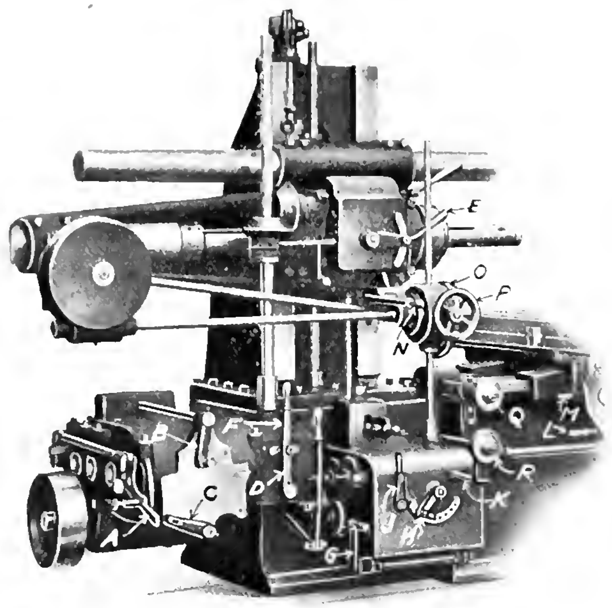
While not specifically so stated in the description furnished us, it seems safe to assume from the drawings and photographs furnished, that in this machine the feed is taken directly from the spindle, instead of from the driving mechanism. This gives the machine the same sort of feeding motion that is provided for the lathe and drill press—that is, one which varies directly with the spindle speed, and is stated as feed per revolution, instead of as feed in inches per minute. For all boring and drilling operations, this is a logical arrangement, though for milling the tendency more recently has been, of course, to provide a feed in inches per minute, such as would be given by regular millers provided with a constant speed drive. As drilling and boring operations will, under ordinary circumstances, constitute by far the greater work of a machine like this, the construction is a rational one. So far as our memory serves us, it has not been applied to any other boring machine of this type.

The feed, by means of one of the vertical shafts shown, is led down to the feed box at the front of the machine, where 21 changes are provided. This mechanism is similar in construction to that for the speed change. It is possible to operate either of them while the machine is in action. Levers *G* and *H* operate the gear cone mechanism, and lever *J* gives the reverse. The feed of the table and the boring bar, and the vertical feeds of the heads on the uprights, are all taken from this mechanism.

The bar feed is taken from a vertical shaft extending upward from the feed box as shown in Fig. 2. This feed is connected and disconnected by lever *K*. The motion is taken to the worm gear at the rear bearing for the boring bar. The hand-wheel *O* operates this movement, sensitively, by hand. By throwing lever *M*, the worm gear is disconnected from the

bar feed pinion shaft allowing a rapid movement to be effected by hand-wheel *O*. The cylinder rack sleeve form of feed is used for the bar. The rack is cut from the solid, and is of wide face and coarse pitch. The design permits the pinion to be brought near the center of pressure in the feeding, giving a decided advantage in drilling, or in spotting bosses with flat cutters.

The longitudinal adjustment of the table along the bed is effected by the square crank or index dial shown at *Q*. The power feed for the cross movement of the table is controlled by levers *L* and *M*. An automatic stop for milling is provided for this apparatus, the dog being adjustable in a slot on the front side of the table, as is usual for milling machines. The power elevating mechanism, controlling both the spindle head and the outboard hearing, is connected to the constant speed shaft so that it is not affected by the speed changes of the spindle. For sensitive adjustment by hand, the squared crankshaft shown at *R* is used.



Enlarged View of End of Machine showing Operating Levers.

Dimensions.

The boring bar is 3¾ inches in diameter. It will feed 30 inches at one setting or 60 inches at a double setting. The front end of the bar is bored to a No. 6 Morse taper. The height from the center of the bar to the top of the table may be varied between 1 inch and 33 inches. The greatest distance available from the base of the spindle to the outer bearing is 78 inches. The working surface of the table is 24 × 48 inches. It has a cross feed with automatic stop of 48 inches. The vertical feed of the saddle is 33 inches. The revolutions per minute of the bar may be varied in geometrical progression, in 24 changes, between 10 and 212 revolutions per minute. The geared positive feeds vary with 21 changes in geometrical progression between 0.004 and 0.500 inch to a revolution of the spindle. The net weight of the machine is about 11,000 pounds.

The design of this machine has been made, so the builders state, as nearly foolproof as possible, great care having been taken to insure it against breakage, and to insure the safety of the operator as well, by enclosing all parts. All the mechanism is accessible for inspection and repair. Dust-proof oilers are provided for all oil holes. Collar and shear pins are provided on all feed shafts, thus preventing injury to the driving mechanism in the case of running against a solid object with the vertical or cross feed. Particular attention should be called to the usefulness of the device as a milling machine. The provision of the overhanging arm, the wide range of feeds and speeds, the strong drive for the spindle, and the facilities provided for holding the cutter, as well as the cross feeds and automatic stop for the work-table, make this tool practicable and serviceable as a milling machine. It will be furnished by the builders, if desired, in the form of a plain milling machine, as a plain boring or drilling machine, or (as in the case here shown) as a universal boring, drilling and milling machine—all from practically the same patterns.

QUICK ADJUSTMENT PIPE WRENCH; Webb & Hildreth Mfg. Co., Gloversville, N. Y. This wrench is intended for general use on piping, lugs, screws, etc.

550-TON FLANGING PRESS; Wm. H. Wood, Media, Pa. This press is intended for the heaviest flanging work. It is provided with one main ram, capable of exerting a pressure of 550 tons. An internal clamping ram for holding the work gives a pressure of 100 tons. Besides this there are four auxiliary cams, and another in the head.

LIGHT PORTABLE DERRICK; Parker Hoist & Derrick Co., 725 Old Colony Bldg., Chicago, Ill. This derrick is intended for general use in contracting and manufacturing plants. It is easily portable, and may be used either as a guy or stiff-legged derrick for steam or hand power. It is made in two sizes, having a capacity of 1,500 pounds and 4,000 pounds respectively.

DRILL GAGE FOR GRINDING CORRECT LIP ANGLES; Remington Tool & Machine Co., 50 Congress St., Boston, Mass. The drill to be measured lies in a V-groove with its point matching the angle gage, which is adjusted to the height of the drill point. By this means the drill may be ground to cut evenly on both lips.

32-INCH PLANER; Rockford Machine Tool Co., Rockford, Ill. This firm has just completed the first of a lot of new 32-inch planers. These are similar in design to the 24-inch size of machine described in the February, 1908, issue of MACHINERY. It is of much heavier construction, however, and will have two heads on the cross-rail and two side heads.

No. 0 BACK-GEARED PLAIN MILLING MACHINE; Owen Machine Tool Co., Dept. M., Springfield, O. The No. 0 milling machine built by this firm has recently been supplied with a back-geared drive, for taking feeds heavier than is usually possible with machines of this size. In other respects, the new design is the same as the plain machine.

DIRECT-DRIVEN LEVER SHEAR; Thomas Carlin's Sons Co., Pittsburg, Pa. This tool is driven directly from a crank on the driving shaft, without the use of intermediate gears, thus giving a high number of cuts per minute. The shear is especially adapted for cutting scrap, etc., of soft steel up to 1½ inch square. The knives are 8 inches long, and the approximate weight of the machine is 6,400 pounds.

THREAD MICROMETER; Ernest R. Seaward, 76 Campfield Ave., Hartford, Conn. This thread micrometer has an adjustable anvil which is set to agree with the required offset for the pitch to be measured. The line of adjustment is parallel with the side of the tool of a 60-degree thread. Formulas and readings for standard threads are stamped on the frame of the micrometer.

MOTOR-DRIVEN PORTABLE DRILLING, GRINDING AND BUFFING OUTFIT; Coates Clipper Mfg. Co., Worcester, Mass. This outfit is somewhat similar, though on a larger scale and for different uses, to the drafting-room outfit built by the same firm and described in this issue. The equipment includes a breast drill, old man, emery wheels, polishers, speed change device and so forth.

METAL NUMBERING MACHINE; American Numbering Machine Co., 291 Essex St., Brooklyn, N. Y. This firm's new Model P metal numbering machine is designed for stamping consecutive numbers on metal pieces, in the power or hand press. Indexing of the figures is done automatically. The speed of the device is limited only by the capacity of the operator. Any size or style of figures can be furnished.

Duplex Grinding Machine: F. H. Otis, 191 Mill St., Rochester, N. Y. This grinding frame carries two others, one of which is provided with a water reservoir and splash pan for wet tool grinding, while the other has the usual rest for miscellaneous dry grinding, and is provided as well with a work-table beneath the wheel, accurately adjustable for height, and useful for surface grinding of dies and other such work.

Tapping Machine for Light Work: John J. Grant, Cleveland, O. This tool is driven by a single belt, running over a three step cone pulley. The reverse belt for backing the tap out has been done away with, this movement being effected instead by gearing contained in the cone pulley. The machine is intended for light tapping, and is of the type in which the reverse is effected by endwise movement of the spindle.

Air Compressor for Shop and Foundry Service: George H. Comstock, Mechanicsburg, Pa. This air compressor is of the enclosed two-cylinder, center-crank, single-action, belt-driven type. The main frame is a single casting, embracing both cylinders (which are water jacketed), the crank shaft bearings and the crank case. The cylinders are 4-inch diameter by 4-inch stroke, and will operate a 2½-inch chipping hammer or two smaller tools when running at 180 revolutions per minute.

Heavy Quadruple Crank Press: E. W. Bliss Co., No. 5 Adams St., Brooklyn, N. Y. This machine is in reality composed of two double crank presses side by side, giving a press with a bed 154 inches long by 10 inches wide, and a correspondingly long slide. The adjustment of the length of the pitman is effected for all four cranks simultaneously, by means of bevel geared shafts operated by sprockets and chains from a driving shaft in the rear, which is in turn operated by power from tight and loose pulleys controlled by a belt shifter. The total weight of the press is over 36 tons.

Hydraulic Variable Speed Drive: Manly Drive Co., 17 State St., New York City. This form of variable speed drive employs a multi-cylinder pump as a driving member, with a similarly constructed engine as the transmitting member. The speed control is effected by varying the stroke of the pump plungers, thus furnishing a greater or less supply of fluid in gallons per minute to the motors. While especially designed for automobile or motor truck service, it should also be useful for other places where the variable speed device is required.

22-Inch Planer: Cincinnati Planer Co., Cincinnati, O. This is the smallest planer ever built by this firm. Aside from being a new size, it incorporates some improvements in design, relating particularly to details. The shifting device is of new construction, designed with special reference to high speed and short stroke work. It is provided with a safety locking device, and is connected with a handle on the opposite side of the bed, so that the machine may be operated from either position. The crank adjusting handles are fixed in position, and are provided with revolving grips, so that the operator can retain a tight hold while turning the screw or rod rapidly.

Hydraulic Valve: Caskey Valve Co., 422 Arcade Building, Philadelphia, Pa. This firm is selling a valve intended particularly for hydraulic service, though it may be used as well for steam or air. It is a plug valve, but is unusual in its construction, in that the plug is straight, instead of being tapered as usual. It is so constructed that the higher the pressure, the more tightly the valve is packed. This is done by introducing the pressure behind leather washers, which are thus spread to fill the holes and prevent leakage of the fluid. This form of valve is built for the large area and low pressure service of the locomotive blowout type, as well as for hydraulic press service.

Precision Lathe: Frederick Pearce, 18 Rose St., New York City. This precision lathe was developed by the builders originally for their own use. It is intended to have the fine workmanship required by makers of delicate instruments, and at the same time to be capable of taking a reasonably heavy chip, considering the size of the lathe. The construction of the bed and slide rest departs from the usual lines, in that the carriage is mounted on ways at the front of the bed instead of on the top, while the tool rest is carried on a vertically adjustable slide on the carriage. This arrangement, besides furnishing an adjustment for the height of the tool, should also make of the machine a convenient precision miller for many varieties of work. Owing to the arrangement of the carriage ways, the carriage may be fed clear past the headstock to the head end of the bed.

Clutch for Imparting Variable Speed to Machines: Variable Speed Clutch Co., Milwaukee, Wis. This clutch is intended not only for starting and stopping machines, but for varying the speed as well. In one form of the device the clutch members are thrown into contact by an air cylinder in which the pressure is maintained at a constant point by a reducing valve. The clutch levers are thrown out of engagement by the centrifugal action of revolving weights. When the speed of the driven member is so high that the weights fly outward against the air pressure, the clutch is relieved, thus setting the limiting speed of the drive. By varying the reducing valve adjustment this speed may be adjusted to any desired amount, giving more or less slip in the clutch. Another valve provides for throwing the air pressure on or off, thus starting and stopping the driven member. The clutch would seem to be the mechanical counterpart of the often conceived hydraulic by-pass arrangement for transmitting power at variable speed, and would apparently be subject to the same limitations.

* * *

In the description of the Collis high-speed drill (made by the High Speed Drill Co., of Dubuque, Iowa) published in the new tools department of the December issue of Machinery, we inadvertently stated that with these drills, special holding chucks are *necessary*. This is, of course, a typographical error. It should have stated that special holding chucks are *unnecessary*.

* * *

RAPID WORK WITH POWER HACK-SAWS.

An interesting test was recently undertaken at the E. C. Atkins & Co.'s plant, Indianapolis, to ascertain the cutting qualities of what is termed the A.A.A. hack-saw blades manufactured by the company, when used on the company's "Kwik Kut" power hack-saw. A piece of circular machine steel, 6 inches in diameter, was placed in the hack-saw machine and a cut was taken through the work in less than two hours, the machine being speeded up to fifty strokes per minute. The cut was true and straight so that no machining or planing was necessary. The machine was then slowed down to forty strokes per minute, and a second cut was completed in one hour and thirty minutes. A third cut was then made at the same speed, but with a five-pound weight added on the saw frame. This time the 6-inch diameter machine steel bar was cut through in one hour and fifteen minutes. In another test of the same hack-saw blades, in order to ascertain their durability, they were kept at work for thirty-two hours cutting annealed tool steel, and it was found that they stood up well for the work and were not entirely worn out. The accompanying half-tone shows the cuts made during the experiment, and illustrates the truth of the surfaces and straightness of the cuts taken.


Rapid Cutting with "Kwik Kut "Hack-saws.

* * *

We are interested in all changes of positions of foremen, superintendents, shop managers and contributors, and request notices of such changes, and of deaths, for publication.

THE CLEVELAND AUTOMATIC MACHINE CO.'S CHICAGO DEMONSTRATING ROOM.

The demonstration of the capabilities of automatic machine tools, perhaps, is more important than that of any other class of machine tools sold. The prospective customer first wishes to be assured that the machine will produce the parts desired true to size and shape, and with the required finish. He also wishes to be convinced that the machine can produce the work in the time specified, and to see with his own eyes the character of the tool equipment. Recognizing the desirability of accommodating "the man from Missouri," the Cleveland Automatic Machine Co., Cleveland, Ohio, last fall opened a demonstrating room at 67 West Washington Street, Chicago, in which are installed four working Cleveland automatic machines. These are the plain, three-holed, standard and new model designs, respectively.

The accompanying illustration shows the demonstrating room and the general arrangement of the machines. The machines, it will be noticed, are arranged *en echelon* on the plan generally followed in screw machine installation, that is, so the bar stock of one machine overlaps and parallels the next machine, and so on. This saving of floor space as compared with that required for the straight alignment generally followed with engine lathes is of much importance. The demonstrating room thus is made a model for automatic machine arrangement in installations for manufacturing.

The Cleveland Automatic Machine Co.'s Chicago Demonstrating Room.

All four machines are performing operations that are commonly regarded as extremely difficult. Customers can be shown the machines under difficult working without imposing on the hospitality of some good-natured manufacturer in whose plant similar machines are at work. Demonstrating rooms are not strictly a novelty in this country, but there are so few of them in which the machines are shown under full working conditions that the opening of this store is likely to attract considerable interest among the trade.

* * *

FIRST ALCOHOL MOTOR CAB IN NEW YORK.

The first alcohol motor cab has made its appearance in New York. It is the product of the factory of the H. H. Franklin Mfg. Co., Syracuse, N. Y., where the engineers have long been experimenting to provide an alcohol motor that would give results equal to those of the gasoline motor. The engine was tested over hundreds of miles of road before being sent out from the factory, and has demonstrated a capability of covering as great a distance for each gallon of alcohol as other motors of like size do for each gallon of gasoline. The new vehicle is of eighteen horse-power, and is identical with the gasoline motor cabs of the 1909 Franklin model except for the provision made for the use of alcohol in place of the gasoline. At first experiments were made with a regular gasoline engine, but after a study of its action an engine was made specially designed for alcohol, and it is this with which the new cab is propelled. Alteration is made as to compression and carburetion. The alcohol is found to produce no bad effect upon the motor. The problem of making a workable alcohol motor has been the subject of much attention on the part of the governments of France, Germany and the United States. The Franklin cab will now demonstrate its every-day practicability in competition with over 500 gasoline motor cabs of the landaulet type in New York City.

* * *

LAST WIRE OF THE MANHATTAN BRIDGE CABLES STRUNG.

The last wire of the four cables of the new Manhattan Bridge across the East River, New York, was strung December 10 in the presence of Mayor McClellan, and other notable guests. The improved method of stringing the cables, illustrated and described in the October issue of MACHINERY, has made the work proceed rapidly, 24,000 miles of wire having been strung in just four months. The span is 1,470 feet, or 130 feet less than the Williamsburg Bridge. The cables are 21¼ inches in diameter and each contains 37 strands of 256 wires each, making a total of 9,472 wires per cable. The wire is 0.192 inch diameter, No. 6 Roebling gage. Following the stringing of the wires begins the work of binding the cables together to shape them into cylindrical form to protect them from the elements. Miles of wire will be wrapped around them and hydraulic presses will be employed for pressing the strands together into the cylindrical shape of the completed cables.

* * *

A clever device for making deadly revolver shooting at night possible by inexperienced shooters, has been patented that is worth attention because of the interesting principle involved. An electric flash lamp is mounted on the revolver barrel parallel with its axis, having a push-button located on the back end convenient for the shooter's thumb. Pressure on the button lights the electric lamp and projects a disk of bright light at a considerable distance, illuminating the object to be aimed at. In the center of the circle of illumination is a dark spot, this being the shadow of a tiny bead in the focus of the flash-light. This shadow marks the exact spot where the bullet will hit, and if the shooter can hold the shadow steadily on his victim he is assured of deadly aim. The attachment really makes it easier for a poor shot to hit an object at night than for a good shot to do accurate shooting by day-light.

OBITUARY.

Geo. W. Corbin.

George W. Corbin, a prominent manufacturer and capitalist of New Britain, Conn., died at his home in that place November 30 in the fiftieth year of his age. Mr. Corbin had been in ill-health for a year or more, but up to a short time before his death appeared to be recovering, and then the end came suddenly. At the time of his death he was president of the Union Mfg. Co., the Corbin Brass Co., the Dean Steel Die Co., the Corbin-Church Co., the People's Savings Bank—all of New Britain, and for several years had been president of the Corbin Cabinet Lock Co. of the same place, resigning last May when ill-health made it impossible for him to attend further the duties of the position. His business career began in the employ of P. & F. Corbin, of New Britain, with which company he remained timekeeper until 1880. Mr. Corbin was a man of much personal popularity, and was made mayor of New Britain in 1894. He was prominent in the fraternal and patriotic societies, having acquired the thirty-third degree in the Masonic order and various honors in other societies. He is survived by a widow and four daughters.

Edwin H. Jones, president of the Vulcan Iron Works, Wilkesbarre, Pa., died at his home in that city December 2, aged sixty-four years.

Warren E. Hill, president of the Continental Iron Works, Greenpoint, Brooklyn, died December 8 of heart disease, aged seventy-four years. Mr. Hill was a member of the Society of Naval Architects and Marine Engineers, and the American Society of Mechanical Engineers.

* * *

PERSONAL.

Henry Kerr has resigned his position with the Boston Gear Works, and has become connected with the New England Gear Works, Boston, Mass.

L. H. Mesker, who has been connected with the Motch & Merryweather Machinery Co. of Cincinnati is now connected with the Cleveland office of Manning, Maxwell & Moore.

Meldon H. Merrill recently resigned his position as salesman for the Westinghouse Electric & Mfg. Co., and has accepted a similar position in the Boston office of the Allis-Chalmers Co.

John L. Walker, formerly auditor for the Buda Foundry & Mfg. Co., has resigned his position, and has been made manager of the "Use-Em-Up" socket department of the American Specialty Co., Chicago, Ill.

Arthur Letherby, who for ten years has been superintendent of the Hamilton Machine Tool Co., has bought the interest of Mr. Philip Fosdick in the Kern Machine Tool Co., Cincinnati, Ohio, and becomes vice-president and superintendent. Mr. Letherby assumes his new duties January 1.

G. M. Basford, assistant to the president of the American Locomotive Co., 30 Church St., New York, has been made acting-secretary of the Railway Business Association. This association has been organized for the purpose of promoting confidence in railways and transportation interests generally.

Joseph A. MacLennan has resigned his position at the Philadelphia works of the Link-Belt Co. to become president of the Wilmot Machinery Co. of New Orleans. Mr. MacLennan was associated with the Link-Belt Co. for over twelve years, and lately was superintendent of the Philadelphia works. His early training was obtained in the erection department of the Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia, Pa.

William P. Sargent, the author of the series: "The Design and Construction of Meal-Working Shops," now running in the engineering edition of this journal, goes with the Curtis Publishing Co., Philadelphia, on or about January 1, in the capacity of mechanical expert to investigate and suggest ways and means for solving the engineering problems that develop with a great publishing business. The company is building a new plant which will be completed in about two years, and it will be designed throughout for the economical production of its publications on a large scale. The circulation of its two journals now is over 6,000,000 copies per month, and plans will be made for the handling of a much larger circulation. The position is peculiar, the parallel of which probably does not exist anywhere else.

JESSE M. SMITH.

Jesse M. Smith, the newly-elected president of the American Society of Mechanical Engineers, was born at Newark, Ohio, 1848. In 1862 he moved to Detroit, Mich., with his father's family, and in 1865 entered Rensselaer Polytechnic Institute, Troy, N. Y., remaining there three years. He traveled in Europe one year and then attended Ecole Centrale des Arts et Manufactures, Paris, three years and received the degree of mechanical engineer, therefrom, in 1872. During vacation periods he visited manufacturing plants in France, Germany and Belgium, and listened to lectures in the Polytechnic Institute of Berlin.

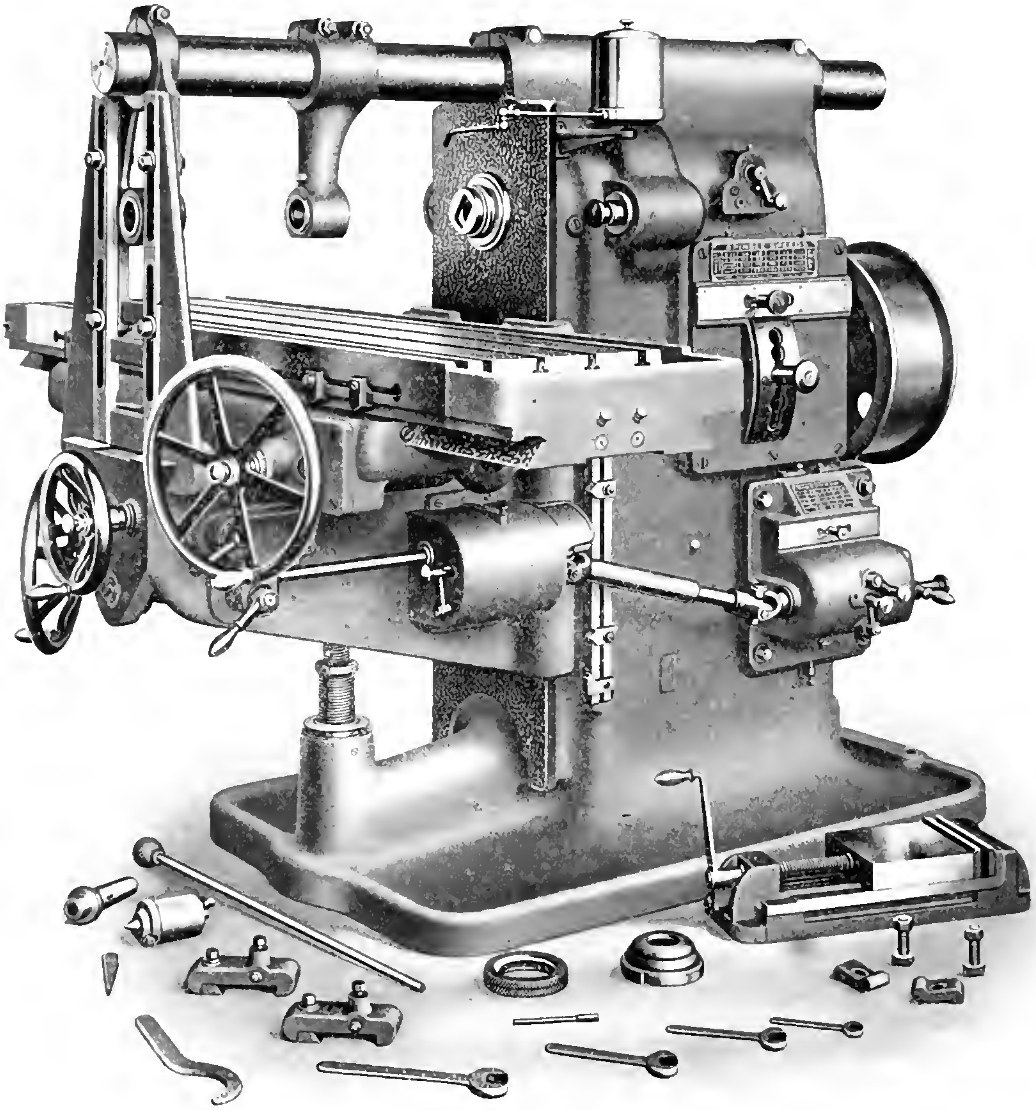
Jesse M. Smith.

Mr. Smith began the practice of engineering in 1873, designing and superintending the erection of blast furnaces for melting iron and native ores with the raw bituminous, in the Hocking Valley, Ohio. He also made surveys of coal mines, opened mines and built coal handling machinery for them and surveyed and constructed railroads from mines to furnaces. He represented the U. S. Electric Lighting Co. in Ohio and Michigan in 1884 to 1886, during which time he erected a number of early incandescent electric light plants, including one of 1,000 lights in the Stillman Hotel, Cleveland, Ohio, which was the first hotel lighted exclusively and continuously by electricity. Mr. Smith returned to Detroit

Brown & Sharpe Mfg. Co.

PROVIDENCE, R. I., U. S. A.

Originators of the Constant Speed Drive Milling Machine



No. 5-B HEAVY PLAIN MILLING MACHINE

Capacity

Longitudinal feed, 50″, transverse feed, 12″.
Vertical feed, 21″. Feeds automatic.

MILLING MACHINES FOR HEAVY SERVICE

Brown & Sharpe Mfg. Co.

PROVIDENCE, R. I., U. S. A.

Experts in Milling Construction and Practice

Careful study of the requirements of milling machines for *Heavy Service* has produced the B. & S. Constant Speed Drive Milling Machine, an example of

POWER AND RIGIDITY

Attention is called

to the massive frame, its great width and depth and the large heavy base supporting it—The extreme vertical depth and large working surface of the table—The length and vertical depth of saddle—The rigid design of the knee which is strongly webbed on the inside and has exceptionally long bearings on the column—The stiff support of the overhanging arm—The driving pulley which is 20" diameter, takes a belt 7" wide and runs at the high speed of 320 R.P.M. developing *ample* and *constant* power for the heaviest cuts within the capacity of the machine—The massive spindle having a recess in the end instead of a slot across and supported by unusually long boxes of large diameter—The large diameter, wide face, and coarse pitch of all the gears—Both the speed and feed changing gears which are hardened, a feature, the value of which no authority will dispute—The lever type of tumbler gear lock which locks that gear rigidly and automatically as soon as the lever is released—The long and wide bearing surfaces accurately scraped and the rigid mounting of all shafts which are hardened and bushed with bronze.

Do these features not show a design of machine capable of developing power without undue stress in any of its parts?

when his father died in 1889 and opened an office as consulting engineer. He designed and erected several power plants and several plants for electric lighting and electric railways, and also apparatus for steam heating with exhaust steam in large manufacturing plants.

In 1883 Mr. Smith was called into service as an expert witness in patent litigation in the U. S. courts. This practice gradually increased, displacing his work as consulting engineer, until in 1898 he moved to New York City to continue the practice of expert in patent causes, exclusively. Among the notable cases of patent litigation in which he acted as an expert witness were: Steam injectors under the Hancock inspirator patents; cylinder lubricators for locomotives; quick-action air brakes under the Westinghouse patents; induction electric motors under the Tesla patents; incandescent electric lamps; cyclone dust collectors, roller mills and middlings purifiers for flour manufacture; pressure filters; steam heating apparatus; typewriters; calculagraph; armored concrete construction, etc.

Mr. Smith became a member of the American Society of Mechanical Engineers in 1883 and was a member of the council as manager 1891-94. He acted as vice-president 1894-96 and again, 1899-01. He is a member of the American Institute of Electrical Engineers, Societe des Ingenieurs Civils de France, Association des Anciens Eleves de l'Ecole Centrale des Arts et Manufactures, Detroit Engineering Society, Society for the Advancement of Science, American Geographical Society, Engineers' Club, and Ohio Society of New York.

* * *

COMING EVENTS.

December 31-January 7.—Ninth annual show of the American Motor Car Manufacturers' Association at Grand Central Palace, New York City.

January 5.—First session of the fourth annual meeting of the Society of Automobile Engineers in New York City held in connection with the Automobile show at the Grand Central Palace.

January 12.—The next monthly meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' Building on Tuesday evening, January 12. The paper will be by Mr. Carl G. Barth of Philadelphia: "The Transmission of Power by Leather Belting," illustrated by lantern slides. It will be a comprehensive summing up of the theory and practice of belting in which conclusions are drawn from the work of Lewis, Bancroft, Bird and others, who have made experiments upon the transmission of power by belting. Valuable charts have been prepared by the author for the solution of belting problems. Mr. Barth's long experience in the scientific running of machine tools, in connection with the introduction of improved shop methods, has shown the need of definite data for the application of belting to machinery and led to the development of the results contained in his paper. His data have been applied to belting in different plants for many years, giving an unusual opportunity to study the problem in great detail.

January 16-23.—Ninth annual show of the Association of Licensed Automobile manufacturers at Madison Square Garden, New York City.

January 22.—Final sessions of the fourth annual meeting of the Society of Automobile Engineers held in connection with the annual show at the Madison Square Garden, New York City.

June 16-18.—Annual convention of the American Railway Master Mechanics Association at Atlantic City, N. J.

June 21-23.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

NEW BOOKS AND PAMPHLETS.

Report of the Commissioner of Education, 1907. 522 pages, 6 x 9 inches. Published by the United States Bureau of Education, Washington, D. C.

Railway Capital and Wages. By W. H. Williams. Pamphlet of 22 pages, 8 x 10 inches, publishing the author's remarks before the Traffic Club of New York.

Mechanical World, Pocket Diary and Year Book for 1909. 395 pages, 4 x 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 6d.

The twenty-second annual issue of the work contains a varied collection of notes, rules, tables and miscellaneous data for mechanics and engineers. The sections on steam turbines and friction clutches have been re-written and extended and a section on chain drives introduced. A number of blank pages in the back part of the book provide for a diary and memoranda.

Producer Gas, Gas Firing and the Advantages of Gas Firing Over the Direct Use of Coal. By Ernest Schmatolla. 16 pages, 5½ x 8½ inches. Published by the author, 317 High Holborn, London, W. C., England. Price, 1 shilling.

This pamphlet states the advantages to be derived from the use of producer gas in preference to that of fuel fed directly into the furnace; also information concerning the methods of utilizing fuels of inferior quality in specially constructed producers, so as to give results superior to high-class coal fired in the ordinary way.

Mine Sampling and Chemical Analyses of Coals Tested at the United States Fuel Testing Plant, Norfolk, Va., in 1907. Bulletin 362. By John Shober Burrows. Published by the Department of Interior, U. S. Geological Survey, Washington, D. C.

Pamphlet giving location of coal beds and detailed sections of the seams at the points where the mine samples were taken, showing the amount of clean coal, and the partings of shale, bone coal, etc., together with chemical analyses of these samples and of the car-load lots as they were received at the testing plant after exposure to the weather for various periods.

Annual Report of the Chief of the Bureau of Steam Engineering to the Secretary of the Navy for the Fiscal Year 1908. Published by the Navy Department, Bureau of Steam Engineering, Washington, D. C.

The report contains financial statement of expenditures for the year in the maintenance of navy yards, naval vessels, etc., purchase of material and other incidental expenses, together with an account of the general operations of the Bureau, including a summary of the work done at the various navy yards of the United States, and a register of ships giving machinery data of all ships carried on the active list and those authorized by Congress and now under design or construction.

Morrison's Spring Tables. By Egbert R. Morrison. 84 pages, 6 x 9 inches. Published by Morrison and Martin, Sharon, Pa.

This book contains data on helical and elliptical springs, both heavy and light. The author has considered a helical spring whose bar is less than 1/16 of an inch in diameter, and an elliptical spring whose plate is less than 1/16 of an inch in thickness, to be a light spring. The tables give the length per inch of solid height; the weight per inch of solid height; free height per inch of solid height; and capacity. There are in addition formulas for calculating the properties of helical springs of round and rectangular section and elliptical springs. Mathematical tables are included to facilitate the use of the formulas.

Forging. By John Lord Bacon. 112 pages, 6½ x 9¼ inches. 178 illustrations. Published by the American School of Correspondence, Chicago, Ill. Price, $1.00.

A manual of practical instruction in the hammering, working, forming and tempering of wrought iron, machine steel, and tool steel, including details of the modern processes of electric welding. The work contains throughout numerous illustrations which supplement and make clear the reference in the text. The chapter headings are as follows: Equipment; Welding; Calculation of Stock for Bent Shapes; Forging Operations; Simple Forging; Calculation of Stock for Forged Work; Tool Steel Work; Tool Forging and Tempering; Heavy Forging; Miscellaneous Processes; and Electric Welding Development.

The Apprenticeship System in its Relation to Industrial Education. By Carroll D. Wright. 116 pages, 6 x 9 inches. Published by the United States Bureau of Education, Washington, D. C.

This is a work of valuable information concerning the industrial school problem. The need for a combination of the apprenticeship and academic education, and ways in which the combination may be effected, as shown by recent experiences in a few of our leading industries, are pointed out. The extent of the apprenticeship system in the United States and other countries is given, together with a description of various new apprenticeship systems which are the educational features of a few typical concerns in this country. Appended to the work is a digest of the apprentice laws of the various states.

Algebra Self-Taught. By W. P. Higgs. 104 pages, 5 x 7 inches. Published by Spon & Chamberlain, 123-125 Liberty Street, New York.

Tenth edition of a volume for the use of mechanics, young engineers and home students. The contents of the book by chapters is as follows: Symbols and the Signs of Operation; the Equation and the Unknown Quantity; Positive and Negative Quantities; Multiplication, Involution, Exponents; Negative Exponents, Roots, and the Use of Exponents as Logarithms; Logarithms; Tables of Logarithms and Proportional Parts; Transformation of Systems of Logarithms; Common Uses of Common Logarithms; Compound Multiplication and the Binomial Theorem; Division, Fractions and Ratio; Geometrical Means; Limit of Series; Square and Cube Roots; and Equations.

Mechanical Drawing and Elementary Machine Design. By John S. Reid and David Reid. 439 pages 6 x 9 inches. 301 illustrations. Published by John Wiley & Sons, New York. Price, $3.00, cloth.

This volume (second edition) is designed to apply the principles of mechanical drawing to the solution of practical problems in machine construction, and to familiarize the student with the arrangement and proportions of the most important machines and their details, and also the best practice in design and construction. The various chapters are as follows: Introductory Instructions; Screws, Nuts and Bolts; Keys, Cotters and Gibbs; Rivets and Riveted Joints; Shafting and Shaft-Couplings; Pipes and Pipe Couplings; Bearings; Sole-plates and Wall Box-frames; Belt Gearing; Toothed Gearing; Valves, Cocks and Oil-cups; Engine Details; Elementary Machine Drawing; Present practice in Drafting-room Conventions and Methods in Making Practical Working Drawings.

CATALOGUES AND CIRCULARS.

Fort Wayne Electric Works, Fort Wayne, Ind. Practical guide for transformer testing.

Allis-Chalmers Co., Milwaukee, Wis. Bulletin 1513 on portable and stationary air compressors.

Western Electric Co., 463 West St., New York. Bulletin No. 5370 on steam turbines built under the Rateau patents.

Western Electric Co., 463 West St., New York. Booklets on design E and design L generators and motors.

American Boiler Economy Co., North American Building, Philadelphia, Pa. Catalogue of the Copes boiler feed regulator.

Western Electric Co., 463 West St., New York. Booklet No. 1078 on magneto telephone wall sets, illustrating the construction.

Westinghouse Electric and Mfg. Co., Pittsburg, Pa. Circular No. 1157, descriptive of Westinghouse type "S" transformers.

General Electric Co., Schenectady, N. Y. Catalogue of motor generator sets, varying in capacity from 0.2 K.W. to 1,500 K.W.

Independent Pneumatic Tool Co., Chicago, Ill. Circular L of "Thor" pneumatic tools and appliances for metal working and wood working.

Artisans' Guild, Benton Harbor, Mich. Catalogue of automatic oiler loose pulleys and automatic oiler sleeves for wood and large iron pulleys.

General Electric Co., Schenectady, N. Y. Catalogue of fan motors and small power motors, embracing both alternating and direct current types.

Cleveland Twist Drill Co., Cleveland, Ohio. Catalogue "Peerless" high-speed reamers in which the blades of high-speed steel are joined to the body by the "Brazo-Hardening" process.

Carpenter Steel Co., Reading, Pa. Pamphlet issued in commemoration of the Vanderbilt Cup Race, on the importance of alloy steels in modern automobile construction.

Hyatt Roller Bearing Co., Newark, N. J. Leaflet entitled "Push Your Business with Less Friction," being an advertisement of the Hyatt anti-friction bearings.

Follansbee Bros. Co., Pittsburg, Pa. Catalogue entitled "Tin Truth" illustrating the manufacture of tin plate in the company's open hearth works and mills at Follansbee, Brooke County, W. Va.

G. M. Yost Mfg. Co., Meadville, Pa. Leaflets listing solid jaw and swivel bottom machinists' vises, universal woodworkers' vises, "Uwanta" special railroad monkey-wrenches, blacksmith's leg vises, etc.

Fosdick Machine Tool Co., Cincinnati, Ohio. Circular illustrating and describing the Fosdick universal radial drills which are built half and full universal in 4-, 5- and 6-foot sizes.

National-Acme Mfg. Co., Cleveland, Ohio. Leaflet of new Acme automatic machine No. 515, which has a chuck capacity of 9/16 inch and a feed of 3 inches.

Norman W. Henley & Son, 132 Nassau St., New York. Catalogue of books for machinists, engineers, mechanics, mechanical engineers, inventors, foundrymen, electricians, draftsmen, etc.

W. H. Nicholson & Co., Wilkesbarre, Pa. Catalogue of Nicholson's inserted blade gas pipe taps, illustrated and described in this number. These taps are made in sizes from 1 to 12 inches inclusive.

MACHINERY

February, 1909.

AXLE TURNING—METHODS AND PRODUCTION.

WILLIAM P. SARGENT *

THERE has always been an unsatisfied feeling in the mind of the writer because of the fact that the power, strength and rigidity of machine tools are so seldom taxed to the extent that the designer provides for, and because the actual output from machines falls so far below an estimated output, based on the cuts and feeds that the machines were capable of carrying.

Any knowledge or understanding of the forces tending to restrict production should be of value to the designer and to the owners of machine tools, and articles treating of the operation of machine tools under actual shop conditions and not with the bright side always showing, should make towards progress in the world of designing. It is this belief that prompts the writer to offer the following observations:

During a recent period of the writer's experience, it involved upon him to make a study of axle turning in a number of shops in the Middle West from which came reports showing an increased production from the machines. After sifting the many notes made during these visits, the methods in vogue in three of the shops were taken as a basis for the forming of a routine of operations that would conserve the time and efforts of the operator and work the machines up to their power and strength. Naturally, some changes in design resulted from this study of machines in operation—not under rosy conditions, but in the cold, hard realm of actual practice where conditions of lighting, heating, power and conveniences for the men were more adverse than favorable.

The following conditions tend towards a large output from axle lathes, especially from the double axle lathe with center drive:

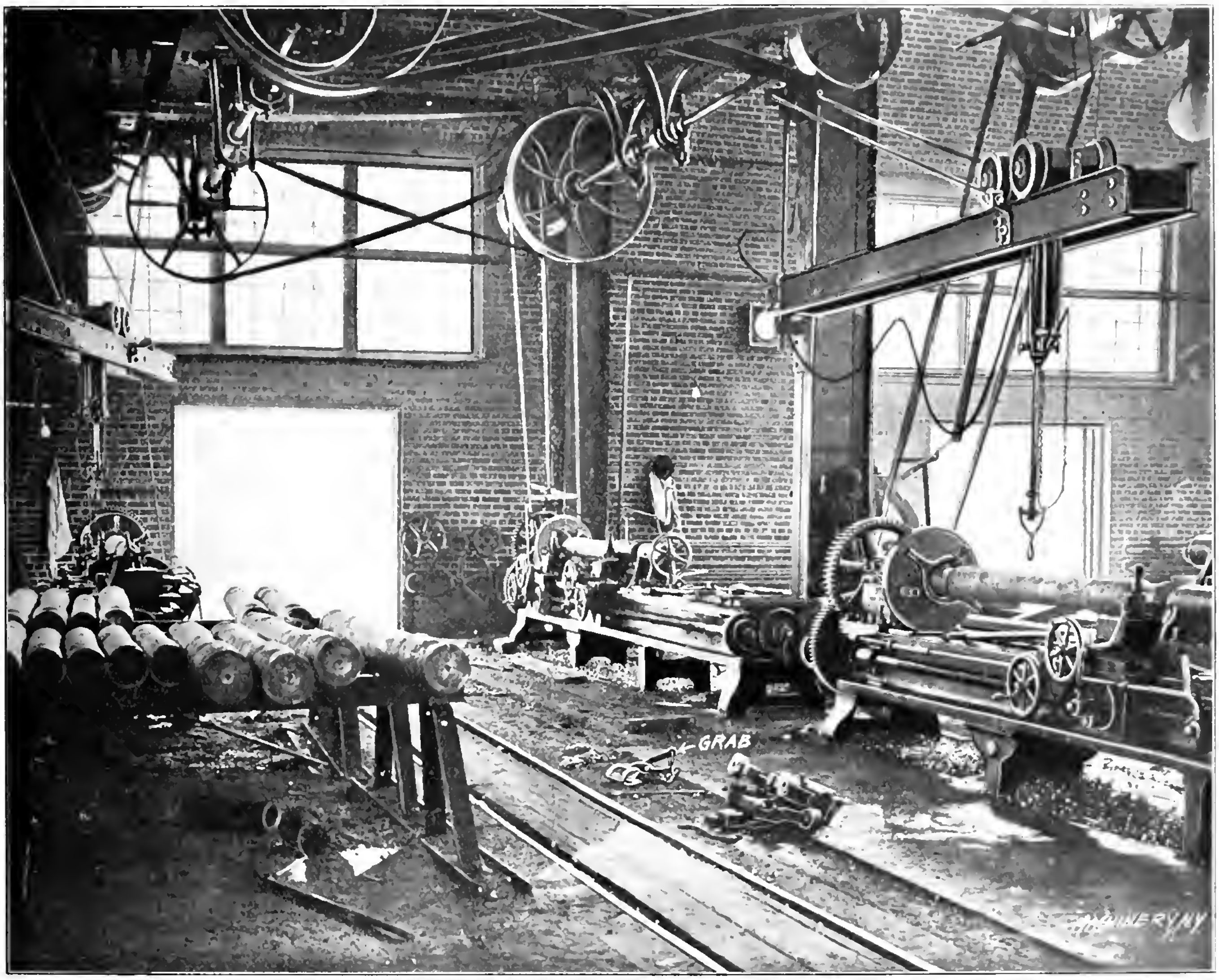


Fig. 1. Axle Turning Department, Shop No. 1.

Machine.—A minimum of obstacles to getting the work in and out; quick-setting driving dogs; quick and easy means of changing speeds and feeds; positive feed stops; a surplus of power.

Machine Auxiliaries—Tools and Gages.—Quick-acting hoists with fairly sensitive control; an abundance of cooling fluid for the tools; tools of efficient cutting angles; duplicate sets of tools for each machine; tools ground in tool-room to approved shapes; tools tempered properly; fixed points on machine for setting tools; limit gages for diameters; length and shoulder gages.

Shop Conditions.—Good light and good ventilation; plenty of work ahead of the machines; axles taken to the wheel press immediately.

Workmen.—A stable piece-work rate, or preferably some form of premium plan.

In order that the reader may make his own deductions and

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* Address: 1528 Arch Street, Philadelphia, Pa.

perhaps work out a routine better than will be given later, the notes will be presented in much the same order in which they were gathered.

The axle turning in shop No. 1, of which the axle department is shown in Fig. 1, seldom went farther than the roughing operation, the axles being forged at this plant, roughed to within 1/8 inch of the finished size and sold to car shops and railroad shops. This phase of the commercial production of axles is presented in connection with the methods of a car-building plant and a railroad shop in order to cover the subject fully. Many of the axles were of the P. R. R. 100,000-pound car type of steel. (See Fig. 2.) These differ from the M. C. B. standards in having the tapering center portion rough turned. This is the explanation of the use of the single axle lathe, which permits of the use of a taper attachment. The rest of the axles were of the M. C. B. 60,000-, 80,000-, or 100,000-pound type, or locomotive driver axles of 7-, 8-, 11-, 12-, or 14-inch diameters. On a single axle lathe, the carriages both feed in one direction and because of this, car axles have to be reversed when being turned. Axle lathes built by the Niles Tool Works of the Niles-Bement-Pond Co. are used exclusively in the shops where the notes were compiled, and are considered to fulfill the demands of the varied conditions successfully.

Methods in Shop No. 1.

The axles are picked up, from the horse at the left in Fig. 1 by means of the grab shown on the floor in the center of the space near the track, and swung around onto the lathe centers, white lead being used as a lubricant for the centers.

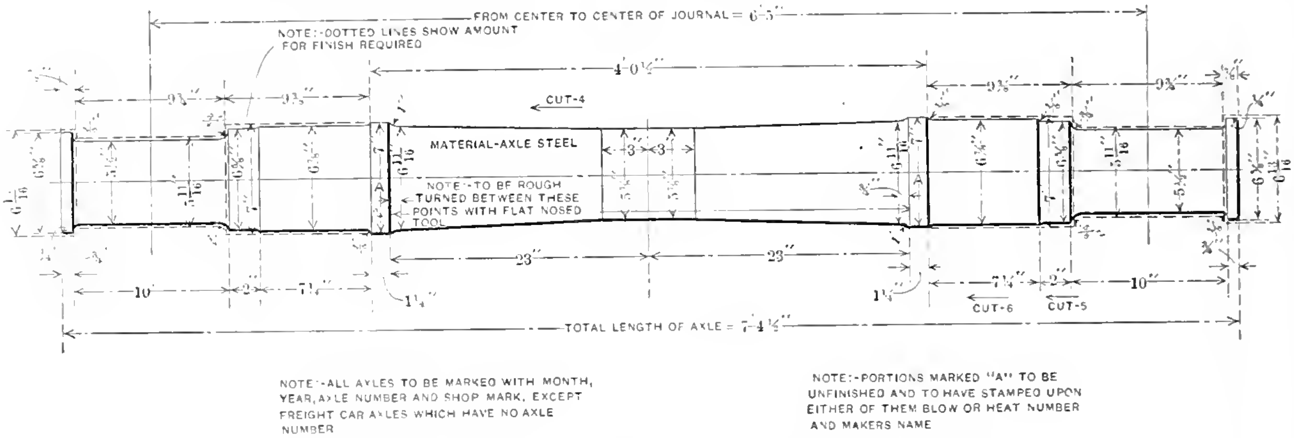


Fig. 2. Pennsylvania Railroad Co.'s 100,000-pound Car Axle, Journal 5 1-2 x 10 inches.

Tools.—The tools used were of high-duty steel, of course, 1 x 2-inch stock, ground as per Fig. 3. the radius *a* being the same as the large fillet of the journal bearing next the "leather bearing" (Fig. 5), and the radius *b* being the same as the small fillet next the collar.

The feed used was generally 1/16 inch per revolution and the average speed of cutting was 45 feet per minute; the tools stood up to this duty for five and six axles.

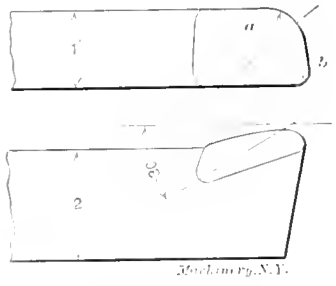


Fig. 3. Lathe Tool used in No. 1 Shop.

The consecutive tool movements are designated as "cut No. 1," etc. (See Figs. 4 and 5.) The tool setting for cut No. 1 was obtained from the machined collar diameter of the previous axle before removing the same from the lathe. The operator stands by the tool for the twelve or more revolutions necessary for this cut, and then feeds the tool in with the cross-slide (calipering for the journal diameter) on cut No. 2, then throws in the power feed for cut No. 3. His next move is to start cut No. 4 with the left-hand tool (an over-run on this cut can do no harm) and he has ample time to return to the right-hand end, throw out the power feed, and feed by hand to finish the journal length to gage. The tool is then set to turn the collar, after which the carriage is run as far towards the tailstock as possible, preparatory to turning the axle end-for-end in the machine. Cut No. 4 is finished by this time, and the axle is then reversed.

Cut No. 5, Fig. 5, is then started and then No. 6. Cut No. 5 is completed by the time No. 6 is started, so No. 7 and No. 8 follow, duplicating No. 2 and No. 3 on the other end. The operator now has two long cuts going at the same time and gets a breathing spell. When cut No. 6 is finished, cut No. 9 is started; then cut No. 10 follows No. 8, the operator staying with No. 10 until the correct length of the leather seat (sometimes called "leather bearing" or "dust-guard bearing") is obtained, allowing the tool on cut No. 9 to over-run and "cut wind." After throwing out the feed on cut No. 9, the right-hand tool is set to the collar diameter ready for the next axle.

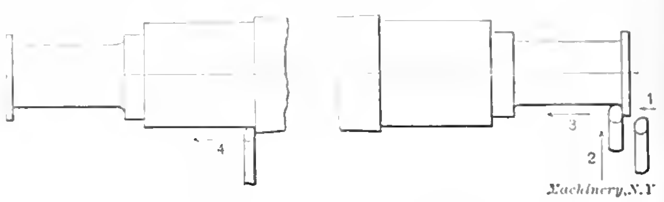


Fig. 4. Cuts taken with First Position of Axle.

Turning Pennsylvania Railroad 100,000-pound Car Axles.

The routine for turning the axles shown in Fig. 2 is simpler than for the M. C. B. type, as the lathes are designed with this particular work in view. Cuts Nos. 1, 2 and 3 are started in succession, and when cut No. 3 is well under way, cut No. 4 is started, using the forming slide (similar to the familiar taper attachment slide on engine lathes). Cuts Nos. 5 and 6 are taken consecutively and the axle is reversed when these cuts are completed.

Production in Shop No. 1.

The output from axle lathes in most shops is governed by the maximum average daily wage that the workmen believe will be permitted without bringing about reductions in the piece-work prices. This proposition holds true in this instance, as may be seen in the following figures; the number of axles per day times the piece price approximates $2.50 per day (the prevailing rate in shops in the immediate vicinity). The time taken to rough finish a 60,000-pound car axle, to within 1/8 inch of the finished size, was 20 to 22 minutes.

Kind and Size.	Number per Day.	Price Paid.
P. R. R. 100,000-lb., turned all over	9 to 10	25 cents.
M. C. B. 100,000-lb.	18 to 20	14 cents.
M. C. B. 80,000-lb.	22 to 24	
M. C. B. 60,000-lb.	25 to 28	10 cents.
Driver Axles.		
14-inch	5	50 cents.
11–12-inch	6 to 7	40 cents.
7–8-inch	9 to 10	25 cents.

NOTE.—The M. C. B. 100,000-pound axles were of very hard and tough steel, and would sometimes require two cuts although they were forged closer than the smaller axles.

Turning 60,000- and 80,000-pound Car Axles at Shop No. 2.

Axles at the car shop No. 2 were turned on a smaller Niles lathe designed for street-car axles, but still the output and quality compared favorably with the work done on the heavy machines at the railroad shop No. 3. The methods in vogue at shop No. 2 were very interesting, particularly because the operator handled his work unassisted, while the workmen in shop No. 3 would often get help from the laborers when putting the axles into the lathe. At shop No. 2 the axles were brought into the shop on high two-wheeled trucks, carrying two or three axles at a time, and rolled onto horses set at the height of the lathe centers. The arrangement of the machines and trestles is shown in the plan Fig. 6. Axles were picked up and swung into the lathe by means of the lever hoist (Fig. 7) arranged to traverse on the arm of a jib-crane of about 10-foot radius. It will be noticed that the work is put in the machine from the front side contrary to the usual practice where the crane is attached to the back of the lathe. When the axle was through the center head it was let down, or rather dropped unceremoniously onto the tool carriages.

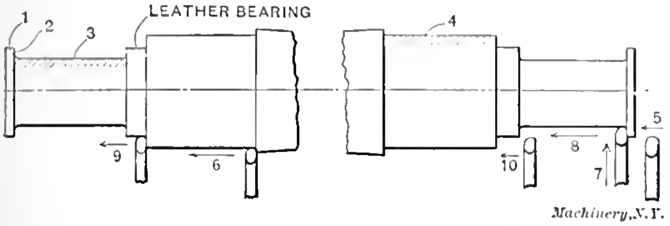


Fig. 5. Cuts taken with Axle Reversed in Lathe.

The left-hand end was raised to its center by means of a small lever, and the right-hand end to its center with the hoist.

Tools.—The tools used were similar to those in use in the railroad shop (see Fig. 11). The cutting angles were 27 degrees for roughing and 20 degrees for finishing. While the axles were on the horses, they were gaged for total length as sometimes the over-length would amount to ½ inch. This extra length was left on the collars, making the distance from shoulder to shoulder the same on all axles. This distance being uniform, the wheels were easily and quickly pressed on to the proper point in relation to the journals, these shoulders serving as reference points for gaging the wheel-pressing.

Feeds.—Feeds of 1/16 inch or 1/12 inch were used for roughing and 1/8 inch for finishing. Following is the order and character of the cuts:

Cut No. 1, *Fig.* 8.—The collar is roughed with right-hand tool. This tool feeds about 2 inches before the operator can return from starting the left-hand tool on the duplicate cut on the other collar. Note.—All right-hand cuts are duplicated on the left-hand end.

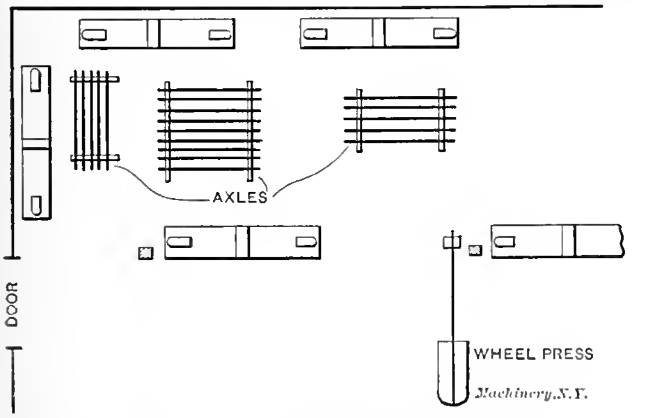


Fig. 6. Arrangement of Machines, Shop No. 2.

Cut No. 2, *Fig.* 8.—The tool is forced into the axle cutting down inside of collar, making allowance for over-length, deep enough to get under the scale where there is the least stock; then the power feed is thrown in.

Cut No. 3, *Fig.* 8.—The right-hand tool is fed by power until the journal length is obtained, using gage as shown.

Cut No. 4, *Fig.* 8.—The right-hand tool makes second cut on journal. The tool is fed in to within 1/32 inch of finished diameter and power feed thrown in.

Cut No. 5, *Fig.* 8.—Roughing cut on leather seat to gage.

Cut No. 6, *Fig.* 8.—Only cut on wheel fit, fine feed, to gage.

Cut No. 7, *Fig.* 8.—Outer edge of collar is chamfered.

Cut No. 8, *Fig.* 8.—Operator puts in finishing tool and finishes cut on collar.

Cut No. 9, *Fig.* 8.—Cutting down inside of collar, finishes the fillet.

Cut No. 10, *Fig.* 8.—Finishing cut on journal, using the other edge of the gage for the fillets.

Cut No. 11, *Fig.* 8.—Operator slightly tapers the wheel fit for about ½ inch to facilitate entrance into the hub of the wheel when pressing on.

Burnishing, Fig. 9.—The finishing tool is taken out and the burnishing roller is put in. This roller is of hardened steel, smoothly polished, and is forced against the axle sufficiently to roll down the high tool marks, leaving a smooth glazed surface. The feed is about ⅛ inch per revolution.

The rolling tools are then taken out and the left-hand roughing tool is set from the collar, ready for the next axle.

Limits.—The axles are turned to within 1/32 inch of the diameter on the journal and to within 0.01 inch of the diameter on the wheel fit. These limits may not seem very rigid for a turning operation, but the workmen consider them so. That they are close enough is self-evident from the number of wheels and axles in use and the uniformity in the reading of the pressure gage when the wheels are being pressed on.

Production.—The above routine of operations enables a 60,000-pound car axle to be put into the lathe, roughed, finished and burnished, and taken out in 45 minutes. This time was made on very tough, hard Carnegie steel. The time on 80,000-pound axles was 60 minutes.

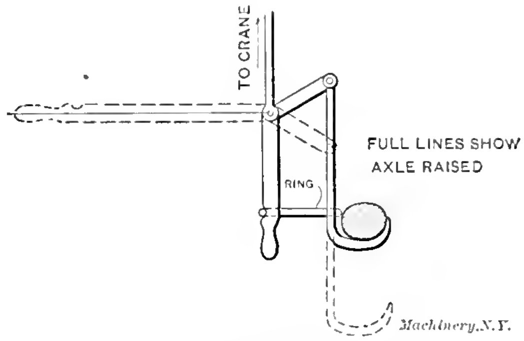


Fig. 7. Lever Hoist for Axle Lathe.

Notes from the Railroad Wheel Shop No. 3.

The first impression was that of the cramped quarters and the poor arrangement of the lathes, car-wheel borers and the wheel-press relative to one another. Then the power was at all times deficient and sometimes almost nil, as the line-shafts were driven by a vertical slide-valve engine whose source of steam supply was at a remote point and inadequate. This condition of the power affected the time per axle greatly, as the operators could seldom carry the amount of feed they wanted, because the amount of stock on the journals varied from ¼ inch to ¾ inch. The axles are centered from the wheel-fit.

The foreman of the wheel shop was a broad and considerate man and well liked by the workmen. This feeling of good will had a great deal to do with keeping the average output up to a mark well above the average in the majority of wheel shops of other roads.

The routine of operations will be taken up briefly, as it followed that of shop No. 2 excepting the order in which some of the cuts were taken and the type of gage used.

Tools.—The roughing and finishing tools were similar to those used in shop No. 2 as shown in Fig. 11. Fig. 10 shows the gage used, no attention being paid to the variation in the length of the axles.

Speeds.—The speeds of cutting averaged 45 feet on the wheel-fit and 35 feet on the journal bearing; the belt remaining on one step of the cone for all cuts. The Niles lathe since has been changed so that a speed correct for the various diameters can be obtained without loss of time. The power required for axle turning justifies a large motor to each tool,

and the ease of making speed changes would naturally bring about an increased output were the wages of the workmen increased by a fair premium plan.

Feeds.—A feed of 1/12 inch was generally used for roughing, and 1/8 inch for finishing. A coarser feed would have been used for finishing but for the difficulty of grinding a sufficient length of straight edge on the tool. This objection would not have held if the tools had been ground to shape in the tool-room.

Routine.—In the following description, the right-hand cuts only will be mentioned. The left-hand cuts follow each right-hand cut in turn. The first roughing cut is taken on the collar and as the leather seat is the same diameter, the operator then moves the tool over and starts this cut, avoiding the calipering necessary in the routine of shop No. 2. The third cut roughs the wheel-fit.

The fourth cut finishes the wheel-fit, the tool not being changed but simply knocked around to present a scraping edge to the work, and the feed changed to 1/8 inch. The journal is then roughed with a 1/12-inch feed. For the sixth or finishing cut on the journal the operator changes to the finishing tool and 1/8-inch feed. This cut removes about 1/64 inch on a side. The seventh and eighth cuts finish the collar and the leather seat. The collar edges are then chamfered. The rolling operation would naturally follow without removing the axle from the machine, but at the time of the writer's visit the journals were burnished in another lathe involving a second handling and taking about ten minutes time of another man's time, besides the time of handling. Since then, however, the burnishing has been done in the same lathe and less than five minutes is added to the time of roughing and finishing. The burnishing roller, shown in Fig. 9, is about 4 inches diameter and of 1¼ inch face. This roller must be very hard, yet not allowed to go out of round in hardening, and must be polished like a mirror, if true, round journals would be obtained.

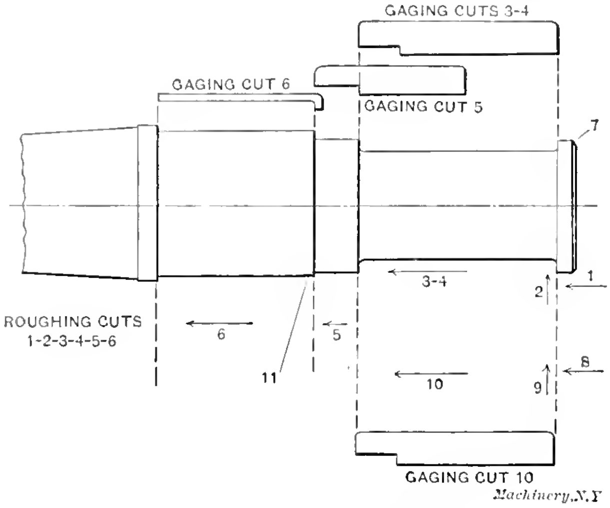


Fig. 8. Order of Axle Cuts in Shop No. 2.

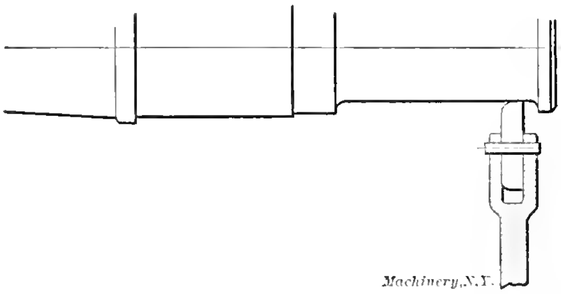


Fig. 9. Burnishing Tool.

Production in Shop No. 3.

To get a line on the production of the lathes was somewhat difficult, as steel, and wrought iron axles were turned in the same lots. Some iron axles were much more difficult to turn than those of steel on account of seams, though the output of iron axles was somewhat greater. Often iron axles would be three-fourths finished and counted as finished, when they were thrown out as defective; also the effective speed was greater on iron axles. The belt was on the same step of the cone for iron axles as for steel, but the resistance to cutting was less and the speed of the line shaft would not drop so much when all the lathes had heavy cuts going at the same time. The foreman of the shop gave the output that could be obtained by crowding, if the workmen felt sure that the piece-price would not be cut, as follows:

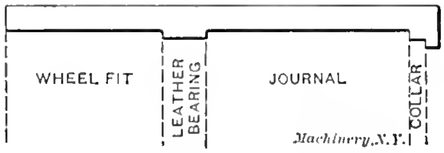


Fig. 10. Gage used in Shop No. 3.

Axle.	Daily Average.	Maximum per Day.	Piece-price.
60,000-lb.—			
Iron	20	24	20 cents.
Steel	16	20	25 cents.
80,000-lb.—			
Iron	16	20	25 cents.
Steel	14	18	35 cents.

These figures were for the roughing and finishing operations. The figures on record from one lathe for a month's run on 80,000-pound axles, more than half of which were of steel, were for 24 ten-hour days—a total of 315, or a daily average of 13. The maximum per day for steel, was 14 and for iron, 18. On one day (writer's observation) on 60,000-pound axles, the first lathe turned 17; the second, 18, and the third, 19, in a ten-hour run.

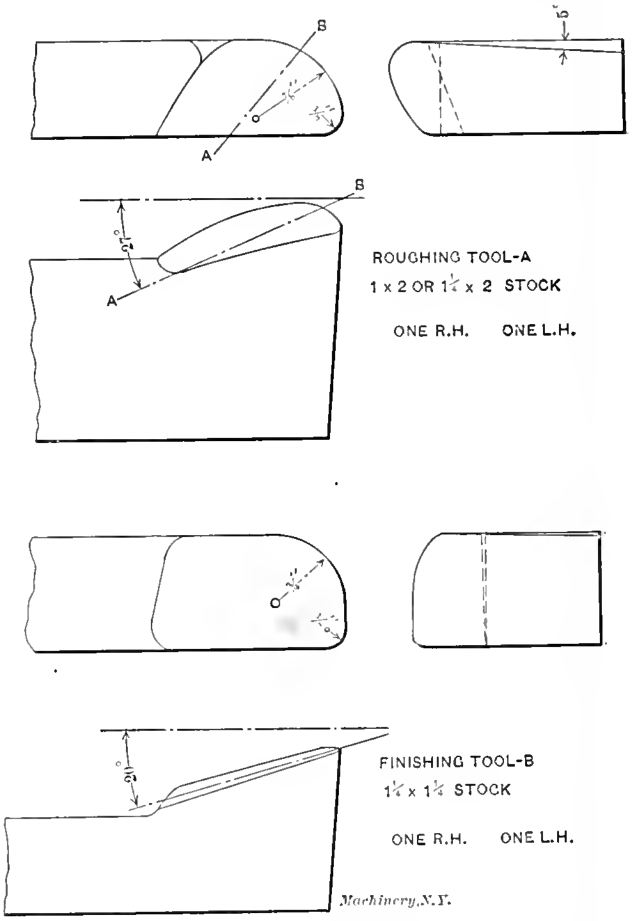


Fig. 11. Tool Shapes A and B.

The time per axle in shops No. 2 and No. 3 is shown comparatively by the following:

	Shop No. 2.	Shop No. 3.
Steel, 60,000-lb.	45 minutes.	32 minutes.
Steel, 80,000-lb.	60 minutes.	48 minutes.

The difference was in a measure due to the less rigid inspection in the railroad shop No. 3 and to a higher wage rate per day.

Recommended Routine.

From the study of the methods of the three shops the following routine was evolved, which has been proven out a number of times, to the writer's knowledge, by a demonstrator. The favoring conditions as presented at the beginning of this paper, should rule if the time is to be approached. This routine is for a double axle lathe and the right-hand cuts described should be duplicated at once with the left-hand tool unless otherwise noted.

Fig. 14 shows a standard M. C. B. axle with a 5 x 9-inch journal with the finished sizes and maximum amount of stock allowed on the different diameters.

Tools.—The tools must be of high duty steel and forged and treated to get a maximum of endurance. The shapes and angles shown in Fig. 11 are recommended as being durable and economical in the power consumption.

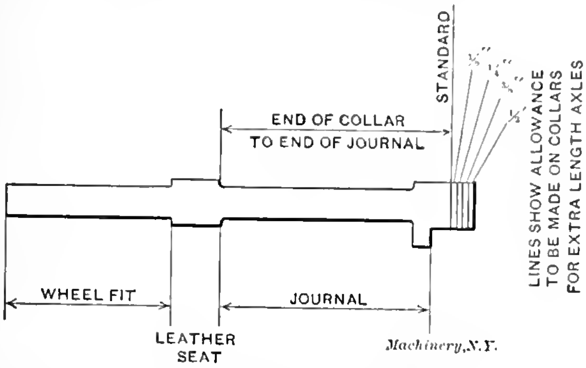


Fig. 12. Approved Form of Gage.

Speeds.—With the above tools and sufficient power, a cutting speed of 45 to 60 feet per minute can be maintained and the tools will not require grinding oftener than every fifth or sixth axle.

Feeds.—When there is less than ⅜-inch stock on a side, ¼-inch feed can be carried easily; when more than ⅜ inch of stock on a side, use 1/12-inch feed.

Gages.—An over-all length gage should be provided. This can be of ¼-inch square steel rod, one end formed with a hook and the other end marked with lines showing the standard length and the surplus lengths by ⅛ inch up to ½ inch.

A gage to be used on the lathe is shown in Fig. 12. This gage combines the features of the gages used in shops No. 2 and No. 3.

The axles should be brought into the shop and placed on horses at a height 3 or 4 inches lower than the lathe centers. The center holes should be lubricated with white lead or heavy grease. Axles should be gaged for length noting the over-length. The form of scissors grab used in shop No. 1 is recommended, as the axle cannot slip but nevertheless it can be released instantly. The driver-dog should be hanging on the nose of the right-hand tailstock ready to slip on the axle when in place. The axles should be gripped at about the same place every time so that they can be placed on centers easily. The hoist can then be swung back out of the way and be ready to take the axle out of the machine without searching for the point at which the axle balances.

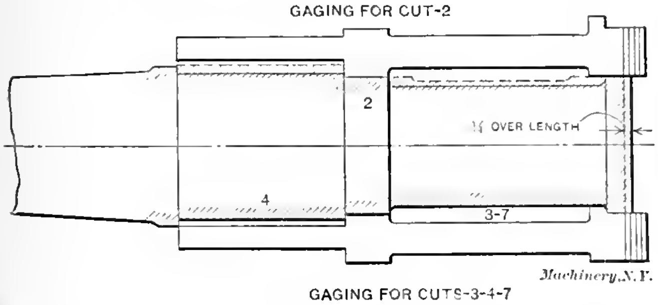


Fig. 13. Illustrating Use of Gage.

Cuts.—As this routine contemplates entering the axles from the rear, the setting for the roughing tool for the first cut on the collar can be obtained by placing a piece of cardboard between the tool and the finished collar before removing an axle from the lathe. For references, see Figs. 13 and 14.

Cut No. 1.—Right-hand collar; tool *A*, Fig. 11; throw in feed right-hand and left-hand; throw out feed right-hand.

Cut No. 2.—Tool *A* on leather seat, right-hand; run the tool over by hand and start the feed; throw out feed on left-hand cut No. 1. Start feed on second cut left-hand; use gage as shown on right-hand cut No. 2, Fig. 13, and throw out feed; same with left-hand tool.

Cut No. 3. Set tool *A* on the journal bearing; feed tool in to within 1/16 inch of finish size, gage as shown; throw in power feed; same with left-hand tool; gage journal length and throw out feed right-hand; same with left-hand.

Cut No. 4. Set tool *A* on the wheel-fit; start cut and caliper; same for left-hand; gage, and throw out feed; same for left-hand. If two cuts are necessary use ⅛-inch feed for both cuts.

Cut No. 5. Set finishing tool *B* on the collar; chamfer outer edge and throw in feed (¼ inch); same for left-hand; throw out feed right-hand.

Cut No. 6. Set tool *B* on the leather seat; change to ⅛ inch feed; run carriage over and start feed; throw out left-hand tool on cut No. 5; gage and throw out feed right-hand; start left-hand tool on cut No. 6; gage and throw out feed left-hand.

Cut No. 7. Set tool *B* on the journal; change feed to ¼ inch; cut down inside of collar; caliper and throw in feed; same with left-hand tool; gage and throw out feed right-hand; same left-hand; finish journal length feeding by hand; same left-hand.

Cut No. 8.—Taper the entering end of wheel-fit, feeding by hand; same left-hand.

Burnishing.—Change feed to ⅛ inch; put in roller right-hand; force roller against journal bearing until desired finish is obtained; throw in power feed; same with left-hand roller; throw out feed right-hand; throw out feed left-hand; roll large fillet right-hand; same left-hand, feeding by hand.

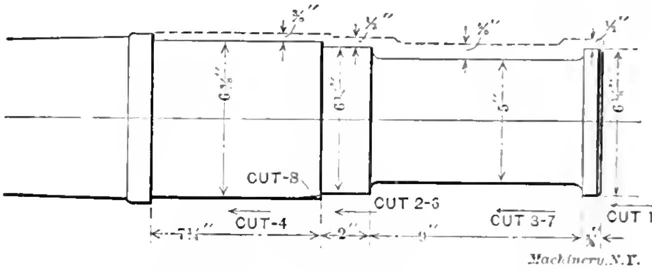


Fig. 14. Master Car Builders Axle, 5 x 9 inch Journal, showing amount of Stock to be Removed.

Change to roughing tools; set to the collar diameter with cardboard between tool and collar; hang the driving dog on the tailstock nose; put sling on axle; draw back the right-hand center; hoist axle clear; run the hoist back on crane arm; swing crane back; lower axle.

By the above routine an axle can be finished with some lost time in from 25 to 30 minutes, and a maximum for a day of ten hours would be from 18 to 20 axles.

It has been stated to the writer, by a reliable observer, that an operator on a Niles motor-driven double axle lathe in the Angus shops of the Canadian Pacific R.R., when "real mad" and on his mettle, had roughed, finished and burnished a 100,000-pound car axle of steel, in 25 minutes, counting from the time of picking up the axle to putting it back on the horse. This was much quicker than the least conservative estimate by the method described, and has been taken as evidence that the writer's estimate is within reason, given that the operator is sufficiently remunerated for the effort, agility and interest required.

* * *

In a recent issue of *Engineering* it is stated that an engine built in 1808, or over a hundred years ago, for a British firm, by Messrs. G. Rennie & Co., of Greenwich, England, has just failed by the breaking of the crank-shaft. The company which built the engine has been called upon to make repairs, and after an examination of the rest of the engine, it was found to be in excellent condition, so that it has been concluded to set it to work again as soon as the repairs have been completed.

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—2.

FRAMING AND GENERAL DESIGN OF CRABS.

R. B. BROWN.

The great difference in appearance of electric crabs lies chiefly in the design of the framing. Some very different opinions seem to exist on the primary question of material, for while certain makers have standard crabs with steel frames for all sizes, others manufacture crabs with cast-iron frames up to a considerable weight. Both types are undoubtedly substantial enough, but there is a limit to their adoption. One of the principal objects in designing an electric crab should be to make the various component parts as accessible as possible for renewal and repair, and in this direction the steel frames, undoubtedly, have the advantage. Another point in favor of steel frames is their lightness, and the consequent saving of material in the girders. Perhaps, in the case of small crabs, say up to five tons, cast-iron sides may be cheapest, if large quantities are being made, but for larger sizes the steel frames are certainly more advantageous to manufacturer and purchaser alike.

Frames made up of double steel plates, or steel plates framed with angles, are much used, but although they make a substantial crab, nothing special can be said in their favor, and they present the same disadvantage as cast-iron sides, in having several closed bearings.

Fig. 4 shows the crab for a 20-ton, three-motor crane with a steel frame of modern design and similar to which large quantities have been made with satisfactory results. Fig. 5 illustrates the same crab, slightly altered to receive an auxiliary barrel for light loads, as sometimes found advantageous. The crab for a four-motor crane is usually of similar construction to the one just referred to, the auxiliary barrel being ar-

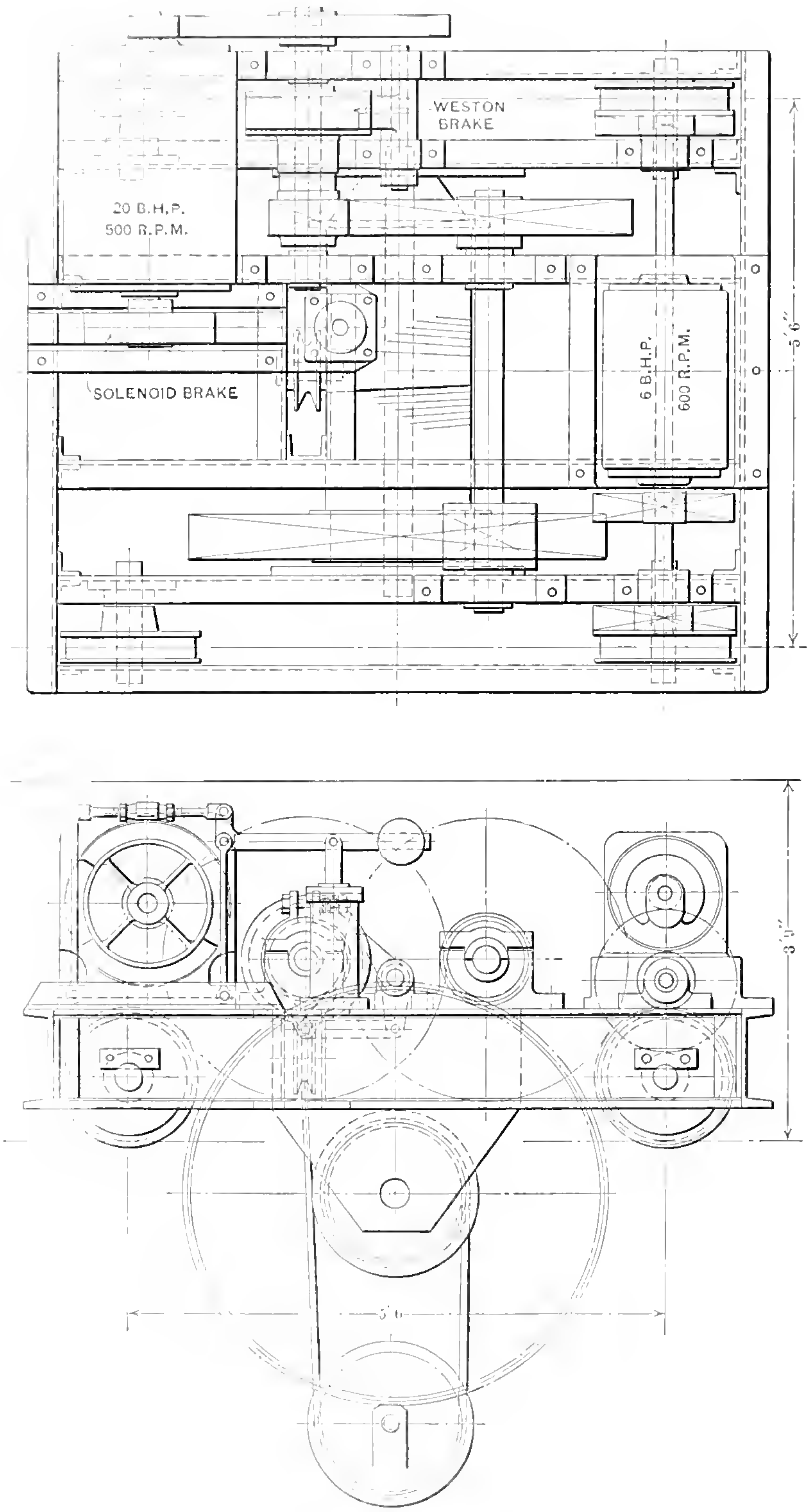


Fig. 4. Crab for 20-ton Three-motor Electric Overhead Crane with Steel Frame.

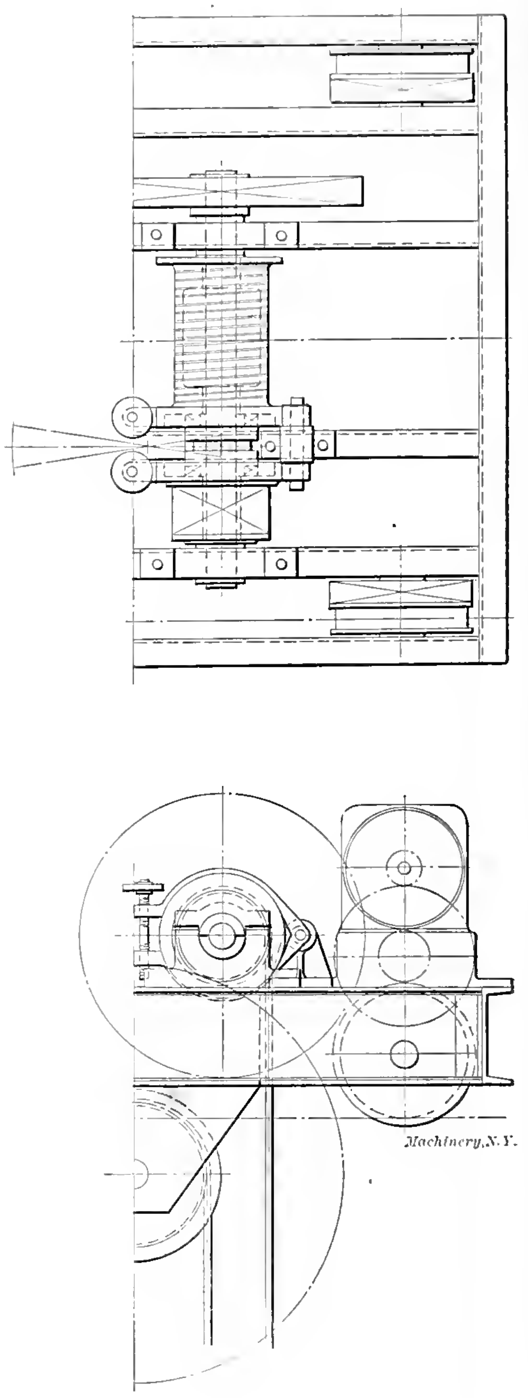
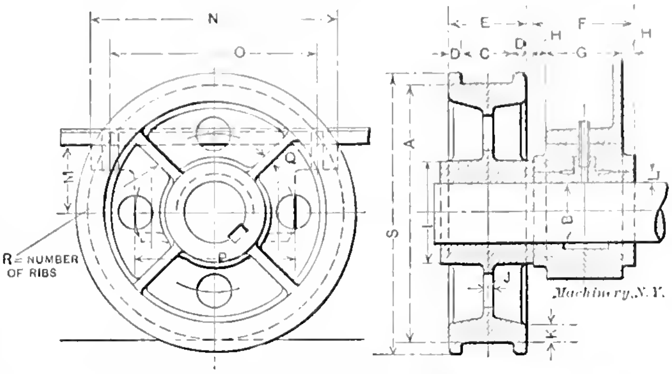


Fig. 5. Crab, Similar to the one shown in Fig. 4, slightly altered to accommodate Auxiliary Barrel for Light Loads.

ranged to suit the framing of the crab. As will be seen from Figs. 4 and 5, all the bearings in crabs of this type are adjustable, except those for the barrels and perhaps the running wheels, which are bushed; since these latter have slow running shafts, and ample bearing surface can be provided, there is no necessity for adjustable bearings. In the designs shown, it will be seen that the main barrel shaft is so situated that by jacking up the crab it can be drawn out clear of the rails, and the barrel and wheel lowered direct to the ground for rebushing or other attention.

Owing to the variety of designs of crab frames in general use, it is practically impossible to give any definite calculations or details which would be of general value. In the case of small crabs, the smallest convenient sections which can be used are generally strong enough to resist all the strains with a large margin of safety, but with the larger sizes, the strength of the sections should be calculated and the stress limited to 4½ or 5 tons per square inch, in order to avoid possible deflection and subsequent binding of shafts and attendant disadvantages.

TABLE III DIMENSIONS OF RUNNERS, AXLES AND BEARINGS.

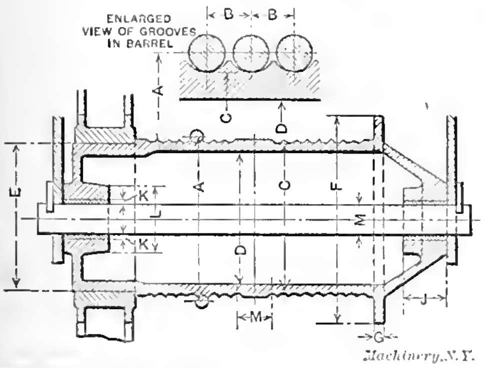


Size of Crane, tons.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	Material
5- 7½	12	3¼	2¼	⅝	3¾	4½	3½	½	6	⅝	¾	5/16	3	14½	11¼	8½	⅝	4	13½	Cast iron
10-15	15	3¾	2¼	¾	4	4½	3½	½	6	⅝	¾	⅜	3½	15½	12½	9½	⅝	4	16½	Cast steel
20-25	15	4	2¾	¾	4¼	5	3½	¾	6¾	⅝	⅞	⅜	4	16½	13½	10¼	⅝	4	16½	Cast steel
30-40	18	5¼	2¾	⅞	4½	5½	4	¾	8¾	¾	1	7/16	5	20	16¾	13¼	¾	5	20	Cast steel
50-60	21	5¾	2¾	1	4¾	6	4	1	9¼	⅞	1¼	½	6	21¼	17½	14½	⅞	5	23	Cast steel

Running Wheels and Axles.

The first question to be considered concerning the crab running wheels is the material, and since they are subject to considerable wear, their durability ought to be considered. For the best class of work, cast-iron runners should not be used for cranes above 10 tons; otherwise the tread may wear quickly, due to the pressure. For crabs below this size, however, cast-iron has been found quite suitable. Crab running wheels should always be made as large in diameter as practicable, and similarly the axles as small as possible, in order to reduce the tractive resistance and consequent current consumption. Table III gives the principal dimensions of runners as usually made, and also the sizes of axles and bearings, which have been calculated as follows:

TABLE IV. DIMENSIONS OF LIFTING BARRELS.



Load, tons.	Number of Ropes.	Size, Circumference, inches.	A	B	C	D	E	F	G	H	J	K	L	M
3	2	1¾	12	⅝	11.45	10½	9¾	12½	⅝	2½	3½	5/16	5	2½
5	2	2¼	15	¾	14.30	13	12¼	15¼	¾	2¾	3½	5/16	5½	2½
7.5	4	2	12	11/16	11.37	10½	9¾	12¾	⅝	2¼	3½	5/16	[illegible]	2½
10	4	2¼	15	¾	14.30	12¾	12¾	15¾	¾	2¾	3½	5/16	5½	2½
15	4	2¾	16½	1	15.62	14½	13¾	18½	[illegible]	3¼	4	[illegible]	6¼	3
20	4	3¼	18	1⅛	17.00	15¼	15¼	19½	1	3¼	4	[illegible]	6½	3
25	4	3½	21	1¼	19.90	18	17½	22¼	1⅛	4	4½	7/16	8	4
30	4	4	24	1⅜	22.70	20½	20	25½	1¼	4¼	4½	7/16	8¾	4
40	4	4½	27	1½	25.50	23	22½	28	1½	5	5	7/16	9½	4½
40	4	5	30	1¾	28.40	30	29½	32	1½	5½	5½	7/16	10	4½

The axles are subject to combined bending and twisting, the former being due to the overhanging distance, which is generally taken from the center of the wheel to the center of the bearing, to ensure stiffness, and the latter from the resistance to traction at the tread of the wheel. For example, it will be seen from Table III that the runner for a 20-ton traveler is 15 inches in diameter; the wheel pressure will be about 6½ tons. Taking the maximum possible resistance to traction at 90 pounds per ton, we have the torsional moment

$$M_t = \frac{90 \times 6.5 \times 7.5}{2,240} = 1.95 \text{ inch-ton.}$$

The maximum effective overhang may be taken at 5 inches, and consequently the bending moment

$$M_b = 6.5 \times 5 = 32.5 \text{ inch-tons.}$$

The equivalent bending moment M_e may be found by the following common formulas:

$$M_e = \tfrac{1}{2} M_b + \tfrac{1}{2}\sqrt{M_b^2 + M_t^2} = 16.25 + \tfrac{1}{2}\sqrt{32.5^2 + 1.95^2} = 16.25 + 16.3 = 32.55 \text{ inch-tons.}$$

Assuming a stress on the material of 5 tons per square inch, the section modulus is

$$\frac{32.55}{5} = 6.51,$$

to which a diameter of 4 inches corresponds.

The working strain in the axles may be increased to 5.5 tons per square inch in the case of crabs of 25 tons and upwards, but it is advisable not to exceed this amount, because even a slight deflection will cause the shaft to bind in the bearings and consequently absorb more power.

After determining the diameter of the axles, sufficient length of journal should be allowed so that the pressure on the bearings is not more than 900 pounds per square inch of projected area. The bearings are usually of cast iron, with a brass lining on the pressure side and fitted with a light cast-iron cap beneath. It is of the greatest importance that these journals should be fitted with proper lubricators, since this provision will lead directly to a reduced current consumption. For crabs of 40 tons and upwards a self-lubricating bearing, as shown in Fig. 6, although more expensive, has been found advantageous. This bearing is designed on the same lines as these which are sometimes fitted to the main traveling wheels. Roller bearings are also occasionally used for these axles.

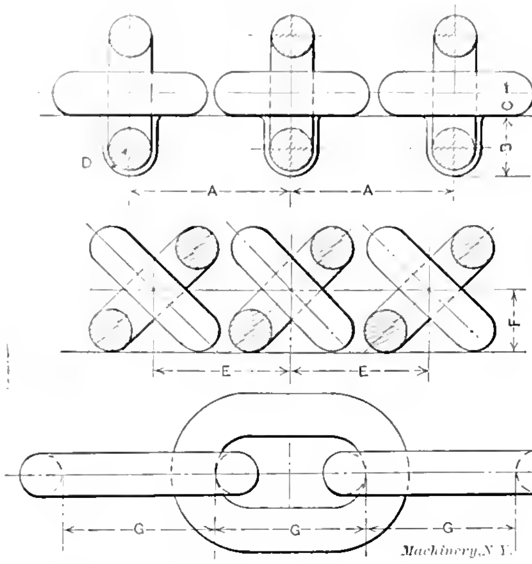
With crabs of 60 tons and upwards it is generally found more economical and convenient to employ short axles supported by a bearing on either side. By this means much smaller journals can be used, and at the same time the gearing can be more compactly arranged since there are no cross axles to clear. One wheel on each side has to be geared with this arrangement.

Barrels, Ropes, and Chains.

Lifting barrels are invariably made of cast iron, cast blank for rope, and the grooves turned out to suit. For chain falls

the grooves are generally cast in. Practically all modern travelers are now fitted with wire rope falls, the alternatives being ordinary chain and pitch link of Gallé chain, the latter being used mostly on the European continent, or for special cranes. Table IV gives particulars of steel ropes suitable for lifting purposes and drums or barrels for same. The factor of safety usually adopted for lifting rope is eight, which allows a good margin of strength even after a few strands have broken. The life and value of the rope depends to a great extent on the size of the barrel and pulleys around which it has to pass. Some rope makers recommend a barrel diameter of six and a half times the circumference of the rope. This is quite suitable and convenient for cranes using ropes under 3½ inches circumference, but above this size it has been found satisfactory to make the barrel and pulleys from five and a half to six times the circumference.

TABLE V. DIMENSIONS OF CRANE CHAINS.



Size, inches	Load, tons.	Weight per Foot, pounds.	A	B	C	D	E	F	G
3/8	1	1.5	1 7/16	17/32	3/16	1/4	1 1/8	1/2	1
7/16	1.3	2.0	1 5/8	19/32	7/32	9/32	1 9/32	37/64	1 1/8
1/2	1.7	2.7	1 13/16	21/32	1/4	5/16	1 1/2	11/16	1 3/8
9/16	2.1	3.3	2 1/16	3/4	9/32	11/32	1 5/8	3/4	1 9/16
5/8	2.7	4.1	2 1/4	13/16	5/16	3/8	1 25/32	53/64	1 5/8
11/16	3.3	4.8	2 1/2	29/32	11/32	13/32	1 15/16	29/32	1 7/8
3/4	3.9	5.9	2 11/16	31/32	3/8	7/16	2 1/8	1	2 1/8
13/16	4.6	6.8	2 7/8	1 1/32	13/32	15/32	2 1/4	1 1/16	2 1/4
7/8	5.4	8.1	3 1/16	1 3/32	7/16	1/2	2 1/2	1 3/16	2 3/8
15/16	6.2	9.0	3 1/4	1 5/32	15/32	17/32	2 5/8	1 1/4	2 1/2
1	7.0	10.3	3 1/2	1 1/4	1/2	9/16	2 3/4	1 5/16	2 5/8
1 1/16	8.0	11.3	3 5/8	1 9/32	17/32	19/32	2 15/16	1 13/32	2 9/16
1 1/8	8.9	12.5	3 3/4	1 5/16	9/16	5/8	3 1/16	1 15/32	2 15/16
1 3/16	9.9	14.3	4	1 13/32	19/32	21/32	3 1/4	1 9/16	3 5/16
1 1/4	10.9	15.8	4 1/4	1 1/2	5/8	11/16	3 7/16	1 21/32	3 3/8

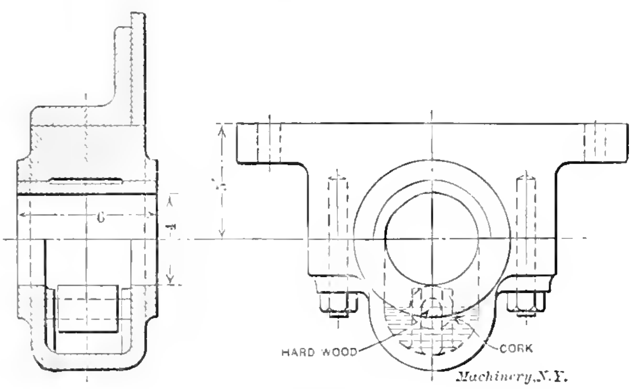


Fig. 6. Self-lubricating Bearing for Shafts in Crabs of 40 ton Capacity and larger.

Another point of importance is the spacing of the ropes or centers of the grooves. For all sizes up to 4 inches circumference, it is necessary to allow one-eighth inch between the ropes, but above that size three-sixteenths inch gap should be provided, if possible. This allowance is due to the fact that the ropes flatten out slightly under the load, and if there is not sufficient side clearance they grind against each other and are likely to break some of the strands.

When chain is used, it is of the type known as short link crane chain, having a breaking strain of about 23 tons per square inch, and is usually stressed from four and a half to five tons per square inch under the working load. Table V gives working loads and dimensions of standard crane chains, and shows the spacing and leading dimensions of suitable chain barrels. The length of the lifting barrel is a quantity which naturally depends on the height of lift, but when designing a standard traveler, it is advisable to allow for sufficient rope to give a vertical lift of thirty feet with two spare coils on either end, this being the maximum height required under ordinary conditions.

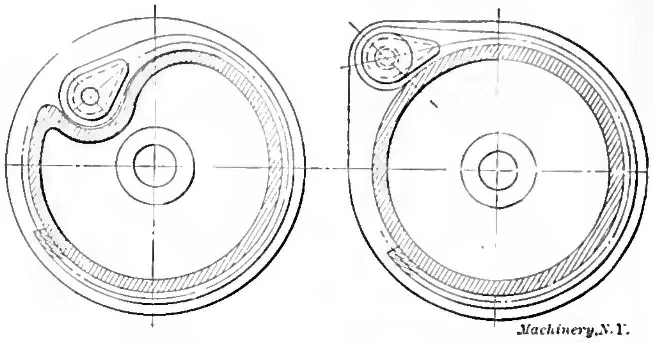


Fig. 7. Two Methods in use for Anchoring the Lifting Ropes.

Chain falls should be avoided for longer lifts than twenty feet, otherwise the barrels become inconveniently large. The principal reason for providing the spare coils referred to is to reduce the strain on the anchors, which, however, should always be strong enough to take the full load. Several methods of anchoring the rope are in use, of which probably the two methods shown in Fig. 7 are the best. In either case, a solid cast iron eye is woven into the end of the rope, and a hole drilled in the eye for a turned pin or stud. This makes a very substantial connection.

It has become universal practice to so arrange the lifting ropes or chains that the load will be lifted centrally and thereby distribute the load equally over each girder. This arrangement is necessary for all cranes above five or seven tons, from which size up to fifty tons the loads should be lifted on four parts of rope, two parts being coiled in right- and left-hand grooves on the barrel, the other end passing around a compensating pulley, as will be seen by referring to Fig. 4. This pulley need not be more in diameter than about twice the circumference of the rope, since it is not subjected to any motion. For cranes up to and including three tons the load should be lifted on a single fall, while for loads of five, six, and seven tons it is more convenient to employ two parts, one coiling on the barrel. There is practically no advantage in providing a central lift for these light cranes, since it is generally impracticable to make the girders light enough to give an ordinary working strain and the little extra weight that will be thrown on one girder will not destroy the economy of construction.

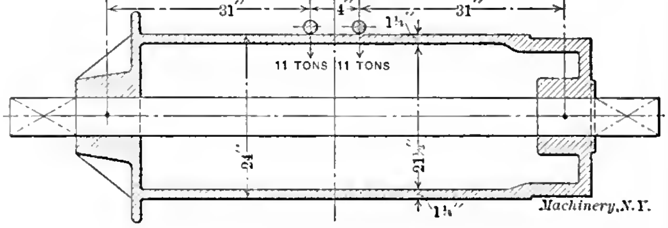


Fig. 8. Barrel for a 40-ton Overhead Electric Crane.

The barrels used for ordinary overhead travelers seldom exceed 30 inches in diameter, and up to this size the method shown in Table IV of fixing the barrel to the wheel has been found to be the cheapest and is almost universally adopted. The thickness of metal in the barrel should be sufficient to resist the maximum bending which occurs when the load is

in the highest position and the ropes are in the center. If the stress from bending is not greater than about 0.75 ton per square inch there will be an ample margin of strength left to safely provide for the compression from the ropes themselves. For example take a forty-ton crane barrel as shown in Fig. 8. The maximum span over which bending takes place is from center to center of the bearings, and the maximum bending moment $M_b = 11 \times 31 = 341$ inch-tons.

$$\text{Section modulus of annulus} = \frac{\pi}{4} \times \frac{R^4 - r^4}{R} = \frac{\pi(12^4 - 10.75^4)}{4 \times 12}$$
$= 483.$

$$\text{Stress} = \frac{341}{483} = 0.7 \text{ ton per square inch.}$$

The size of the barrel shaft should be made sufficient to take the bending from the center of the support to the center of the bearing at a stress of about 5 tons per square inch, and the length of the bearing should be such that the pressure on same is about 900 pounds per square inch.

* * *

FLOATING CHUCK FOR FACING GEAR BLANKS.

As we have before remarked, there is much more to the problem of obtaining accurate gears than is involved in careful attention to the cutting operation itself. For instance, having the finished teeth run true involves more than simply having a true running work arbor, especially if the blanks are mounted on the arbor in gangs and are cut several at a time. Under such conditions, it is very necessary to have the blanks accurately faced in parallel planes, exactly normal to the axis of the central hole. If this matter is disregarded, the blanks will spring the gang arbor very much out of true when tightened on it.

Various methods are followed to produce parallel faces. One of these, used in the shops of the Cincinnati Shaper Co., employs a special tool slide with roughing and finishing facing tools, arranged to operate on both sides of the blank, which is keyed to a drive arbor. This method was described in connection with the builders' key-seating attachment in the new tools department of the September, 1908 issue of MACHINERY. Other methods that the writer has seen tried, involve the grinding of the sides of the blanks, which are held on magnetic chucks in special face grinding machines. This operation is not done for the sake of any fineness of finish or accuracy in the thickness of the finished product, but simply for the purpose of obtaining accurate gear cutting in the case of blanks mounted in gangs.

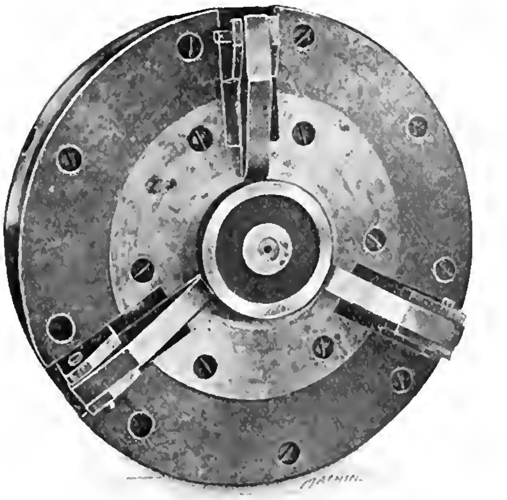


Fig. 1. A Chuck for Facing Gear Blanks, which holds them without Side Strain or Distortion.

One of the most ingenious and satisfactory solutions of this problem that has come to our notice is that followed in the shop of the Fellows Gear Shaper Co., of Springfield, Vt., where it is used particularly for finishing blanks such as those used for change gears, which are made in large quantities. The first operation on these blanks consists in facing one side and chucking the hole, in an ordinary turret lathe. The only point worth mention in this operation relates to the necessity for taking enough cuts across the face and through the bore to insure that these two surfaces shall be finished very accurately with relation to each other.

After this operation has been completed, the blanks are faced on the unfinished side in the chuck shown in the accompanying illustrations. This is the most interesting operation, as the chuck is decidedly novel in its action. As may be seen in Fig. 2, where it is shown dismantled, the device was made from an old scroll chuck of the usual construction, which had become so worn that its accuracy was more than questionable. What little accuracy it had left was, in fact, eliminated, by machining out the seat for the scroll to a greater width, so that it could float in the groove with ⅛ inch or so of movement. Special jaws of the kind shown in Fig. 2 were next made, fitting the scroll and the slides in the body of the chuck, and provided with pivoted holding-down dogs and "spuds," similar to those commonly used for holding thin work on the planer. Over the face of the chuck was screwed the plate shown, which was provided with a central hole in which was driven a stud closely fitting the bore of the gear blank.

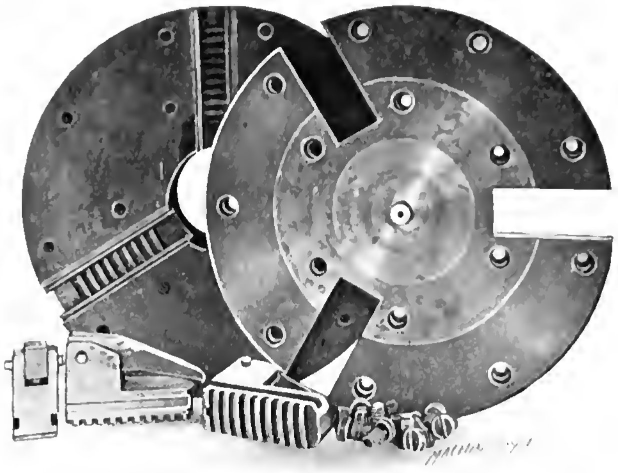


Fig. 2. The Chuck Dismantled, showing Clamp Jaws and Floating Scroll.

The use of this chuck will now be clearly understood. In Fig. 1 the blank is seen placed on the stud, with its finished face against the plate. Each time the chuck is placed on the machine, this plate is refaced, and a new plug is put in and turned down to fit the bore of the hole. If the lathe is in a reasonably good condition, assurance is then given that the locating surfaces for the work will run with the utmost accuracy. The work being placed on the stud and pressed with its finished face against the plate, the jaws are screwed down, with the edges of the dogs pressing against the periphery of the blank in such a way as to hold it firmly against the plate. It will be seen that the loose fit of the scroll in its seat equalizes the pressure on the three sides of the blank, so that it is simply pressed backward into position, without the possibility of being forced sidewise and out of true in any direction. When the facing is completed on a blank thus held, every assurance is given that the face will be true with the bore, parallel with the finished surface on the opposite side of the blank.

The final turning operation is done on a gang arbor, mounted in the spindle of the lathe. The utmost accuracy in turning the periphery of the blank is not necessary, although, if the gang arbor is true, the preceding operations will insure good work in this final turning. Finishing the work in gangs like this reduces the cost of this operation to a very low figure even though it requires three operations. It might perhaps be done somewhat more cheaply by a set of screw machine tools that would finish the blanks in one operation (using special chuck jaws, back facing attachment, etc.), but the greater truth obtained by this method makes the operation less costly in the long run if quiet running gears are desired.

RECENT DEVELOPMENTS IN GEAR-CUTTING MACHINERY.

RALPH E. FLANDERS.*

The past year has been one of great activity in machine design, as is plainly shown by the files of contemporary technical journals In no line has this activity been more marked than in that of gear-cutting machinery in its various forms.

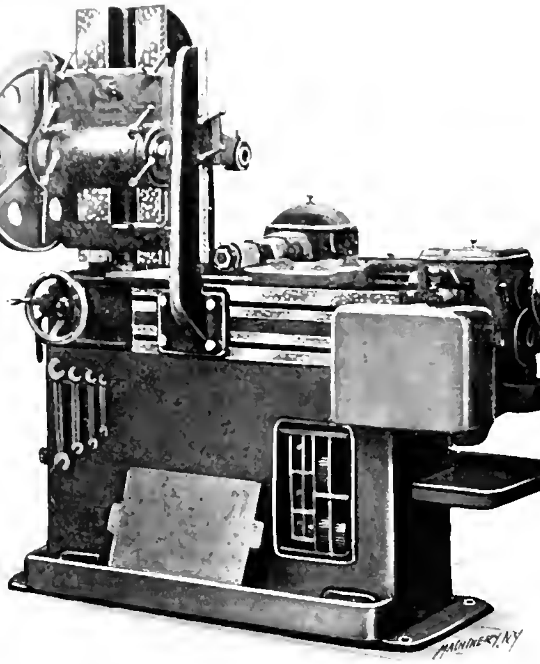


Fig. 1. A German Automatic Spur Gear Cutter which shows the Influence of American Design.

In the months covering the publication of the author's series of articles on this subject (see the issues of MACHINERY from January to September, 1908) the department of New Machinery and Tools illustrated a number of designs which were not included in the articles. Several new examples of foreign gear-cutting machinery have also come to light. This article will briefly describe such of these machines as have not previously been illustrated. The classification of the series of articles referred to will be followed.

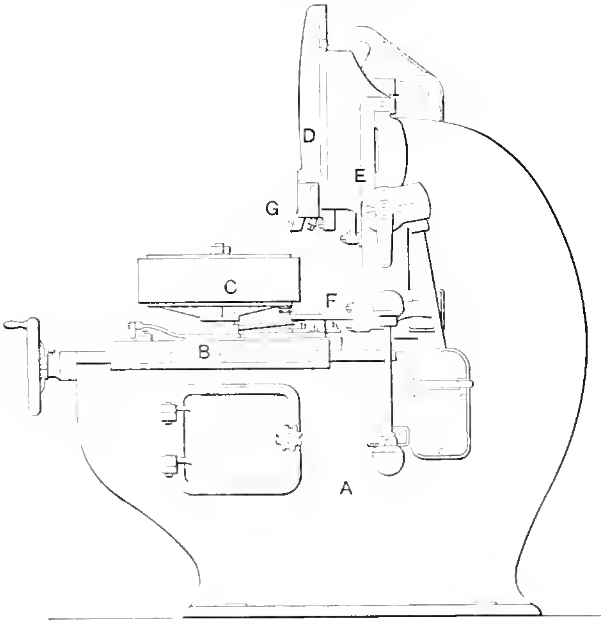


Fig. 2. Elevation of a French Spur Gear Generating Machine employing a Rack Tooth Form of Shaper Tool.

Machines for Cutting the Teeth of Spur Gears.

In Fig. 1 is shown a German machine of the orthodox type which shows American influence very strongly. The mechanism is carefully enclosed, fixed handles are provided for all the adjustments, and the usual form of rim rests, outboard supports, etc., are also provided. The speed and feed changes, as well as the indexing, are effected by change gears. This machine is built by Shubert & Salzer, Chemnitz, Germany.

Two new machines have been developed in Europe for cutting spur gears on the molding-generating principle by the shaping operation. A tool, which is given the shape of a rack tooth, is fed in the direction of the travel of an imaginary rack, past the gear blank, which is, at the same time, rotated in the proper ratio. The first of these machines, shown in Figs. 2 and 3, is built by the Société Francaise de Machines-Outils, St. Ouen, Paris. The resemblance of this machine to a slotter is at once evident. The work, which is shown mounted on the work arbor at *C*, is carried by table *B* which is adjusted in and out on the bed *A* of the machine to give the adjustment for diameter. The tools *G*, having the outline of the rack tooth, are mounted on a ram *D*, which is, in turn, guided in a cross slide *E*, which travels on a cross rail solid with the frame of the machine. In cutting a tooth, the tool starts in at one side of the blank, and the ram *D* on cross slide *E* is fed from right to left, in the face view of the machine. This lateral motion is transmitted by means of rack teeth on arm *F*, engaging suitable mechanism on the work table for rotating work *C* in unison with the lateral movement of the tool. When one tooth has thus been cut, and the slide *E* has been returned to the starting point, the work is indexed, and a second cut is taken in the same manner—and so on until all the teeth are cut. The capacity of this machine is for work up to 20 inches in diameter.

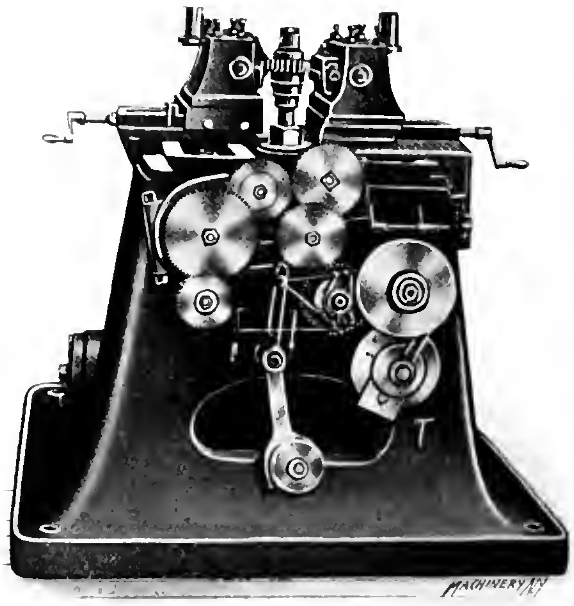


Fig. 4. An English Spur Gear Generating Machine employing Multiple Tools of Rack-shaped Outline.

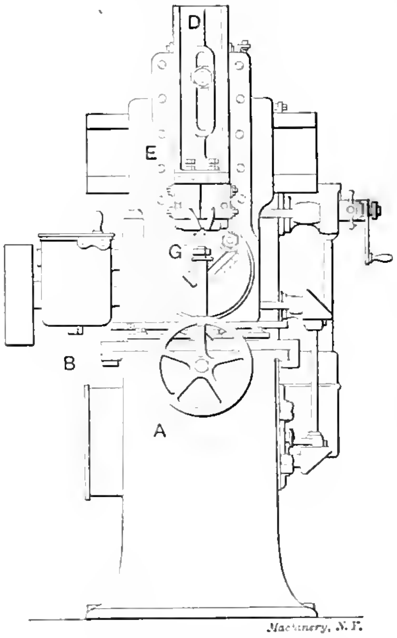


Fig. 3. The Face View of Spur Gear Generating Machine.

The second machine is built by Spencer & Spiers of Huddersfield, England. The construction and movements are entirely different from the previous example, though the principle is the same. There are two sets of tools *AA*, as shown in the plan view Fig. 5, disposed on opposite sides of the work *B*. Each of these tools is formed of several rack teeth.

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* Associate Editor of MACHINERY.

As the work is reciprocated up and down between them by crank *G* and connecting-rod *F*, these tools are fed in the direction of their pitch line in opposite directions, and the work is revolved in unison at the proper ratio. To effect this, the tools are mounted on parallel slides *E*, which carry racks engaging gear *D*, within the base of the machine. *D* also has worm-wheel teeth cut on it, driven by a worm which is connected by change gearing with worm-wheel *C*, which rotates the work. Owing to the fact that the two tools have several teeth each, it is possible to finish pinions and small gears at one passage. For larger gears, provision is made for bringing the tools to the starting point again, and taking a second cut, with the work turned to present a new portion of the periphery to the action of the cutting edges.

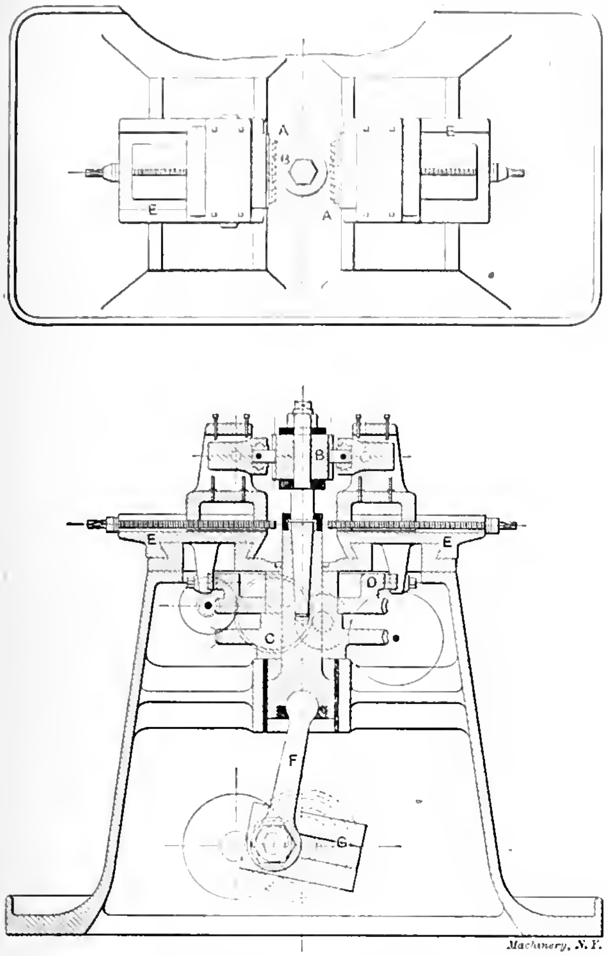

Fig. 5. Plan and Vertical Section through the Machine shown in Fig. 4, with Details of Controlling Mechanism.

The makers of this machine state that no outboard supporting bearing for the work arbor has been found necessary, owing to the fact that the cuts are perfectly balanced. This is effected by the use of the two tools, one on each side of the work. A larger machine has been built in which the tool slides reciprocate vertically instead of the work, the latter being mounted on a spindle which revolves as the cutters are fed past it. The design illustrated in Fig. 4 has been somewhat improved in later models.

The activity in the design of hobbing machines also continues unabated. Four new examples of this class of gear cutters are shown herewith. The first of these is built by the Ateliers de Constructions Mecaniques ci-devant Ducommun, Mulhouse, Alsace. As may be seen in Fig. 6, it has the appearance of being of unusually rigid construction. The work spindle head slides through an opening in the column, being firmly supported in all directions. A heavy outboard bearing of the usual form is provided. The work spindle head is counterbalanced. As nearly as may be judged from the engraving (definite information on this point is lacking) the machine is also arranged for the cutting of spur and spiral gears by the formed tool process. The dividing plate for hand indexing will be seen below the index wheel at the left of the engraving.

Another machine of the same type built by Gildemeister & Co., A. G., Bielefeld, Germany (see Fig. 7), is of the more usual form in which the cutter spindle is carried on the column while the work table is adjusted on the bed. Fig. 8 shows this machine cutting a spiral gear with a formed cutter. This operation requires very little change in the mechanism needed for straight spur gear hobbing, it being only necessary to connect the change gears for driving the work spindle with the feed-screw, instead of with the cutter spindle, and to provide means for hand indexing. The wide provision of this arrangement on European machines is doubtless due to the patent restrictions on the spiral gear hobbing process.

Another hobbing machine, built by Wilhelm Junghans Werkzeugmaschinenfabrik, Chemnitz, Germany, has the base and column in one solid casting (see Fig. 9). It is also provided with elaborate rim and work supporting arrangements, there being an outboard bearing for the spindle, and rim supports both front and back. This machine is designed for hobbing spur and worm gears. It is also provided, when so desired, with hand indexing mechanism for cutting spur gears with formed cutters.

Mention might be made here of a rather unusual extension of the hobbing process, and one which at first thought would seem to be impracticable. This is reported in a paper read before the British Institution of Mechanical Engineers in July, 1908, on "The Evolution and Methods of Manufacture of Spur Gearing" by Mr. Thomas Humpage, the maker of a hobbing machine previously illustrated. Mr. Humpage relates that he has experimentally built and used a corundum "hob" for finishing gears on which a few thousandths had been left for grinding. In using these hobs or worms, the tool is adjusted axially so that one side of the thread touches one side of the teeth of the work. The wheel is then fed down automatically, grinding one side of all the teeth and generating them to the finished form. The machine is next stopped, the wheel raised by hand, and a finishing cut taken. The other sides of the teeth are then ground and finished in the same way. The author proposes to make a machine using a hob of this kind in which a device like that on the fly-tool worm-hobbing machines will be used for traversing the corundum to distribute the wear across its length. It is found that the wear on the worm is very slight, being about a thousandth of an inch in the worn part for cutting a 70-tooth, 7-pitch, 1¼-inch face cast iron wheel, which was finished in eight minutes. In the complete machine, the author proposes to mount a corundum wheel for truing up

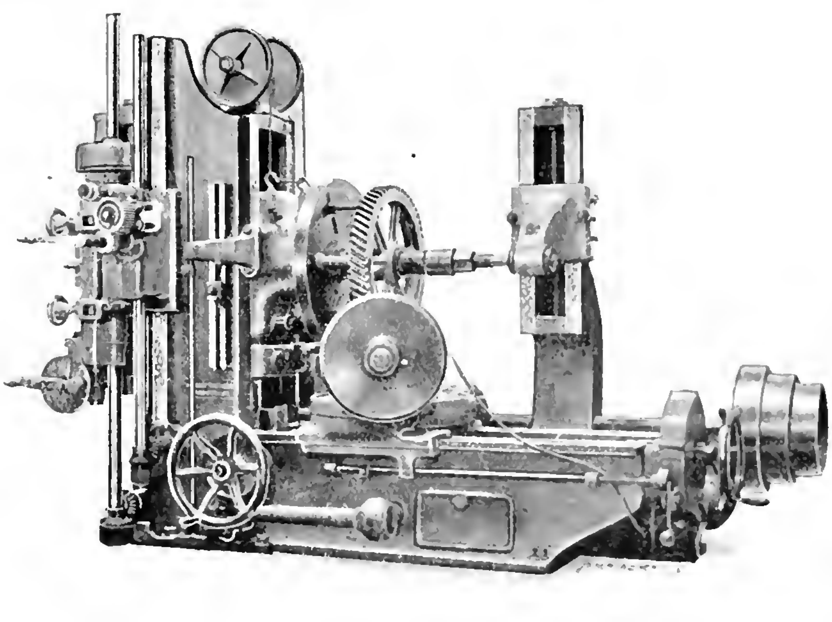

Fig. 6. Ducommun Gear-hobbing Machine cutting a Spiral Gear.

the worm. He suggests also that this finishing process should be applied to all gears, whether soft or hardened.

Machines for Cutting Internal Gearing.

The only new development in cutting internal gearing which has come to the writer's notice during the past year is that shown in Fig. 10, which illustrates the surprising operation of hobbing an internal gear. This operation bears the same relation to the hobbing machine in which it is done, that the use of an internal gear-cutting attachment bears to the orthdox spur gear cutting machine. The method of driving through a train of gearing connecting the cutter with the regular spindle, is identical. With this attachment, the hob has a pitch surface of a barrel-shaped form, with the radius of curvature corresponding with the pitch radius of the wheel to be cut. In producing these hobs, a master internal toothed wheel is hardened, so that the teeth act as cutters. The soft hob blank is then placed in the machine the same as when at work, as shown in Fig. 10, and a theoretically correct profile is generated on it by the hardened internal wheel. The hob itself is then relieved, hardened and ground ready for use. It is adapted only to cutting gears of the diameter and pitch for which it was made. David Brown & Sons, Huddersfield, England, are the originators of this device.

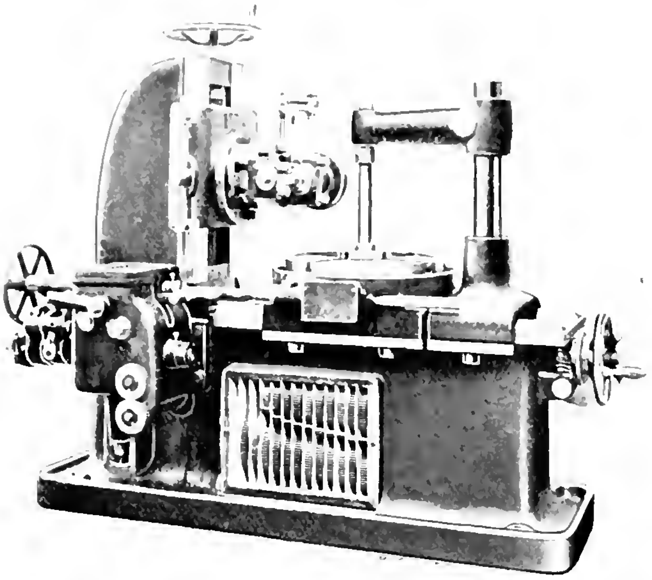

Fig. 7. The Gildemeister Gear Hobbing Machine.

Machines for Cutting the Teeth of Worm Gears.

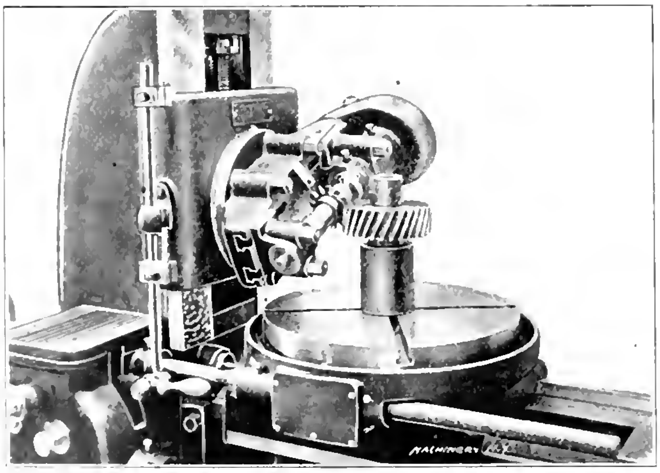

Fig. 8. The Gildemeister Machine cutting a Spiral Gear by the Formed Tool Process.

A machine similar to those illustrated in Figs. 119 to 128 of the previous series of articles, has recently been placed on the market by J. Holroyd & Co., Ltd., Perserverence Works, Milnrow near Rochdale, England. The machine is, of course, under the classification given it, adapted for using either a tapered hob or a fly tool for cutting the teeth of worm-wheels. The cutter bar is moved axially for the feed, and is so connected by differential gearing with the worm-wheel revolving the work spindle as to keep the tool and work constantly in register. This machine, as may be seen in Fig. 11, is similar in general design to that illustrated in Fig. 122, in that the work spindle is vertical and stationary as to location on the bed, while the cutter slide is carried by a column horizontally adjustable for the diameter of the work. The machine is of unusual size and capacity. It will hob wheels from 12 inches to 72 inches in diameter. The main bearing of the work spindle is 8 inches in diameter by 16 inches long. The approximate weight of the whole apparatus is ten tons. This same firm builds a machine of similar design for smaller work in which, however, the work spindle, instead of the cutter slide column, is horizontally adjustable.

Machines for Cutting the Teeth of Bevel Gears.

A firm in Budapest, Hungary, whose name translated into English reads "Small Arms and Machine Factory Co., Ltd.," has built for a number of years the templet bevel gear planer shown in Fig. 12. In this machine the work spindle is adjustable for the pitch cone angle, by moving it in a concave circular seat in the bed. This seat keeps the axis of the work spindle always in line with the horizontal axis of the swiveling adjustment. The outer end of the work arbor is supported in a yoke which swivels about this axis. The mechanism on the upper part of the machine is the tool head, which carries two crank-driven slides, each of which carries a tool. These slides are confined by guides which are pivoted about an axis passing through the apex of the pitch cone. The whole mechanism swivels about the horizontal axis passing through the same point. As the tools are swung down into the teeth about this horizontal axis, they are spread apart about the vertical axis by the action of fingers on each tool slide guide, which bear on opposite sides of a suitably formed templet, held in the templet holder at the upper right of the machine. The swinging downward of the tool slide mechanism is accomplished by a revolving nut on the swiveling screw which connects this mechanism with the bracket to which the templet is clamped. This latter is held in slides which are adjustable for both vertical and horizontal movement. In having the tools swivel about both axes while the work remains stationary, this machine resembles the Gleason machine shown in Fig. 151. It is not, however, automatic.

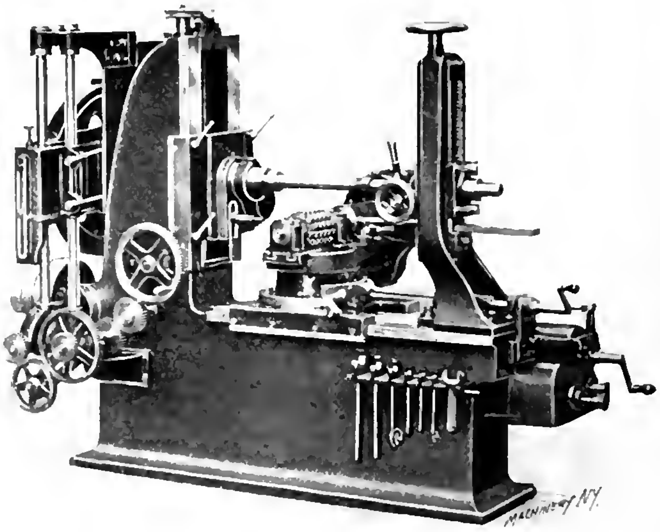

Fig. 9. Junghans Spur Gear Hobbing Machine.

In Figs. 13 and 14 is shown a recently developed templet machine for finishing the teeth of bevel gears, made by Earl H. Browning, of the Browning Engineering Works, Cleveland, Ohio. As in the previous case, two tools are used, each mounted in separate slides which are swiveled about a common horizontal axis passing through the apex of the pitch cone of the gear to give the desired outline to the tooth. This swiveling of the cutter slides under the action of the templet takes place simultaneously with the swinging of the work-carrying head about a vertical axis. That is to say, as the tooth of the gear is swung in between the points of the tools the latter are opened up with the proper movement to give the

desired tooth outline. As the points of both tools travel toward the apex of the pitch cone of the gear, the outline of the templet is reproduced on a decreasing scale from the large to the small end of the tooth. In the details of the design this machine is original. One of the points of novelty is the use of the quick change speed gear box seen on the work spindle head in Fig. 13, for the indexing mechanism. This gear box, in combination with a further change of four ratios, gives the entire range for cutting any ordinary number of teeth without the use of loose change gears. The changes of speed and feed are also effected by quick change gear boxes. Fig. 14 shows a face view of the cutter slides, with the tools in place in the toolholders. The line of movement of the cutting points of the tools is toward the apex of the pointed rod shown at the center of the swinging attachment of the slides. In this machine, the templet, which is not here shown, is in the form of a cylindrical cam, which is rotated in unison with the swinging of the work spindle head around the bed. This cam has two grooves, each of which controls a roller attached to the outer ends of the tool slide guides, which are thus controlled.

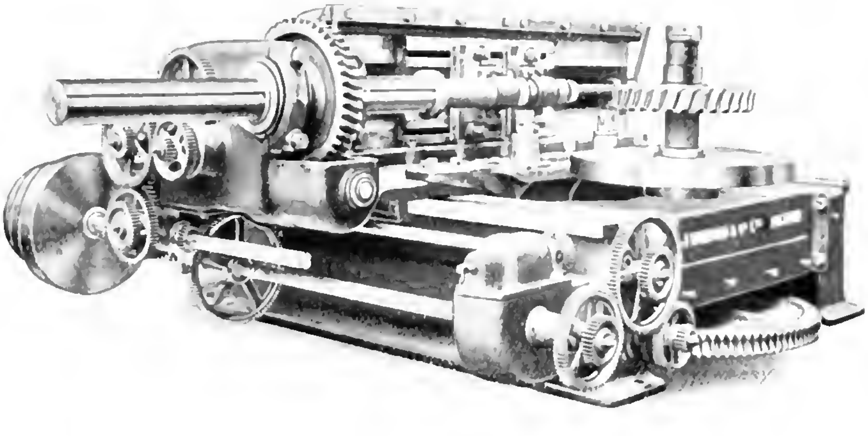
Fig. 11. The Holroyd Worm Gear Generating Machine using a Fly Tool or Taper Hob.

An English machine of the molding-generating type operating on the shaper principle is shown in Fig. 15. Here the axes of both the work and the imaginary crown gear are stationary, the blank and the tool swinging about these axes. The proper ratio of rolling movement of these two parts is obtained by change gears.' The machine has two distinctive features not found in other generating machines, so far as the writer is aware. One of them is the provision made in the mechanism for automatically gashing the wheel preparatory to the finishing generating cut. In this operation the blank is swung around into the reciprocating tool, the slide being locked in position, until the proper depth has been cut. It is then returned rapidly and the work is indexed for the next cut, which is taken in the same way. This swinging of the work into the cutter and back again is effected by the adjustable crank shown at the front of the machine, which has a slow ratchet feed for cutting to depth, and a quick movement for returning. This same crank mechanism is used without the slow ratchet feeding for bringing the cutter into depth for starting the generating cut, and swinging it back at its completion to clear for the automatic indexing in the finishing operation. The other distinguishing feature of this machine is the provision made for correcting the teeth for interference. In other generating machines, this correction is made by altering the addendum and dedendum of the gear and pinions in cases where it is necessary. In this case it is done by modifying the tops of the teeth the same as in the standard shapes for spur gears. To accomplish this the swiveling movement of the tool slide is retarded as the tool is leaving the point of the tooth. A slotted cam groove will be seen, cut in a sector which is fastened behind the outer end of the swinging tool slide. This cam groove controls the movement of a short slide, which, in turn, by means of the diagonal groove and block shown, gives a relative movement between the slide itself and the sector on which it is mounted. This movement is sufficient to trim the tops of the teeth as required. The builder of this machine is the Churchill Machine Tool Co., Ltd., Manchester, England.

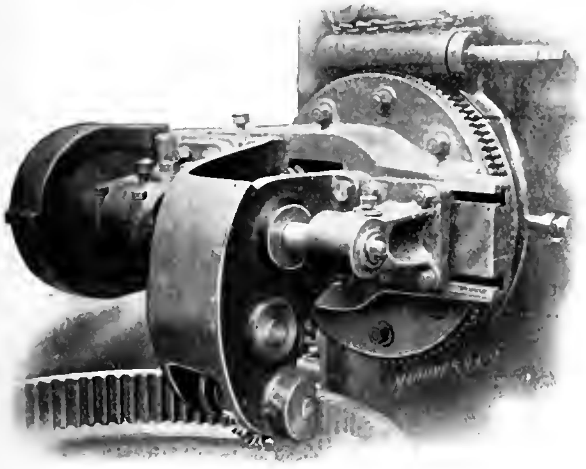
Fig 10. An Attachment for Hobbing Internal Gears.

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The United States Geological Survey's annual report on the mineral resources in the United States for 1906 has just been issued. It appears that the value of the metallic products of the country in 1906 was $866,110,856 and of the nonmetallic $1,016,194,350. Coal is the most important of the mineral products and iron comes second, the value of the products of each in 1906 being slightly more than $500,000,000. Copper comes third with a value of $177,595,888. The clay products come in the fourth place, gold occupies the fifth place, and petroleum the sixth. It is noteworthy that the lead output of the country exceeds that of the silver output. The greatest increase in the year is shown in the production of coal, copper, and cement. Pennsylvania produces nearly one-third of the mineral output of the country, Ohio one-tenth, and Illinois, New York and West Virginia occupy, respectively, the third, fourth and fifth places as mineral producing states.

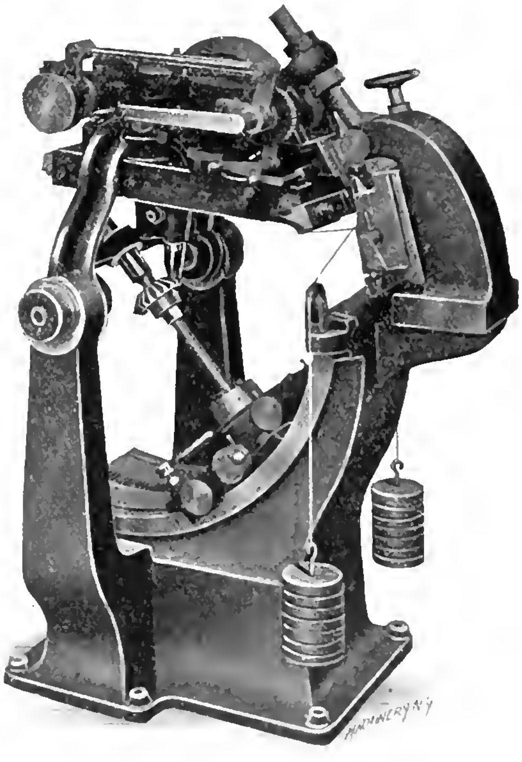
Fig. 12. A Hungarian Templet Bevel Gear Planer.

CENTRIFUGAL PUMPS.*

E. N. PERCY†

Many engineers agree that it is only a matter of time and development before centrifugal pumps will displace the reciprocating type for most classes of work. Owing to their high speed, they occupy little space, and as they have no moving parts except the runner, there is less complication and repairs; consequently, they are more reliable, and give less trouble.

Centrifugal pumps are admirably adapted for direct connection with electric motors, steam turbines, steam or gas engines, or belt drives when high speeds are necessary. They run silently, there are no pipe shocks, nor is an air chamber necessary. If the discharge valve is closed, no harm results, as the pressure does not rise, and the load on the pump is removed; hence, like a shunt wound dynamo, it is self-regulating, only doing work in proportion to the quantity of water pumped (approximately). A battery of centrifugals can be connected in series for one duty, requiring high pressure, and in parallel for another duty requiring low pressure and great quantity. The motor and pump are always directly connected and can operate without any foundation, even at the end of a rope in a deep well. For fire service, there is no danger of bursting hose or pipes; for this reason, if for no other, there should be a special field for them in Tammany fire departments. This type is also adapted to the handling of beers, chemicals, and other liquids liable to contamination or erosion in action, as there are no valves or other details to cause trouble.

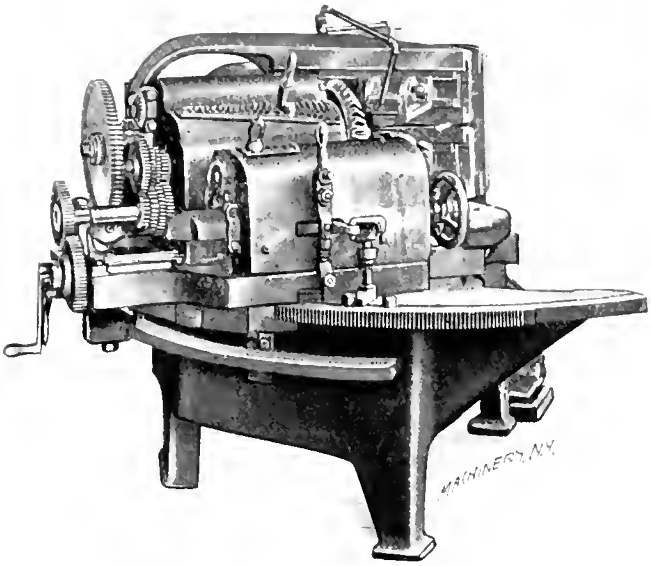

Fig. 13. The Browning Templet Bevel Gear Planer.

The common, commercial, volute pump seldom gives over 45 per cent efficiency, but can easily be designed to give 65 per cent, and be manufactured just as cheaply. A high-duty pump for a special condition will give 88 to 90 per cent efficiency, but, so far, these results have been confined to European makes, American manufacturers not securing much over 80 per cent at official trials. The multi-stage pumps are divided into two classes, the commercial and the high duty. They operate at various speeds dependent upon innumerable conditions. For the best efficiency, any centrifugal pump operates at but one speed. Pumps without guide vanes can have a fair efficiency over a very wide range of speed, owing partly to the fact that the suction column adjusts its rotation to some extent to suit the runner speed. The velocity of a high-speed pump can be reduced with only a slight falling off in the efficiency, but the low-speed type becomes inefficient very fast on being speeded up, because of the excessive eddies in the casing. With a high-duty pump provided with guide vanes, any change of speed is attended with great efficiency losses, because of the eddies between runner blades and guide vanes. If variable speed is a necessary feature, the guide blades must be movable to suit conditions, as in a variable speed water turbine. When the quantity of water varies (as by adjusting the discharge valve), as before, the plain volute pump has a fair efficiency over a wide range of variation, but the high-duty pump again suffers from eddies between the runner and guide vanes. In this case, also, it is customary to have variable guide vanes if a high efficiency for all conditions is desired. When one considers the commercial efficiency, which includes cost of repairs, reliability, spare parts, silence, and space occupied, the centrifugal pump is entitled to a high rating.

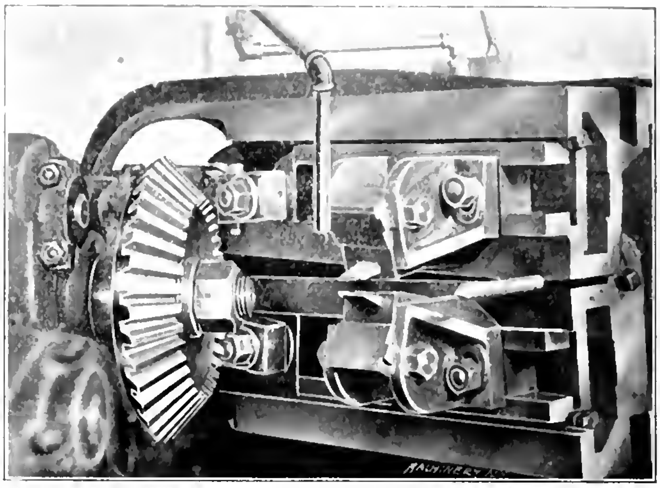

Fig. 14. Detail of the Browning Machine, showing Two Tool-holders.

Of the various powers for driving centrifugals, the electric motor, steam turbine, steam engine, and gas engine, are all far more economical than the ordinary steam pump using from 40 to 80 pounds of steam per horse-power per hour. When used in municipal waterworks service, the pumps can be run in parallel for ordinary service work, and connected in series for fires or flushing the mains. Many cities have this system, particularly in the West. When used in connection with tank supply, a float valve may be placed at the end of the discharge valve, as the pressure cannot rise when the valve closes, and the power necessary varies as the quantity of water pumped, with an additional variation due to change of efficiency.

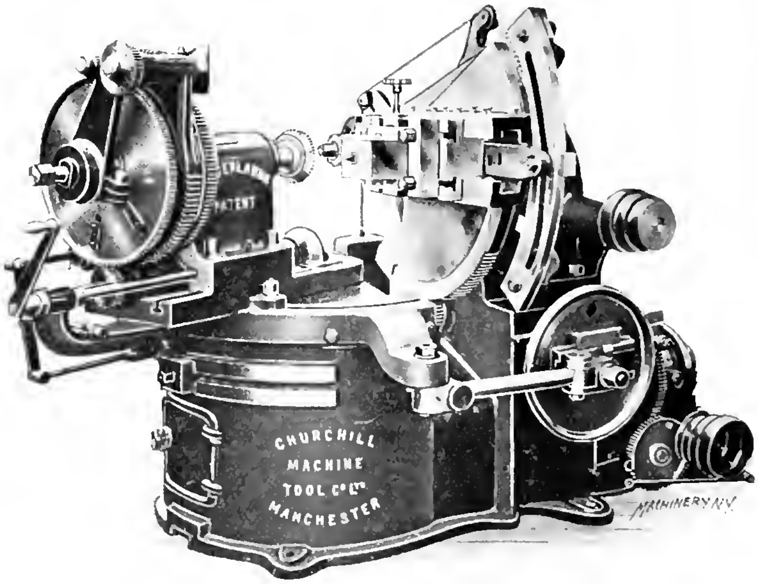

Fig. 15. The Churchill Bevel Gear Generating Machine, in which Provision is made for Modifying the Teeth to avoid Interference.

Of late, it has been customary to supply large buildings and hotels with a regular system of piping for ice water. It

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* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: Centrifugal Pumps, April and January, 1907; A New Method of Pumping Heavy Crude Fuel Oil or Other Thick Viscous Fluid, July, 1906; The Compound Pumping Engine, February, 1906; The Limit in Pumping Machinery, August, 1905; Pumping Heavy Fluids, April, 1905.

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is obvious that this must be an endless system, with constant circulation. There is no better nor more economical method than to have this maintained by a small centrifugal pump. No roof tank is necessary, although it is often used, as the pump can maintain the service, and a spare pump is cheaper than a tank, since they are so small. If a closed pressure tank is used at the bottom, the upward and downward moving columns balance, and the pump has only friction and weight of water actually used to overcome. A tank at the top gives a reserve capacity, and it may be either open or closed, but it is a source of loss by convection of heat, due to water remaining there.

One of the chief uses of centrifugals is in the irrigation of land. Their small first cost opens up a field hitherto precluded by the cost, complication, upkeep, and lack of economy of reciprocating pumps of the same capacity. Now, the farmer can, by a small gas engine or wood-burning steam engine and a centrifugal pump, irrigate his land from a nearby stream, canal or lake, and the cost is so nominal for small lifts as not to need serious consideration. The extreme height of lift for profitable irrigation seems to be around 170 to 200 feet, varying with conditions such as quality of land, cost of fuel, and value of crop. Irrigation on a large scale has been most successfully practiced by pumping, and plants up to 1,000 horse-power are in use.

Centrifugal pumps are now used in many large power plants as feed pumps, as they have many advantages over the ordinary type. There is no pipe shock or noise, and they work quietly, without air chambers, at a continuous speed, regardless of the quantity of water handled. Of course, the efficiency varies, but it is fairly good for a wide range of work, and at the worst, when driven by an electric motor or steam turbine, the centrifugal pump uses less steam than the reciprocating type. As a condenser circulating pump, the centrifugal's good points are well known. It is probable, however, that in the future, circulating pumps in large plants will be smaller and run at a higher speed, driven by an electric motor or steam turbine. For the handling of sewage, or bilge water full of ashes, coal, debris and grease, the centrifugal type of pump has no equal. In fact, many a good ship has gone down because the valves of a reciprocating pump became clogged at a critical time. This type can be operated while submerged in the bilge, the power being transmitted by a vertical shaft running to a motor or turbine placed above the pump.

As a mine sinking pump, the centrifugal has made its reputation. It is compact, being self-contained, and highly efficient. For regular mine pumping stations, the multi-stage pump, with a waterproof electric motor, needs neither engineer nor a dry station. In fact, it will run entirely submerged. Whereas the steam pumping station needed a complete engineering crew, many repairs, and a complete duplicate plant to insure safety. Deep tube wells 10 and 12 inches in diameter are now pumped by submerged multi-stage pumps driven by highly-efficient electric motors, which is preferable to the single cylinder deep well steam pump, using from 60 to 100 pounds of steam per horse-power hour, and requiring careful operation, and many repairs.

All over the city of Berlin, Germany, are numerous beautiful fountains. Near each is a small electro-centrifugal pump drawing water from the canals which cross the city in every direction, and discharging it to the fountain. They have no attendant, and are never shut down, or attended to in any way, except by an inspector who looks at them several times a week, seldom, however, doing anything to them. What reciprocating pump could perform this duty without being practically rebuilt every year or two? [The life of any pump depends, of course, greatly upon the chemical properties of, and the amount of grit in the liquid being pumped. Under favorable conditions, well-constructed reciprocating pumps will often run for years without giving any great trouble and without requiring much attention.—Editor.] In a like manner, in those parts of the country where electricity can be obtained from power lines, pumps driven by motors can be set up for irrigation or other purposes, and no attention paid to them for weeks at a time. This may not be advisable, but it is actually the case in many western farming communities.

For wrecking, salvaging and dry dock work, the centrifugal pump holds supreme sway because of its portability and cheapness. For the draining of land and marshes it has been used exclusively by the Dutch and by the engineers who have drained the Ferrarri Marshes of Northern Italy; the two greatest pieces of reclamation known to history. Of course, this refers to the time of modern pumping, since the Dutch have ceased to depend on windmills. The use of centrifugal pumps for hydraulic dredging has done much to improve our harbors and cheapen canal work. When made properly, they even endure this terrific wear, which could not even be thought of in connection with a reciprocating pump. As a lubricating pump for large systems of forced lubrication, the centrifugal maintains a constant pressure, no matter what the conditions of lubrication are, nor how often they change. In hydraulic elevator service, it is the ideal pump, because, without governors or regulating apparatus of any kind, it maintains a constant pressure, always supplying all the water necessary, up to the limit of its horse-power, and works equally well under pressure tank or open system. It could be used to advantage with hydraulic hoisting or manufacturing machinery. Steam turbine driven centrifugals have been applied to some of our most prominent fire boats, and they are now recognized by the underwriters, provided certain conditions relative to priming, etc., are met with.

To sum up, the centrifugal pump is a very modern piece of machinery, the growth and importance of which, in this country, is just beginning to be realized.

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TO DETERMINE SIZE OF GAS AND OIL ENGINE CYLINDERS.

NEWTON WRIGHT.*

The determination of the size of a gas engine cylinder from the heating value of the fuel, and the pressure caused by the theoretical rise of temperature, is impractical, as the losses due to incomplete combustion, cooling effect of jacket, and incomplete expansion, cannot be estimated with any great degree of accuracy. The size is most conveniently determined from the known fuel consumption of engines of similar power and type, provided the ratio of air to gas is also known. The formulas given in this article will aid in determining the size required, in this manner. In the formulas given the notation used is as follows:

d = diameter of cylinder in inches,
s = stroke in inches,
n = revolutions per minute,
H = brake horse-power per cylinder,
c = cubic feet of gas per brake horse-power hour,
w = pounds of oil per brake horse-power hour,
r = ratio of air to gas or vapor,
r_1 = ratio of air and products of combustion (in clearance space) to gas or vapor,
k = ratio of total capacity of cylinder to piston displacement,
V = piston displacement per stroke in cubic inches,
V_1 = piston displacement in cubic inches per brake horse-power,
v = clearance volume in cubic inches,
m = ratio of diameter to stroke.

One pound of heavy oil gives about 12 cubic feet of vapor, and one pound of light oil about 6 cubic feet; consequently, in applying the following formula for the ratio of air to gas or vapor, to oil engines, 12 w and 6 w, respectively, are substituted for c. The value of the ratio r is expressed by the formula

$$r = \frac{d^2sn}{cH \times 72} - 1.$$

The ratio r varies from 2 to 3.3 for producer gas, from 7 to 12 for lighting gas, from 27 to 40 for vapor of heavy oil, and from 36 to 52 for the vapor of light oil. With the most economical engines the value of r lies between the two figures given, but is generally nearer the lower than the higher. Per-

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haps the average figures would be with producer gas, 2.4, lighting gas, 9; heavy oil, 30; and light oil, 40. In the two last instances, this value of the ratio would make 360 cubic feet of air per pound of heavy oil, and 240 cubic feet of air per pound of light oil.

The value of the ratio of air and products of combustion (in clearance space) to gas or vapor is expressed by the formula:

$$r_1 = \frac{d^2snk}{cH \times 72} - 1.$$

The ratio k of total capacity of cylinder to piston displacement is given in Table I.

TABLE I. RATIO OF TOTAL CYLINDER CAPACITY TO PISTON DISPLACEMENT.

Absolute Compression in Pounds per square inch.	k	Absolute Compression in Pounds per square inch.	k
30	2.65	75	1.46
45	1.86	90	1.38
60	1.58	105	1.33

The value of k is higher than it apparently would be, as the heating of the air following the compression causes the pressure to rise in a greater ratio than that due to the actual compression. When means are taken to clear the cylinder of the products of combustion, as is usual with engines working on producer gas, then r_1 will equal the ratio of pure air to gas.

The value of the piston displacement per stroke, in cubic inches, V, is expressed by the formula:

$$V = \frac{Hc\ (r+1)\ 57.6}{n}$$

The relation between the diameter of the cylinder and the other quantities affecting it, is expressed by the formula:

$$d = 4.2\sqrt{m}\ \sqrt[3]{\frac{Hc\ (r+1)}{n}}$$

The ratio of the diameter to the stroke m equals, of course, $\frac{d}{s}$, or $d = sm$. From the formula given it will be seen that if the length of stroke is given, the power of the engine will be proportional to the square of the diameter, but if the ratio of the diameter to the stroke is given, the power will be proportional to the cube of the diameter. Table II gives the usual values of m employed.

The clearance volume is determined by the formula,

$$v = V\ (k - 1) = d^2s \times 0.7854\ (k - 1).$$

The total volume of the cylinder equals $V + v = Vk$.

TABLE II. COMMON VALUES FOR QUANTITIES ENTERING IN CALCULATION OF SIZE OF GAS AND OIL ENGINE CYLINDERS.

Fuel Used.	H	c or w	n	m	V_1
Producer Gas.....	20- 50	85	170	0.6	100
	50-100	80	160	0.7	100
	over 100	75	150	0 9	100
Lighting Gas. ...	to 5	30	300	0.5	60
	5-20	25	220	0.5	66
	20-50	20	170	0.6	70
	H	w	n	m	V_1
Heavy Oil	to 5	1.2	300	0.5	87
	5-20	0.9	220	0.5	88
	20-50	0.7	170	0.6	90
Light Oil..... ...	to 1½	1.	750	0.6	19
	5	0.75	750	0.8	14

The compression varies from 35 to 80 pounds per square inch, and is usually about 75 pounds. The piston speed in feet per minute is from 400 to 700 in gas and heavy oil engines of less than 200 H.P. per cylinder, up to 1,000 in the largest engines. In light oil engines the piston speed is seldom less than 650 feet per minute, even in the smallest sizes, and more in the larger.

Assuming a consumption of 80 cubic feet of producer gas per brake horse-power, 25 cubic feet of lighting gas, 0.9 pound of heavy oil and 0.75 pound of light oil, and taking the average values of r as given in the first part of this article, the following formula may be employed for finding the diameter of the cylinders, if the ratio between the diameter and the length of stroke is given.

$$d = f\sqrt[3]{m}\ \sqrt[3]{\frac{H}{n}} = \frac{f\sqrt[3]{m}}{\sqrt[3]{\frac{n}{H}}}$$

In this formula f is a coefficient which equals 27.2 for producer gas, 26.4 for lighting gas, 29 for heavy oil, and 24 for light oil. At ordinary speed H would equal, approximately, $\frac{d^2}{5}$ for producer gas, $\frac{d^2}{4}$ for lighting gas, $\frac{d^2}{6}$ for heavy oil, and $\frac{d^2}{4}$ for light oil. These formulas, however, will not hold good for very small engines, say under 10 H.P., except for those using light oil.

The heating value of the fuel is usually as follows: Producer gas, 150 B. T. U. per cubic foot; lighting gas, 660 B. T. U. per cubic foot; heavy oil (specific gravity about 0.88), 20,000 B. T. U. per pound; light oil (specific gravity about 0.69), 28,000 B. T. U. per pound.

As has been mentioned before, one pound of heavy oil gives 12 cubic feet of vapor and one pound of light oil about 6 cubic feet, so that the heating value per cubic foot of vapor is 1,660 with heavy oil, and 4,660 with light oil.

Taking the average ratios of r as given before, the heating value of the mixture of air and gas drawn into the cylinder per cubic foot is, with producer gas 45, with lighting gas 66, with heavy oil 55, and with light oil 114. If the clearance space is allowed for, and assuming 75 pounds compression, the figures are 37, 48, 37 and 80, respectively. A theoretically perfect engine requires 2,545 B. T. U. per horse-power-hour, corresponding to a consumption of 17 cubic feet of producer gas, 3.9 cubic feet of lighting gas, 0.125 pound of heavy oil, 0.091 pound of light oil. If the efficiency of the gas producer is taken into account, minus 0.182 pound of anthracite or 0.212 pound of slack as one pound of coal, the producer gives about 62 to 70 feet of gas.

The preceding formulas refer to ordinary 4-cycle single-acting engines. For engines with several cylinders, the power, fuel consumption, etc., should be taken for one cylinder alone, and if a double-acting cylinder, the power, fuel, etc., for one end.

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From a note in the *Mechanical Engineer* for December 25, 1908, it is evident that English mechanics and engineers are also feeling the need of more intimate connection between technical education and shop practice. A committee of the Northeast Coast Institution of Engineers and Shipbuilders has made the suggestion that apprentices be divided into two classes, one to be known as "ordinary apprentices" and the other as "pupils," the latter receiving rather more wages and also serving six years' apprenticeship, half of this to be passed in the works and the other half at college. For "ordinary apprentices" it was recommended that preference should be given to those with the highest leaving certificates at the elementary day school, where the committee recommend youths intending to qualify as artisans should receive, when possible, some instruction in elementary science, and that each year they would be given marks for examinations, time-keeping, good conduct, industry, and progress, bonuses being given for exceeding a certain number of marks. The pupil class will be trained to recruit the ranks of draughtsmen, managers, superintendents, employers, etc. Those who have passed a three years' course in engineering at a university college and obtained a certificate from it, would be taken as pupils for a three years' course, and in other cases workshop experience and college study would be combined for a period of six years, the pay to be higher after the first year's college course. Ordinary apprentices would be promoted to the pupil class on passing suitable examinations, during the course of their apprenticeship.

PACKING MACHINE TOOLS FOR EXPORT.

Machinery for export must be packed in a much more thorough manner than is necessary for domestic shipping, if it passes unharmed the rough handling it inevitably receives. It is generally sufficient for domestic shipment to crate a machine simply, as it probably will not be turned over or roughly handled in the course of transportation, and even may not leave the car on which it was loaded until it reaches its destination. In the case of foreign shipment the condition is entirely different. It is shifted from one vehicle to another many times in its course and is very unceremoniously handled. A box containing a machine tool worth thousands of dollars is of no more importance to a stevedore than one containing dog biscuit. Even if carefully handled, there is the effect of storms at sea to be considered. The pitching and rolling of a vessel in seaway may cause great damage to a machine improperly packed in its box. All machinery for foreign shipment must be braced in its boxing in such a way that it will not shift position or throw great loads on slender parts even when lowered into the hold of the steamer with the machine on end or upside down.

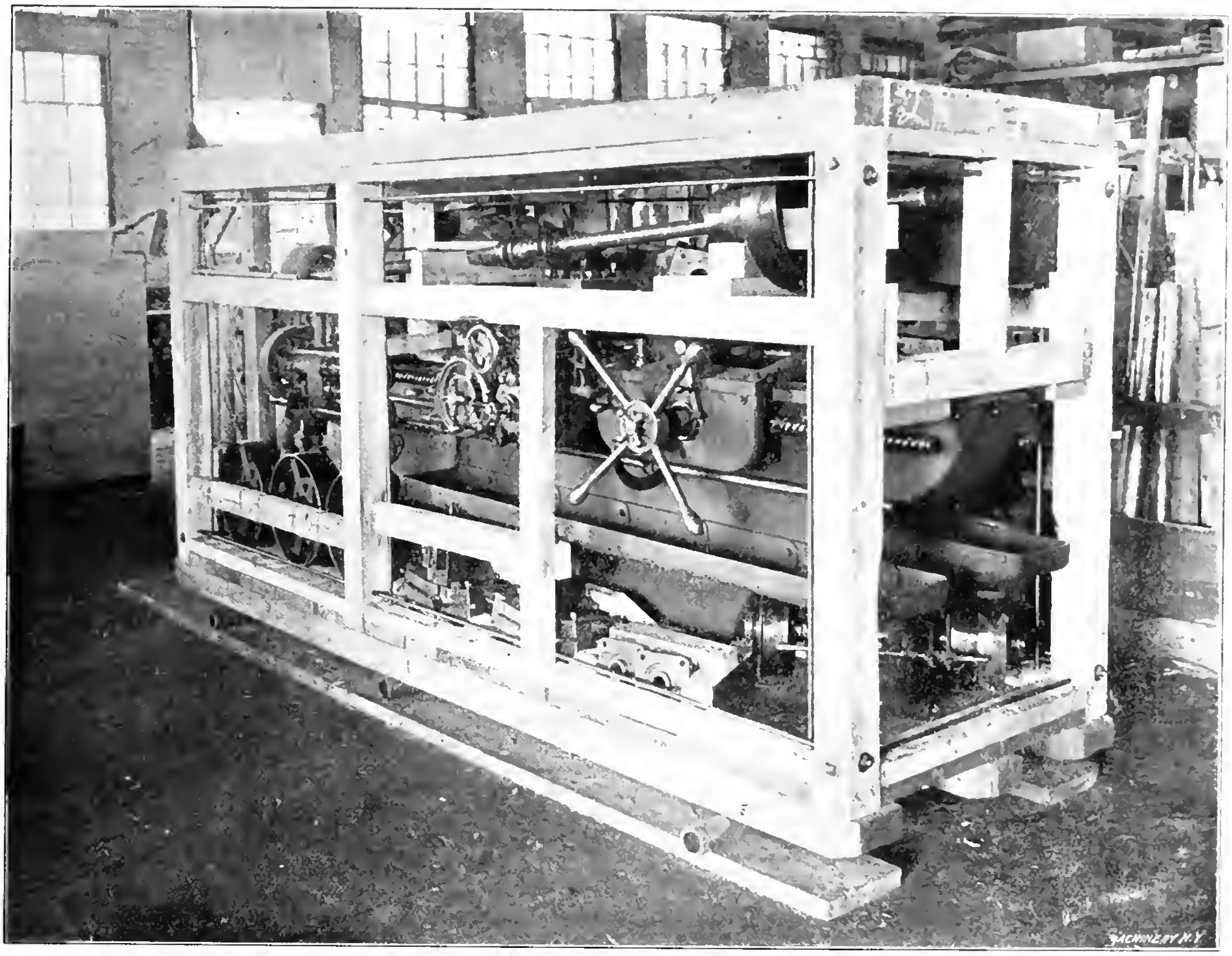

Fig. 1. Framing of Export Case for Gisholt Turret Lathe. Note Size of Framing, and Through-bolts tying it together.

Many American machine tool builders have boxed their machines very poorly, the result being that when received by European agents, parts were found broken, and the machines in a generally bad condition. Oftentimes the breakage of a small part has delayed putting the machine into use, weeks or even months, the consequence being that the customer is dissatisfied with the delay, and often sales have been lost by the breakage of a trifling small part which the agent was unable to promptly replace. The subject of packing machinery for export was very ably handled in a paper contributed by Mr. Paul Roux to the American Chamber of Commerce, Paris (see MACHINERY, April, 1904) in which our manufacturers were warned of the bad effect on foreign customers, produced by lax practice in preparing for foreign shipment. But some American builders had learned the lesson thoroughly long before that time and for years have packed their machines in a way that leaves little for criticism.

The accompanying photographs illustrate the very thorough and substantial way in which machine tools built by the Gisholt Machine Co., Madison, Wis., are prepared for foreign shipment. The company has developed the practice illustrated, through experience, and since it began following this method of boxing and packing, it has virtually eliminated all complaint regarding bad condition of machines received by its customers across the water.

Fig. 1 shows a Gisholt turret lathe in the strong frame made for foreign shipment, on which the outside covering of boards has not yet been nailed. It will be noticed that the very substantial framing is tied together by long ½-inch bolts, thus strongly reinforcing the joining of the timbers at the corners. The posts are made of 4 x 6-inch hemlock, and the remainder of the frame of 4 x 4-inch hemlock. The flooring is made of 2 x 10-inch hemlock and the skidding of 4 x 6-inch No. 2 hemlock. For boarding the outside of the case, No. 2 shiplap is used.

Figs. 2 and 3 are two views of a case containing the bed, table, feed box, head-stock, shields, etc., of a 42-inch Gisholt boring mill. The same specifications in regard to posts, overhead work, skids and boarding used for boxing the turret lathe, apply to the boring mill. Fig. 4 shows a case containing the top rail, down slides and cross-rail of the same machine, while Fig. 5 shows a case containing the housings. In these casings the use of ½-inch through-bolts is not found necessary as the weight of the parts is not so great as to rack apart the nailing of the timbers.

In Fig. 6 two machines completely boxed and loaded on a car ready to move out of the shop are shown. All bright parts of the machines are thoroughly slushed with No. 98 "Cosmic" slushing compound, while the tops of the machines are covered with tar paper. Then on top of the completely enclosed case is fastened a layer of waterproof paper lined with burlap, thus making a tight roof and insuring the machines from

becoming wet when exposed to storms on wharves. Some manufacturers have overdone the waterproofing act by lining the case throughout with tarred paper. Such a lining prevents circulation of air and causes dampness to collect which rusts finished surfaces even though protected with slushing compounds.

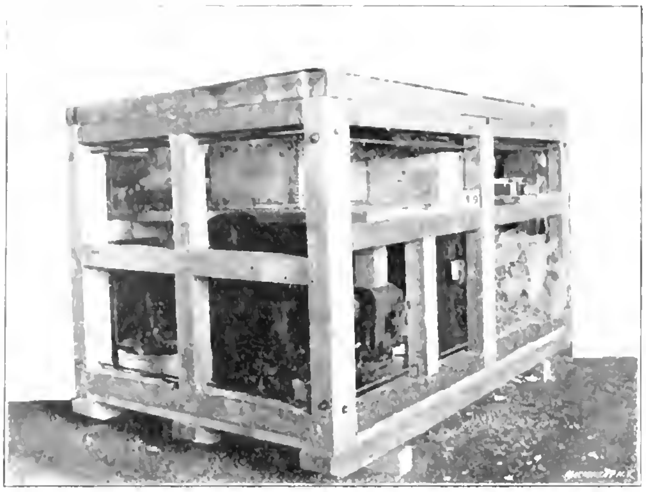

Fig. 2. Framing of Export Case for Gisholt 42-inch Boring Mill—Bed, Table, Feed-box, Head-stock, etc.

Special note should be taken of the thorough way in which the accessory parts are cleated down, and the manner in which heavy parts are supported by the framing. The proper preparation of a heavy machine so as to withstand foreign shipment is costly of time, labor and lumber, and much thought should be given to the design of package. Much can be learned in the latter regard from a careful study of these illustrations. It must be remembered that in lowering a machine into the hold of a steamer it is quite possible that the box will be suspended with the machine upside down, or what may be worse, from one end if it is too long to go down the hatchways horizontally. No slender part should be in contact with the thin boarding, as a blow or heavy pressure may be transmitted to the part with bad effect. The dropping of a case is not an unknown accident, and, of course, no framework sustaining a heavy machine will withstand a drop of many feet, but a drop of a few feet should not be disastrous, and is not likely to be, if boxed as here illustrated. Following is a summary of the principal points that should be observed in packing machines for export:

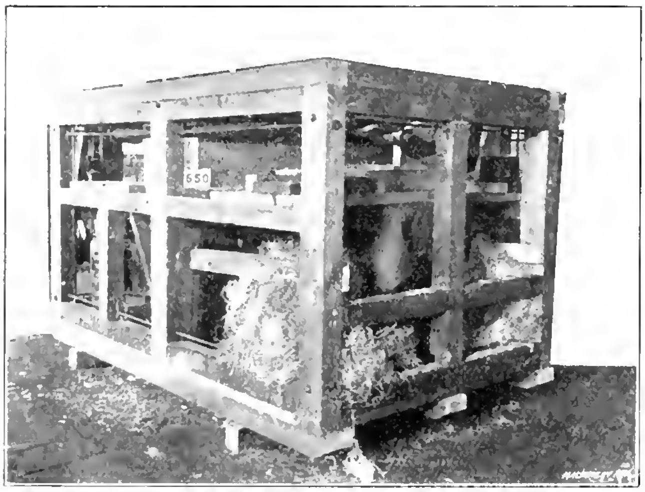

Fig. 3. Framing of Export Case for Gisholt 42-inch Boring Mill—Bed, Table, Feed-box, Head-stock, etc.

1.—Dismount all projecting slender parts to save space and to prevent breakage by side pressure. Saving of space is important as 40 cubic feet is reckoned a ton even if the actual weight is less.

2.—Avoid packages weighing more than 4½ tons if possible. The freight rate is much higher for packages exceeding this limit than for lesser weights. Keep all weights less than two tons if it can be accomplished without making assembly too difficult.

3.—In dismounting machines take into consideration ignorance of the parties receiving it, and avoid as much as possible dismounting parts that require careful adjustment for the successful working of the machine.

4.—Fill all the screw holes with wood or waste soaked in slushing oil, to prevent filling with dirt and rust.

5.—Tag all parts removed, giving their position or use on the machine.

6.—Prepare a list of all the detached parts to accompany the machine, which will show if any part has been lost in transit or custom house examination. Assembled drawings or photographs are desirable also, to facilitate erection.

7.—Cover all finished parts with a reliable slushing oil to prevent rusting during transit. The salt air and dampness of the sea voyage will attack unprotected finished parts to an extent almost unbelievable by one having known only the protection needed for land transport.

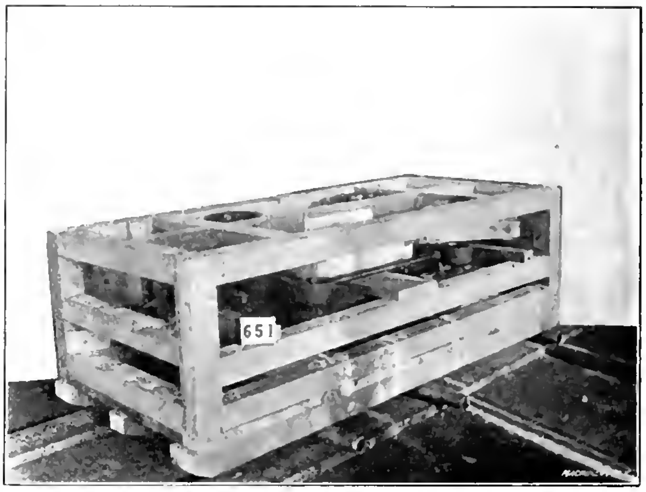

Fig. 4. Framing of Export Case for 42-inch Gisholt Boring Mill—Top-rail, Down-slides and Cross-rail.

8.—Build the package with strong skids, floor and framework, reinforced by through-bolts, if large, heavy machines are to be shipped without dismounting the frames from the legs.

9.—Support all heavy overhanging parts with cross girts from side frames, and pack accessory parts so that they cannot change position even if the case is overturned.

10.—Provide a waterproof roof and board the sides so as to resist driving storms of rain or snow. Leave an opening 12 x 18 inches in one side, the cover of which can readily be removed for custom house examination. Mark the screws holding the panel so that they will readily be found and removed without damaging the case.

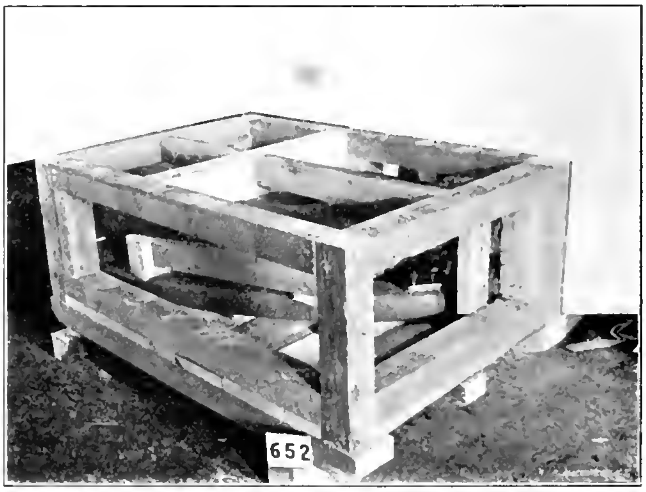

Fig. 5. Framing of Export Case for 42-inch Gisholt Boring Mill—Housings.

11.—Mark the case with the gross and net weight, volume in cubic feet, port of destination, names of consignee and shipper, name, number and capacity of machine; also designate the top or bottom and the nails or screws that should be first removed in unpacking.

DISTINCTIVE COLORS FOR PIPING IN A MANUFACTURING PLANT.*

OSCAR E. PERRIGO.†

There has recently been a good deal of discussion on the subject of painting the piping of a power plant in distinctive colors for the purpose of identifying the use of the various lines of pipe. The subject has appeared to be of sufficient importance to attract the attention of the members of the American Society of Mechanical Engineers, and a proposition has been made to standardize a system of colors which it is assumed should be somewhat suggestive of the use of the pipes and easily memorized by even the dullest intellect in the plant.

For many years the writer has been an advocate of the principle of making use of the well-known peculiarity in the minds of men to quickly recognize colors and their significance in preference to any amount of printed or written directions that can be given. Thus, in the pattern-shop a certain set of distinctive colors was given to patterns to indicate the metal of which they were to be cast, and to indicate what part of a pattern was to be cast in metal and what parts were the cores and the core-prints. In one establishment which had all its castings made outside the plant, much difficulty and annoyance had been experienced by having patterns sent to the wrong foundry, or ordered of the wrong metal. The result of the method of using distinctive colors worked so well that in seven years' use not a single casting was sent to the wrong foundry or made of the wrong metal. This seemed to prove the practical value of the system.

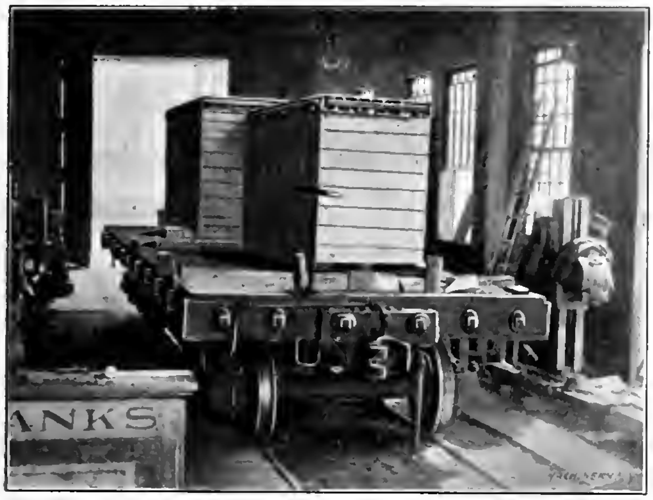

Fig. 6. Two Machines completely boxed and loaded on Car Ready for Shipment.

In the shop and office systems, the cards and blanks used had their distinctive colors, indicating their individual purposes, or the departments in which they were used. The men soon learned the signification of the colors, with no instruction whatever. Cards and blanks were habitually referred to by their colors rather than by the titles printed at the top. The work of sorting, arranging, and of generally handling them was greatly lessened and the question of efficiency favorably affected.

In the year 1891 the writer took charge of a manufacturing plant that had been started in "the good old times" (about 1850) in one small building, and which had been remodeled and added to at various times as the necessities of the business required, until it comprised no less than thirteen buildings and additions. There had been no general plan by which this work of development had proceeded, but each successive addition had been made to meet the emergencies of the hour and without much consideration for the future needs of the business. The result, so far as shafting, piping, transportation facilities, etc., were concerned, was much complication and a perplexing growth representing a maximum of expense and a minimum of efficiency. To bring something like order out of the chaos of piping, was a task that can be better appreciated by a man who has had a similar problem to solve, than by any amount of written description. Most of the piping had been done by outside workmen, and at various times, each of whom seemed to have endeavored to get as much piping and as many fittings into his particular job as possible, without reference to the necessities of the case or to previous or future conditions. Consequently, the systems of piping for steam, water, gas, and the fire protection system of sprinkling, were in an almost hopeless tangle, and generally two or three times as much piping put up as was needed. The sprinkling system was really the only piping in the plant that was put up according to a regularly formulated plan, and was, of course, distinguishable by the constantly recurring sprinkler heads upon all the smaller overhead pipes. As a preliminary to revising this piping system (excepting the sprinkler system), a comprehensive plan was worked out and workmen regularly employed by the company began the changes in accordance with it. These changes were continued until the entire piping system (except the sprinkler pipes) was completed according to the plan. When this work was begun, a great deal of difficulty was experienced in tracing out the various lines of piping, and on one occasion when a plug was removed from a tee for the purpose of making an extension to the gas lighting system, a jet of water convinced the gas fitter that he was on the wrong line of piping. Several incidents (or accidents) of this kind led the writer to use distinctive colors to identify the different lines of piping. Accordingly, after considering the question thoroughly, he adopted the following system of colors.

Red: For sprinkler pipes and all water pipes connected to the fire pump and used for fire purposes.

Green: For all other water pipes.

Blue: For all gas piping.

Brown: For all heating coils and the piping leading to them.

Black: For all other steam pipes.

When the men started the work of painting the pipes, and the scheme became known around the plant, there were a great many free opinions expressed as to the sane condition of the superintendent's mind. There was much wagging of wise heads among "the old timers," and a good many jokes by the "smart Alecs," as to what kind of a scheme would happen next; but in a few weeks the novelty of the innovation wore off and the sober second thoughts of the makers of shop opinions brought about a realizing sense of the fitness of the scheme to the purposes for which it was intended, and like the scheme for distinctive colors for patterns, and for distinctive colors for cards, blanks, etc., the practical utility of the system was readily conceded.

In the years of practical experience since that time, each trial of the system of identification by means of distinctive colors has still further strengthened the opinion that it is a very valuable and practically useful scheme, and that there are an infinite number of uses to which it can be profitably put in the organization and routine systems of any manufacturing plant.

* * *

Some interesting particulars of gears made from a special composition termed "Unica," which appears to constitute a new departure in silent power transmission, are given in our European contemporaries. These gears are made principally from compressed cotton, and tests carried out at the Royal Testing Institute in Berlin show that their resistance to indentation is 45 per cent greater than German rawhide at 1,120 pounds pressure per square inch, and that they offer 100 per cent greater resistance to displacement than rawhide at maximum pressure. Other advantages of the gears are stated to be that they are not affected by oil, and are cheaper than other types of silent gears. They can be key-seated the same as ordinary metal gears without fear of failure, and without the necessity of using bushings. The ultimate breaking stress sustained by the teeth of gears made from this material was shown by the experiments to be 51 per cent over that of German rawhide pinions and 27 per cent above that of vulcanized fiber pinions. It is stated that in strength the gears equal cast iron gears.

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* For previous article on color scheme for piping, see page 621, July, 1907, engineering edition.

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LATHE KINKS.

PAUL W. ABBOTT *

I once worked in a place where I was doing a medium grade of tool work, where there was no milling machine or drill press which I could use, so that it devolved upon me to do these two operations in the lathe the greater part of the time. Some of the schemes for doing this work, and the regular lathe work, will be presented in the following article.

The lathe used was a 16-inch Prentice with a first-class taper attachment, and it had the following equipment, the most of which I designed and made: One 12-inch three-jawed universal chuck, one 10-inch four-jawed combination chuck, and two drill chucks, one for rough use and the other kept for small, special jobs that necessitated a true running chuck. These chucks were mounted on hollow tool steel plugs, so that a bar of stock up to the capacity of the chuck could be run through and worked on. There was also one pair of special 60-degree cone centers used for nothing but the best work; one pair 60-degree cone cutters for ordinary work; one pair 90-degree cone centers (both hardened), used for rough, hurried work which I centered with a center punch; one long 60-degree cone center, projecting about 4 inches from the chuck, to be used on a piece of work that projected beyond the arbor or inside of a hole; two 60-degree half-cone centers for the tail-stock, one cut clear to center for squaring small work, and one cut down within 3/16 inch of center for heavier work; two pair 60-degree cone centers which were turned down; one pair to ½ inch and one pair to 5/16 inch diameter for getting inside of small holes; and one pair of centers for wood turning, of which I had a little now and then. As there was quite a little work on samples which were pointed 90 degrees, there was also a pair of 90-degree hollow centers, and three sizes of half-hollow centers for the tail-stock. Some of the work had round ends highly polished, and for that there was a steel center with a brass plug inserted in the end, which could be hand-tooled out to fit the work. All of the centers were draw-polished on the taper, and the head-stock centers were highly polished on the end that projected from center hole, while the tail-stock centers were left black. Thus they could be distinguished at a glance.

The collection of lathe tools consisted of about 300 of all kinds, shapes and sizes which were suitable for work ranging from 1/16 inch to 10 inches diameter. There was a set of Armstrong regular turners for holding high-speed steel bits, which I used altogether on regular turning. For drilling there were Nos. 1, 2, and 3 Morse sockets fitted to the lathe, and the following rigs: For regular plain drilling there was a plate, as shown in Fig. 1, which fitted the tail-stock spindle snugly, the work being supported by hand or blocked up on the bed of the lathe or carriage. For drilling round work, there was a V-block (Fig. 2), which was used with the plate shown in Fig. 1, the work being supported by hand. For drilling such jobs as shown in Fig. 3, or anything irregular in shape, an angle iron *A* was bolted on the side of the cross slide (Fig. 4), and the work *B* to be drilled strapped onto it. Any angle could be obtained in this way, and in drilling a row of holes it was particularly handy as the cross slide could be run along to first one hole and then the other. When drilling such work as a large box tool which was too large to mount on the angle iron, the cross slide was removed and the work strapped onto the ways of the cross slide as shown in Fig. 5. For drilling round work such as collars, I had a number of pieces of cold rolled steel of different diameters, from which one was selected to fit the hole in the collar, which was then drilled by using the V-block on the tail-stock spindle.

For milling jobs I had a number of arbors and a varied assortment of cutters. One of the best rigs, and one which no tool-maker should be without, was a 9-inch slitting saw, 1/16 inch thick, which was kept mounted on an arbor all the time with the dog on the arbor, ready to put in the lathe at a minute's notice. Another useful fixture consisted of a flat block of cast iron about 6 inches long, 4 inches wide, and 1½ inch thick, having two 90-degree V's in it at right angles to each other, and a number of tapped holes. This block, which was bolted to the top of the cross slide, and moved with it, was put to numberless uses. If I wanted a flat handle, such as shown in Fig. 6, did I wait for a forging? Not I!—simply reached under the bench and dug out a piece of soft steel the right thickness, laid off the right shape on it, strapped it to the block, and sawed it out to shape; the whole operation taking about five minutes. The saw ran at approximately 200 feet per minute (it had fine teeth, about 14 to the inch), and it was fed through a ⅜-inch flat stock at the rate of 2 inches per minute. If I wanted to cut off a piece of bar stock, I never went to the shaper to do it; I could saw a piece off with this rig while I was getting the shaper ready. A few of the pieces for which this rig was used are shown in Figs. 7, 8 and 9. If a number of pieces were to be cut from the bar it was strapped down loosely in the V-groove, and a stop put on the outside of the block to bring the pieces all the same length. The carriage was then locked and the pieces sawed. One inch cold rolled stock could be cut off at the rate of one piece per minute. Lard oil was used as a lubricant. When cutting brass the saw ran at 500 feet per minute. For milling such jobs as the heads of special cap-screws or squared ends on drill chuck wrenches, the rig shown in Fig. 10, which was mounted on the cross slide, was used. For this fixture there was a set of cast-iron bushings with holes varying by sixteenths of an inch for different sizes of work. I used to

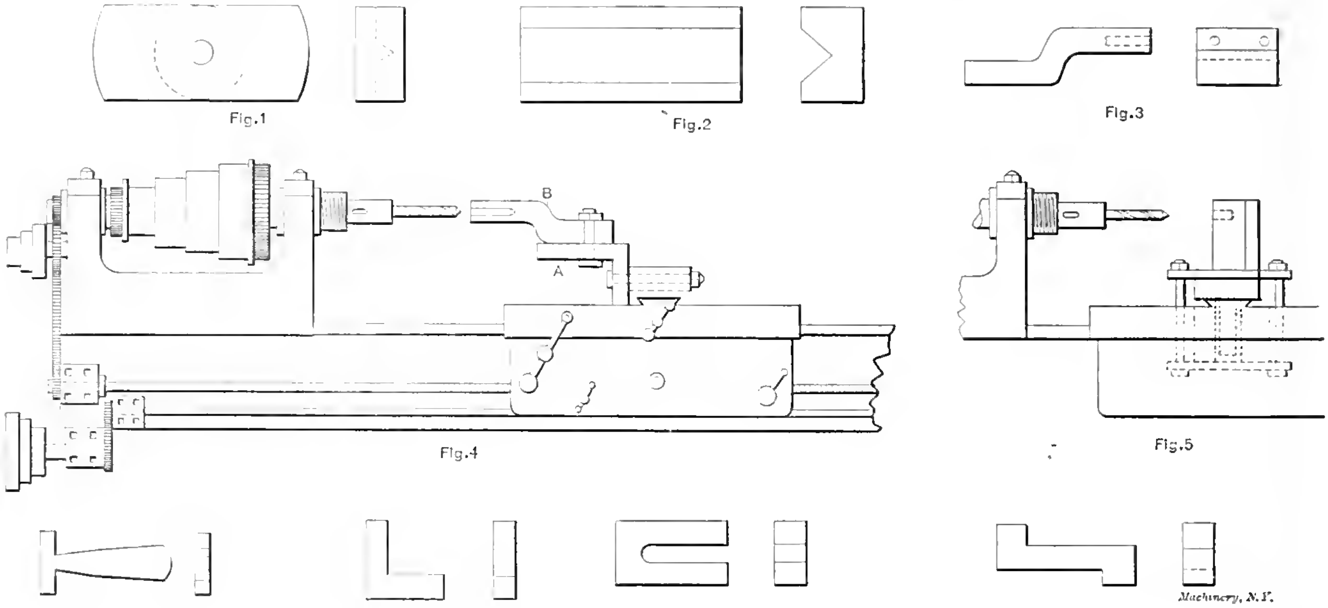

Fig.1 Fig.2 Fig.3 Fig.4 Fig.5 Fig.6 Fig.7 Fig.8 Fig.9

Figs. 1 to 9. Tools for, and Examples of, Work done on the Lathe.

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* 18 Waterford Street, Lowell, Mass.

have some bushings to make, similar to the one shown at *C*, which had to be cut into four equal parts. For doing this job there was a squared bushing *D* and the arbor *E*. The squared bushing was inserted in the body of the fixture in place of the round one; the square headed set-screws removed, and a thumb-screw having a flat end put in. The arbor *E* was inserted in the squared bushing, and the screw tightened down on it. The bushing to be slit was slipped onto the arbor, and the counterbored washer *F* tightened against the end. The jig was blocked up to such a height that the arbor *E*, where the bushing went on, just touched the saw, passing underneath it, the saw running backward. The flat sides on the bushing *D* served as an index for the four cuts as the thumb-screw was tightened down on each side. Split collets were also sawed in this jig, and short end mills and countersinks were fluted with it. Such a job as milling the face of the small cam, shown in Fig. 11, was done by strapping the V-block (Fig. 2) on the cross slide with the V lengthwise of the lathe, and strapping the arbor, holding the cam in the V so the arbor could be turned with a wrench on the end. Then with an end mill held in the drill chuck, and getting the proper depth of cut by feeding in the cross slide, which when in far enough was locked, the arbor was revolved and the piece milled to the shape required, except the sharp corner, which was afterward filed.

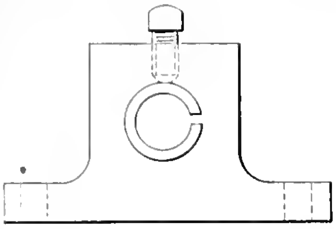
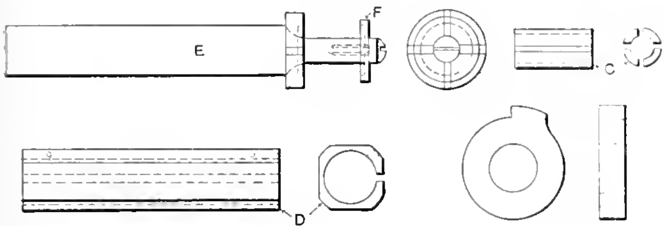


Fig.10



Machinery, N.Y.
Fig.11

Figs. 10 and 11. Fixture for Milling on the Lathe and Examples of Work.

For boring jobs I had the universal and combination chucks, a 16-inch face-plate, and a 6-inch four-jawed, independent, reversible-jaw chuck for small eccentric work, and a 4 x 6-inch angle iron. Some of my boring jobs were as small as ⅛-inch diameter, and others as large as 10 inches diameter. The boring on the angle iron was of the usual nature—boxes, bearings, etc., for repairs on machines. When pieces were too large for the face-plate they were strapped to the carriage and a boring bar used. When boring holes in the ends of long shafts, the angle iron was mounted on the side of the cross slide as in drilling, and the shaft was strapped in the V-groove in the angle iron. A drill was first used, and then a small boring tool which was held in the drill chuck. The boring tool is shown in Fig. 12. This feature of having 90-degree V's planed in the angle iron is a valuable one where there is any round work handled on the angle iron.

In connection with the cutting of small pitch threads, I always used carborundum slip stones to resharpen the thread tool before taking the final finishing cuts; in this way it was not necessary to remove the tool and disturb its setting. Slip stones of a medium grade of coarseness will remove 0.002 or 0.003 inch from a small surface in no time. These were also used on repair work. When reaming odd size holes, if the reamer was cutting a little large it could be stoned 0.002 inch under size in two minutes. For straight lathe work I had a number of features for facilitating the speed at which it could be done. There were three rests for the lathe: the regular center rest, a follow rest, and a rest for light work (Fig. 13) which fastened to the tail-stock spindle. For the center rest I had five sets of jaws; one set for small work down to 3/16 inch diameter; one set of shorter jaws for the usual run of work, one set still shorter for work up to the full capacity of the rest; one set of jaws that were tapered off to 3/16 inch square on their ends, for taper work; one set of steel jaws 5/16 inch thick to go in between shoulders or other narrow places. Thus there were sets of jaws for all the work that came along, and there was no waiting to file jaws to take in a large piece of work and then find them too short for the next small work that came. The slots in the rest were numbered and the jaws were numbered to correspond, so that the latter always lined up correctly. On the jaws a center line was marked so that as they wore away and had to be filed off on the sides to make them narrower on their points, they could be filed to the center line and always be lined up with the center line of the lathe. The follow rest, which was of the usual type, had several sets of jaws for different sizes of work. The rest shown in Fig. 13 is not very common, but is mighty handy on small work. The arms *G* are adjustable on the shaft, and the jaws *H* are of brass and are also adjustable.

The feed on this lathe was thrown in by a T-handle *J* which could be turned either way, and also thrown out by revolving in the same direction. When turning a long piece in the lathe a bar was fastened to the bed of the lathe, as shown in Fig. 14, and in that an adjustable rod *K* which, when the feed handle struck it, would throw the feed out. This was very handy, as I could be doing something else while turning a long piece.

I used to have a number of long, square threaded screws of mild steel to make 1¾ inch diameter, three threads per inch. When doing square threading an Armstrong tool-holder was used for holding ⅜-inch square tool bits; these bits were made of Novo steel. There was one tool for roughing and one for finishing, 0.005 inch being left on each side of the thread to remove with the finishing tool.

As there was no compound rest for the lathe, when doing angular work other means had to be provided. For angles up to 10 degrees, measured from a line at right angles to the ways, setting the tail-stock over would do. For angles up to 15 degrees, measured from a line parallel to the ways, the taper attachment was used, but for angles of larger degree, another scheme was adopted. The carriage feed and the cross feed could both be thrown in together, which gave an angle of about 45 degrees. This angle could be varied either way by setting the tail-stock over or by connecting up the taper attachment. This was applied in a very practical manner to the making of some 90-degree inserted tooth countersinks, 5 inches in diameter. I used this method for turning the 90-degree nose of the countersink, and boring the 90-degree steel cone which fitted the nose, which was afterward cut up into sections for holding the teeth. Having no indexing attachment on the shaper, the graduating was all done in the lathe with the gearing, using a sharp-pointed tool in the tool-post, and then transferring the work to the shaper and working to the lines. When cutting off a piece on an arbor, I always set my calipers to about 0.005 inch over the size of the arbor, and then, holding the calipers in the slot made by the cutting-off tool, cut away freely until the calipers slipped over the work. This is only a little kink, but it often saves cutting into the arbor. There are various ways of fix-

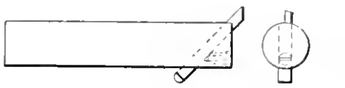


Fig. 12

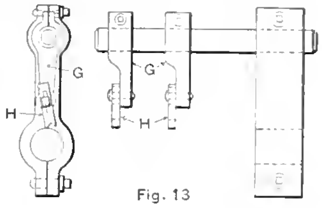


Fig. 13

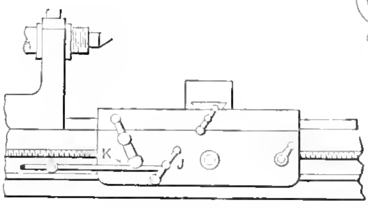


Fig. 14

Machinery, N.Y.


Fig. 15

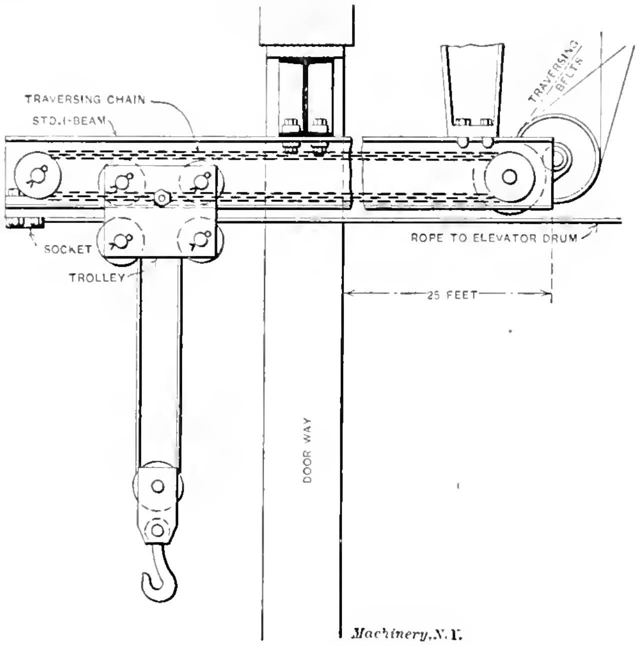
Figs. 12 to 15. Automatic Feed Stop and Miscellaneous Lathe Toole.

ing the ends of centers, but the best way I know of is shown in Fig. 15. A center finished like this will stand any amount of banging without injuring the fit in the center hole. Some of these kinks may not be new to all, but they are all good ones, and time savers.

* * *

A CONVENIENT OUTSIDE SHOP HOIST.

The shop of E. E. Bartlett, of Boston, the builder of the Greenerd arbor press, is located on the sixth floor of a factory building. As the elevator service is not particularly convenient, and as the castings for the larger sizes of the arbor presses are quite heavy, they are hoisted up the outside of the building and in through a door onto the floor of the shop. The same arrangement is used for lowering the finished work. This is a very common practice. The ordinary rig consists of a wooden beam projecting over the doorway for a few feet and provided with an eye-bolt to which a block and tackle is rigged, which is operated by anything that comes handy. For hoisting a bale of hay with such an arrangement to the second story of a stable, a horse is hitched to the end of the rope; in manufacturing establishments the horse is sometimes used, but the hauling is more often done with some homemade winding arrangement.



Machinery,N.Y.

A Convenient Hoist for Handling Material through an Outside Doorway in an Upper Floor.

Mr. Bartlett has improved on the primitive construction in a way that gives him little reason to regret the inefficiency of the elevator. The arrangement is shown diagrammatically in the accompanying line engraving. A steel I-beam, properly proportioned, is firmly suspended beneath the arch of the door-way, projecting outdoors for a sufficient distance to allow the material to clear the sides of the building, and extending inward for 25 feet or so over a shipping and receiving floor. On the under flanges of this I-beam runs a trolley, provided with two idler sheaves. Over these passes a wire rope, from which, by means of a block and hook, the load is suspended as shown. The outer end of this rope is fastened to the outer end of the I-beam, while the inner end is led back to a regular commercial form of elevator hoist provided with the usual stops to prevent overwinding, and having the usual arrangement of shifting belts for raising or lowering the load as required. The controlling ropes for this elevator hoist are brought to a point near a window beside the doorway, where the operator can have a full view of the operation, both indoors and out.

The trolley is connected with a chain running over the idler at the outer end of the beam and over a sprocket at the inner end. This sprocket is connected by gearing with tight and loose reversing pulleys, whose belt shifter is operated by cords which are also led to the operator's position by the window. It will be seen that with this familiar arrangement of trolley and hoisting rope, the load may be raised or lowered and traversed, together or separately, the two motions being independent of each other. The operator at the window raises the load from the truck below until it reaches the level of the doorway, then runs the trolley in by power until it reaches the desired position over the receiving floor, when it is lowered and released. One great advantage of this arrangement, from the standpoint of safety, is the avoiding of the necessity for leaning out through the door to pull the load in; a frequent cause of accidents is thus avoided. Another advantage is the convenience, in shipping, of being able to take work from the floor and deposit it in the wagon, without requiring the intermediate operation of shifting on rollers into the elevator, and from the elevator to the truck. The whole arrangement is very simple, and may be made almost entirely from commercial parts. For hoisting loose castings a basket is used, made of boiler iron.

* * *

EXPERIMENTS WITH ROPE AND BELT DRIVES.

Some experiments have been undertaken by the Technical Institute at Charlottenburg, Germany, in order to establish definitely the loss of energy in transmitting power by means of belts and ropes. These experiments indicate that the capacity of belts for transmitting power at high velocity is considerably higher than given by ordinary formulas and calculating methods. It appears from the experiments that it is an advantage in belt drives to use large pulley diameters, and consequently high peripheral velocity. Considerably better results are obtained if the pulleys are made from wood for diameters less than 24 inches. An idler for obtaining the required tension, placed close to the small pulley and having a diameter at least 50 per cent greater than this pulley, does not reduce the efficiency of the drive in any appreciable degree when the belt speed is not greater than 100 feet per second. An idler for producing proper tension and for providing larger angle of contact on the smaller pulley is therefore to be recommended in belt drives of high ratio between the sizes of the pulleys.

The friction in the bearings is considerably greater for rope drives than for belt drives, because ropes must be under higher tension than belts, all other conditions being equal. The efficiency of rope drives decreases considerably for high speeds, while it increases for belt drives. When high peripheral velocity is required it is therefore advisable to use belts rather than ropes. In the case of rope drives the efficiency is also reduced when the diameter of the pulley or sheave is reduced, due to the power required for bending the rope, whereas the diameter of pulley in belt drives is of very little consequence, within rather large limits. The highest efficiency obtained during the tests referred to was 98 per cent with the belt drive, all conditions being ideal. Power transmission by means of a single rope, gave 97 per cent as the highest efficiency; using two ropes side by side, made the highest efficiency 95 per cent; and only 90 per cent efficiency was obtained with four ropes side by side. The efficiency in the case of rope drives thus decreases about in proportion to the number of ropes employed. The figures quoted give the actual efficiency of the drive, the friction losses in the bearings being subtracted. The latter are also greater in the case of ropes than in the case of belts, due to the higher tension required in rope drives. While idlers in the case of belt drives did not appreciably decrease the efficiency, in the case of rope drives it was found that idler sheaves decreased the efficiency considerably.

* * *

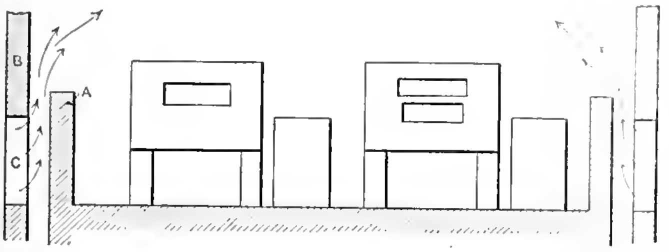
A scheme for securing efficient industrial education which undoubtedly could, in a modified form, be worked to advantage in many of our industrial centers in the United States, has been adopted by a number of English firms. It appears that some municipalities maintain public evening schools especially adapted to the needs of apprentices, but as the expenses for these evening schools are rather too high to be borne directly by the municipality, if efficient instruction is to be given, the local firms have agreed to pay a certain sum for the instruction of each of their respective apprentices who joins an evening class, and monthly reports are forwarded the firms as to the attendance and progress of the students.

THE MANUFACTURE OF TAPS—2.

In the January issue, the turning, threading, squaring, fluting, chamfering, and relieving of taps, as practiced in the manufacture of these tools by the Wells Bros. Co., Greenfield, Mass., was treated in detail. It is proposed in the present and concluding article on the manufacture of taps to treat of the hardening and other operations still remaining to be performed on the taps, and also to refer briefly to some of the many interesting features of the shop equipment and systems used in the works of the Wells Bros. Co.

Hardening.

The hardening of taps and dies in this plant is carried on according to the most modern methods, and several features have been introduced which are of particular interest. The hardening room is completely dark except for what little daylight comes in through the ventilators in the ceiling. There is an advantage in having this room dark as it is possible for the hardener to judge exactly the heat of the pieces to be hardened, by their color. It would seem that a hardening room without windows would be rather uncomfortable, but the ventilation is of the best, and the arrangement for securing efficient ventilation without letting in the light is indicated diagrammatically in Fig. 20. The hardening room proper may be said to consist of a concrete tank *A* having walls extending up about 3 feet from the floor. Outside of these walls are the actual outside walls *B* of the building, which are provided with openings or windows *C* below the level of the top of the walls *A*. From these windows the air circulates through the room, escaping through ventilators in the ceiling.



Machinery,N.Y.

Fig. 20. Diagrammatical Sketch of Arrangement of Hardening Room.

This system of ventilation evidently is unusually efficient, as the hardening room was much cooler than a great many others which the writer has known, in which the windows for ventilation and light were provided directly in the walls. It is evident that it is permissible to have the windows constantly open and secure better ventilation in a case where the arrangement is as indicated in Fig. 20, because the cold air does not strike the furnace directly, nor does the draft inconvenience the operators, as is often the case when ordinary windows in a hardening room are opened.

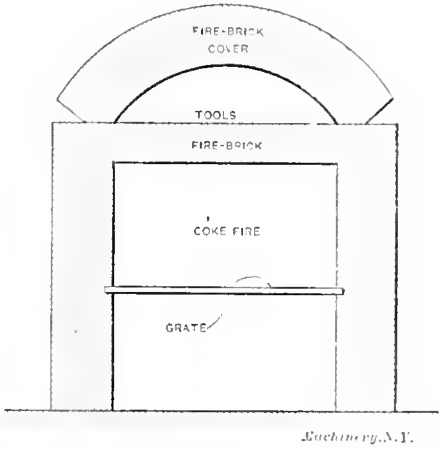
The furnaces, which are of the company's own design, are heated by oil fuel. An underground tank is provided outside of the works, having a capacity of 6,000 gallons. From this the oil is pumped to a small tank where it is under pressure and from where it goes to the various furnaces. The surplus oil returns to the big tank by a return pipe. All piping is under the concrete floor in the hardening room. There are two regular hardening furnaces installed in the works, one for large and one for small work. No lead pots filled with molten lead are used for ordinary hardening, as it is considered that the method of hardening in lead is a poor one, and that in order to obtain satisfactory results more modern methods must be employed. The hardening furnace for small work is provided with ten tubes or pipes 1½ inch in diameter and 14 inches long. These tubes pass directly through the furnace and the outside walls of the furnace frame, and are open at the front end. The flames from the burners strike the outside of that part of these tubes which is inside the furnace. The pipe used is ordinary gas pipe, and burns out in from four to six weeks.

The work is placed in half circular shells and pushed into the tubes where it is heated slowly and very uniformly. The operator observes when the work has reached the correct hardening temperature, then he removes the half circular shell with the work from the tube, and dumps it directly into the hardening bath which consists of ordinary brine. It has been found that this method of hardening is superior to any that has been tried in the works, and that the taps come out of the hardening bath with a remarkably even texture. Taps up to five-eighths inch diameter are hardened in this manner.

Larger taps are hardened in a furnace where the oil fuel strikes cast iron plates on which the work rests. The work is heated very slowly. By distributing the flame from the burner in a certain way, it is possible to heat the furnace and the cast iron plate at one end much more than at the other. The work is first put in at the cooler end of the furnace, and gradually moved over to the hottest part, and when it has been in long enough to insure a uniform heat throughout the work, even on large pieces, it is removed and quenched, as usual.

Some taps, like bit brace taps, for instance, are not turned up from the solid stock but are drop forged. These drop forgings must be annealed before the taps are turned to the correct size. The annealing is done in an ordinary annealing furnace, the work being packed with cast iron chips in cast iron boxes and a cover of cast iron placed on the boxes. These boxes are placed in the furnace in the morning and the fire is kept going for ten hours. The boxes are then removed from the furnace the next morning.

Some interesting things seen in the hardening room which do not have direct bearing on the manufacture of taps, may here be mentioned. One is the method for obtaining the mottled effect which the company produces on die-stocks and several other tools having large polished surfaces. In order to obtain a fine mottled effect on the steel, the object to be treated is first highly polished and then very carefully cleaned from all oil in hot soda solution. It is then slowly heated to a temperature of from 150 to 200 degrees by placing it on the hot fire-brick covering the top of the furnace. When heated to the degree mentioned, the steel is put in a pot of heated cyanide of potassium and brought to a dark red heat. It is then dipped into clear water and vigorously moved about in this. Unless the work is moved about when cooling off in the water, the mottled effect desired will not be obtained.



Machinery,N.Y.

Fig. 21. Diagrammatical Section of Hardening Furnace for High-speed Steel.

Gages are not hardened by heating in the furnace the same as regular tools, but are pack hardened. The gages to be hardened are packed in ordinary ground bone in cast iron boxes covered with fire clay on top, and then heated for about three hours.

For hardening high-speed steel, a special furnace, shown diagrammatically in Fig. 21, is employed. For obtaining the heat required, coke and an air blast are employed. Small work is heated from three to four minutes and quenched in linseed oil mixed with ordinary salt; as much salt as the oil will dissolve is used.

Long taps which require straightening are heated to a straw temper and then placed under a straightening press having two cast iron blocks in which the tap rests at the ends. A screw with a block bearing on the tap is then used for obtaining the required pressure for straightening the tap. All taps are tempered in oil, and the temper is drawn to a temperature of from 430 to 450 degrees F.

Polishing the Taps.

[illegible] the shank of the tap is polished. After hardening the [illegible] again returned to the polishing room where [illegible] polished in the flutes by means of a small [illegible] of semi-circular cross-section. The taps are [illegible] burred between the threads with a piece of [illegible] hoop iron, which is caused by hand to slide [illegible] between the teeth, the tap meanwhile being revolved on centers. After this burring operation the taps are cleaned [illegible] threads by a wire brush revolving at high speed. Then the shank and the end and corners of the square are polished by hand.

A view of the polishing room is shown in Fig. 22. All polishing and grinding is done by hand; the polishing room is unusually free from dust owing to the fact that every wheel is provided with a sheet-steel hood connecting with an exhaust system under the floor. The arrangement is shown plainly in Fig. 23, which also shows a machine of rather ancient design, it having been built in 1877. The most interesting thing about this machine is that it is provided simply with ordinary cast iron boxes carefully protected from dust by dust caps, and while it has been in constant use for the last thirty-two years, the boxes are still in good condition. This indicates the possibilities of regular cast iron boxes for journals running at high-speed, provided the boxes are carefully protected from grit and dust.

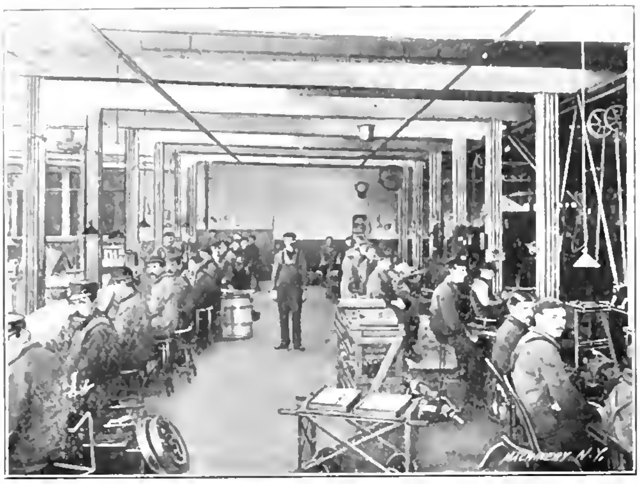


Fig. 22. Grinding Department—A Common Form of Shop Truck used in the Shops is shown in the Foreground.

Tools for Inspecting the Taps.

The taps are now ready for the inspection department, a view of which is shown in Fig. 24. It should be mentioned in this connection, however, that between each operation of any consequence all tools go to the inspection department to be inspected before the next operation on the tools is performed. In the inspection department the system of gages developed by the Wells Bros. Co., examples of which are shown in Figs. 19 (January issue) and 25, play an important part. Fig. 25 shows two thread micrometer gages for measuring the angle diameters of taps; these micrometers are provided with large dials at the measuring screw end of the device, the dials being graduated so that 0.0001 inch can be easily read off, this amount being equivalent to 3/64 inch on the periphery of the dial. These thread micrometers are made according to the principle developed by the company, having the two measuring points offset half of the pitch so that each point enters directly into a thread in the tap to be measured. In the foreground is shown a block holding a number of measuring points which can be substituted in these measuring instruments for different pitches and classes of threads.

On the right-hand side in Fig. 25 are shown two thread micrometers mounted in convenient holders, which are provided with points for measuring the angle diameters of threads, the anvil point being adjustable for different pitches, the same as in the larger instruments. In the same illustration is also shown an interesting gage for measuring the [illegible] and width of the flat of Acme standard thread tools. In Fig. 19 are shown the regular working gages employed in the works and in the inspection room. We have already referred to the limit gages *A* and *B* for measuring diameters of plain work. It will be seen that these gages are also made with sharp points, as shown at *C*, for measuring the angle diameter of threads. This system of gages, as well as some of those shown in Fig. 25, has previously been described in MACHINERY in the August and September, 1907, issues. For measuring the lead, gages as shown at *D*, Fig. 19, are used.

The company is at the present time preparing to place on the market a system of limit gages which have been used in the works for some time, of which one example is shown at *E*, Fig. 19, the female gages being placed in the box shown, and the male gages being seen in front of the box. The feature of these gages is that each gage is surrounded by a hard rubber ring on the outside, one being black and one being red. The black color indicates the maximum limit gage and the red color the minimum gage, the red color being the "danger signal." This same indicating system is followed in regard to the handles of the plug gages. The advantage of such visible indications of the maximum and minimum gage, which obviate the necessity of looking for the stamping on the gages, is evident.

The system of setting the limit gages of the type shown at *C*, Fig. 19, is of considerable interest. In order to make it possible to set the gages easily to any predetermined limits, a special threaded plug is provided, having a very slight taper. At a certain place on this plug the exact standard size is indicated by a line. The taper for each plug is so selected that the next thread below the size line marked is 0.001 inch less in diameter than the standard diameter at the line, the second thread, 0.002 inch less, and so forth; the first thread above the size line is, of course, 0.001 inch larger in diameter than this dimension. By adjusting the maximum and minimum limits of the gages to this taper plug, the gages can evidently be set to any limits varying by 0.001 inch, and if special care is used, limits as close as 0.0005 may be obtained. The same system, of course, can also be used for the setting of the plain limit gages *A* and *B* in Fig. 19, a plain plug with size lines being used.

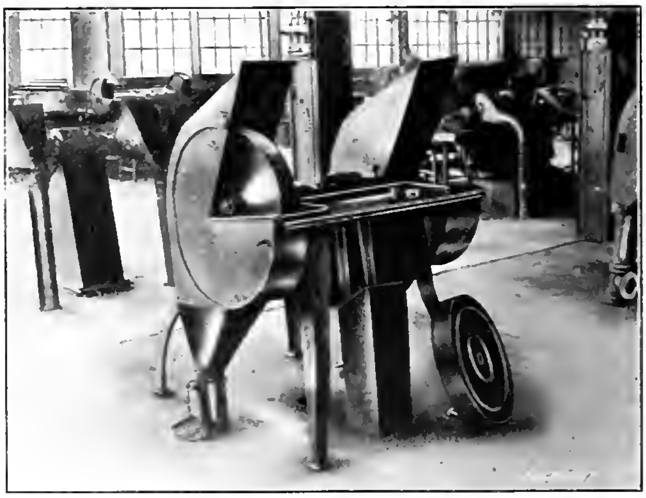


Fig. 23. An Old Grinder built in 1877 which still gives Efficient Service. Note also System used for Exhausting the Dust due to Grinding.

The Stock Room.

After the inspection the taps go into the stock-room, where the smaller ones are put away in drawers, as shown in the foreground of Fig. 26. The larger taps are put away on open shelves. All the racks and shelves are made of metal, and the shelves are adjustable for height on principles similar to those employed in adjustable shelve bookcases. This gives great flexibility to the storage system. The stock-room is also unusually light, due to the fact that there are no solid partitions such as are necessary when the shelves are made from wood. On each of the drawers in which the smaller taps are contained, the kind, size, and pitch of the tap is marked, and also the minimum and maximum number of taps which ought to be kept in stock. When the storekeeper finds that the number of taps of a certain kind is running down towards the minimum limit, he puts in an order for a new supply of

this kind of taps. In this way a full supply of all sizes and pitches are assured without any elaborate system of bookkeeping.

Some Features of Interest in the Shop.

There are many features in the shop equipment and the systems employed, which are seldom seen in other plants. One of the first things which the observer will notice is the liberal use made of concrete. Not only are the floor in the shop and the larger machine foundations made of concrete, but many smaller machines are provided with concrete supports instead of cast iron legs, and it is stated that the cost of concrete used for this purpose is only from one-fourth to one-fifth that of iron legs. Concrete is also used largely for supports for work benches, and in the shipping room the writer saw a large bench made entirely out of concrete, intended to be used for nailing boxes; the noise commonly present in the shipping room, due to the hammer blows in nailing boxes and crates and the vibrations in the benches and floors, are largely eliminated in this shipping room, due to the fact that there are no vibrations in the supporting bench or floor, and it appears from a comparison with other places within the writer's experience that the larger proportion of the noise is due not to the nailing operation itself, but to the fact that the box or crate is supported on a flimsy and vibrating support.

All tools are stored in the shop in cabinets with sliding glass doors, and the benches in front of these cabinets are covered with linoleum. It has been found that it is not only cheaper to keep the benches thus covered, if a neat appearance is valued, than it would be to try to keep a wooden bench in fairly good condition, but it is also much easier to keep clean. All cutters are placed on wooden pegs mounted in blocks, and on the end of each block is given the sizes of the cutters and the purpose for which they are intended.

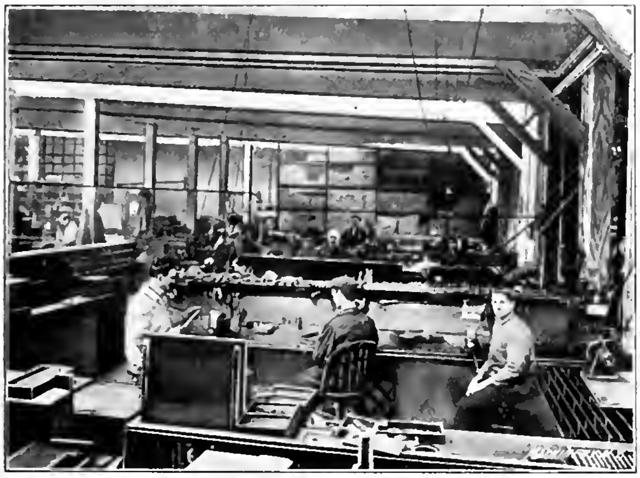


Fig 24. Inspection Department.

Each foreman in the shop is supplied wtih a volume of blueprints bound in a loose leaf binder, and he is also provided with a loose leaf binder for all special instructions given to his department from the superintendent's office. All gages are turned in to the inspection department once a week to be inspected and adjusted.

Besides the regular stock-room, a storeroom is also provided for work in progress. All work goes to this storeroom between each operation, and as mentioned before, it is then inspected if the operation warrants this. On regular taps only the threading and finishing is inspected, there being practically no chance for mistakes in the other operations inasmuch as the operators are provided with limit gages which determine whether the work is made as required. One of the features in the shop which saves a large amount of handling of the material, and makes its transportation from one part of the shop to another convenient, is the use of box trucks of the type shown in Fig. 27. This truck is practically an iron truck provided with a wood lining, and it rests on four wheels, one at each end and one on each side, as shown. When the work has been placed in the truck after having been finished in one department, it is transported to the storeroom for unfinished work, and remains in the truck until it is sent to the department where the next operation is to be performed. It is then taken out of the truck as it is wanted for the machines, and when the operation is performed it is placed in another truck ready to go back to the storeroom again; in this way any superfluous amount of handling the material is avoided. These box trucks at the same time provide good means for storage of the articles.

In the same illustration is also shown one of the very convenient benches used all over the shop. It will be noticed that it consists mainly of an iron frame provided with two wooden shelves. All over the shop one finds trucks and stands of various types built up with iron frames, Mr. Wells being a great believer in "iron furniture" on account of its strength and durability. The interesting feature about this work bench, however, is that it has no sliding drawers, but is provided with two cast iron semi-circular trays which are mounted on a stud at the center of the circle, and when the material contained in the trays is wanted, all that is required is to swing the tray out so that the contents are exposed. It is clear that in this way the whole contents of the tray will become visible when the tray is swung out completely, whereas in the case of a drawer, it is not usually possible to pull it out far enough to see the complete contents, particularly when heavy tools are stored away in it. Besides, the difficulty of trying to pull out a drawer containing heavy tools and making it slide freely is well known. In the engraving, Fig. 27, the upper tray is shown closed, while the lower one is shown swung out so that about three-quarters of the contents are exposed to view.

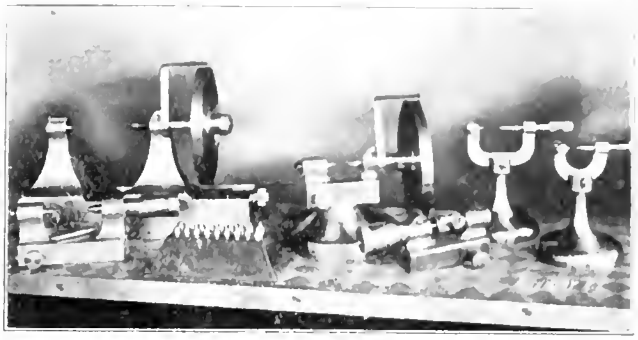


Fig. 25. A Set of Thread Micrometer Gages of the Wells Bros Co.'s Type, used in Inspecting Taps.

The equipment in the shop is highly specialized. In a general way one might say that there are very few standard machine tools, and there are few machines of modern make. This, however, in no way interferes with the efficiency of the shop, for it is plainly in evidence that a simple machine designed exclusively for performing one specific operation is a far better investment, and far more efficient for the work it is intended to do in specialized manufacture, than would be one of the modern universal machines which in many respects are largely tool-room machines. It is Mr. Wells' opinion that in most classes of manufacture the highest efficiency can be reached by simple improvements of the ordinary design of machine tools rather than by departing too far from the old line of tools and trying to introduce new features which

Fig. 26. A "Street" in the Stock-room where the Finished Work is Stored.

are seldom or never required in ordinary manufacture. There are many machines in the shop which were built twenty or more years ago which are still in use and which perform the work they are used upon fully as efficiently as would a standard modern machine tool, but it is understood that these conditions are true only in cases where the manufacture is highly specialized as in the case of making taps and dies.

Being a one-story shop and provided with skylights, it is exceptionally well lighted, a feature which is also evidenced by the appearance of the half-tones, the photographs for which were taken on a very dark and foggy day with no direct sunlight whatever.

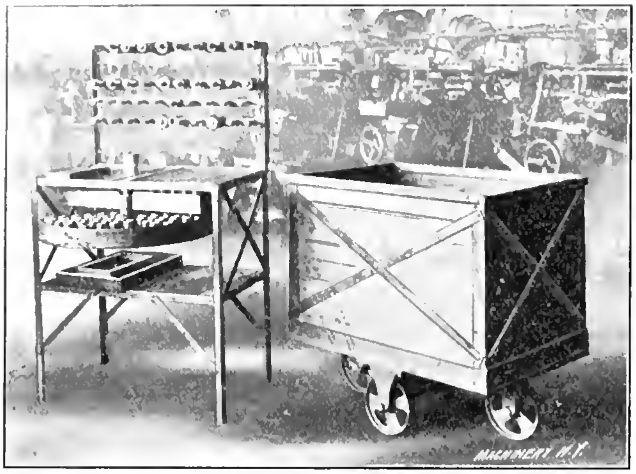


Fig. 27. A Work Bench with Handy "Drawers" and a Storage Truck used Extensively in the Shops.

After having noted the methods at present employed in the making of taps in a highly specialized tap manufacturing plant, it may be interesting to refer to the methods which Mr. Wells and his brother first employed when they started in making taps thirty-three years ago. Special machinery, and even the now common types of standard machines, were then not as common as now, and when manufacturing on a small scale in particular, some methods which to-day would be considered rather crude, were employed. Mr. Wells tells of how they used to cut off the tap blanks in the blacksmith shop from the rough stock, one man wielding the sledge while another held the cold chisel. The threading was all done in ordinary lathes with chasers, Mr. Wells being the first man who employed chasers for thread cutting at the Wiley & Russel Co.'s Works in Greenfield in 1874. The fluting at that time was done in a small milling machine where one tap was fluted at a time, one man being required for each machine to feed the table by hand. At first the tempering of the taps was done in an oil stove. Little by little, as the shop grew, these methods were superseded by more efficient ones, until at the present time the manufacture is placed on the efficient basis outlined by the present description of the plant and the methods.

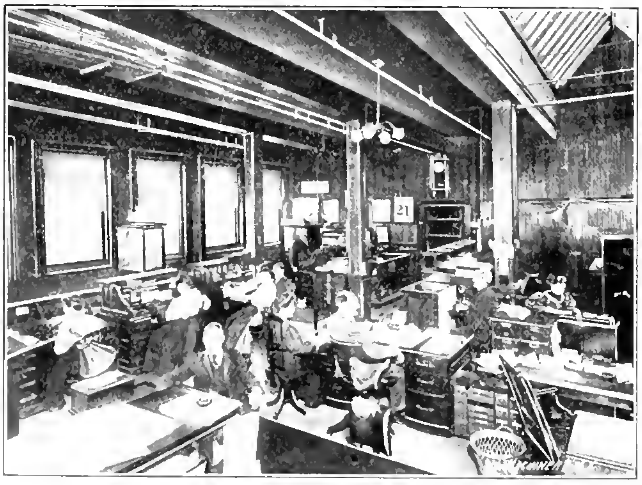


Fig. 28. Office of the Wells Bros. Co.

HOW TO GET A JOB.

A. P. PRESS.

Well, the hard times have come and gone again and the boys are out hunting for jobs. Now, there is a lot of difference between getting a job and holding it. Some fellows are natural job-getters, and others are job-keepers; and when the job-keeper really loses his job, he is "up against it for fair." I have done lots of job hunting, and I have had the jobs hunting for me; and there is a big difference between the two kinds of sport.

In most of the big factories, nowadays, the hiring and sacking is done by a hiring clerk, who doesn't know a tool-maker from a power-press hand. When the foreman of a department wants half a dozen men he orders them the same as he would the same number of files from the stock-room, and after he gets them he sorts them out, keeps what he wants, and lets the rest go. Now, this is all very well for the shop, but it's kind of hard on the fellow who is doing the hunting. And so a few words to him may help him bag his game:

First, be sure what you can do and do *well*. Go after a job in that line, and if it is not there, take the next place. If a man comes to me and tells me he knows how to break stone, and that he can break them quickly, then I have some encouragement to try him, for the man that can do one thing well can learn to do another well, provided it is in his capacity to do it at all. Don't tell me that you can do anything, for of all answers to an inquiry as to what a man can do, that's the most discouraging; in fact, it isn't any use to talk with the applicant further.

Second, don't run in a hard-luck story about your wife and seven small children, because if the boss is "onto his job" it won't help your case a mite; he isn't running a free soup house but he is trying to "deliver the goods" and not have the freight charges too high. If you are hard up, he may give you a dollar, but he won't give you a job.

When you want a job just ask the boss flat if he wants a good vise hand, or whatever your "best hold" is; tell him what pay you want, and that you will go in and work and work quickly, and if you are not worth the price to just drop you and there will be no hard feelings. If he has a job to give you can get it.

Third, if you are an old fellow and wear glasses, put them on before you go in; then you won't feel "streaked" when you get on the job and have to wear them. I well remember the last job that I went for; I heard the boss coming up the corridor and I put them on in a hurry. He came in, talked a minute and said he was looking for a man with plenty of experience and asked if I would go on as foreman. Well, I guessed I would, and I did and made good.

Now, a word about cheek—not gall—just cheek. The boss saw a new man sweeping up the shop, so he said: "When did you come in?" "Yesterday, sor." "Who hired you?" "The man over there, sor," said the sweeper, pointing to the other sweeper down at the end of the room. "Well, how's this, Tom?" said the "super," calling up the old hand. "Well, sor, had more work than I could do, and so I put him on." "Well, I'll be d—," said the super, but he went into the office and had a good laugh over it and ended by putting him on the books.

Lately, the graft mania that we have had for the last few years has had its effect in some of the shops, and there has been a lot of what I would call "foreman grafting" done—mostly in the big shops. The foreman will charge a man, say, $5 for his job, and then collect it on the installment plan. There is one thing worse than to give a man a dollar for a job, and that is to take it, for the moment that you do that you put yourself in the other man's power. The case to which I refer came up lately; the man paid his $5, came in and worked a few days, and then, not liking it, went to the office and stated the case and wanted to know whether, if he got through, he could get his $5 back again. There was "something doing" right away.

* * *

According to the *Brass World*, the best spring metals (alloys) are those which do not contain zinc. When zinc is present crystallization is more apt to occur.

JIGS AND FIXTURES—11.

EXAMPLES OF BORING JIGS.

EINAR MORIN *

In the January issue of MACHINERY the fundamental principles of boring jigs were outlined. In the present installment a number of applications of these principles to boring jigs that have been designed for shop use will be shown.

In Fig. 126 are shown two views of a small jig supported directly on the work to be bored. This jig is used for boring out a cross-slide carriage, and is located on the work by the dove-tail slide and held in place by the two set-screws *A*. The two bushings *B* are driven into the solid part of the jig and the two corresponding bushings *C* are placed in the loose leaf *D* which is removed when the jig is placed in position on, or removed from, the work. The two set-screws *A* do not bear directly on the side of the carriage but are provided with brass or steel shoes as shown in Fig. 130, where *E* is the shoe. The leaf *D* cannot be attached permanently to the jig and simply swung out of the way when the jig is located on the work, because it could not be swung in place after the jig is applied on account of the small clearance in the cross-slide carriage. The leaf is therefore made loose, which is an objectionable feature, but lugs have been carried up on the casting on both sides of the leaf as shown, to give good support; these lugs are carefully finished to fit the leaf, and the latter is located and held in place by ground plugs.

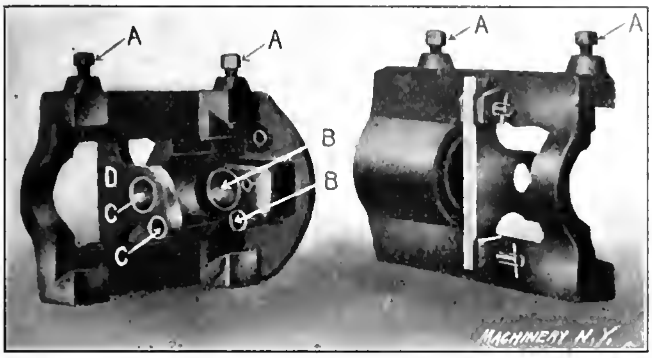


Fig. 126. Example of Small Boring Jig, with Removable Leaf for Holding Guiding Bushings.

In Fig. 127 is shown a boring jig which receives the work *A* between two uprights. The work in this case is the tail-stock of a lathe where two holes *B* and *C* are to be bored out. The bottom surface of the tail-stock is finished before boring, and is located on the finished bottom of the jig by means of a key and keyway. The keyway is cut in the jig and is a little wider than the key in the work, and the set-screws *D* bring the key against one side of the keyway, that side being in accurate relation to the hole *B* to be bored in the tail-stock. Longitudinally the work is located by a stop pin, against which it is brought up by a set-screw from the opposite side. The tail-stock is held to the jig by bolts *E* exactly as it is held on the lathe bed.

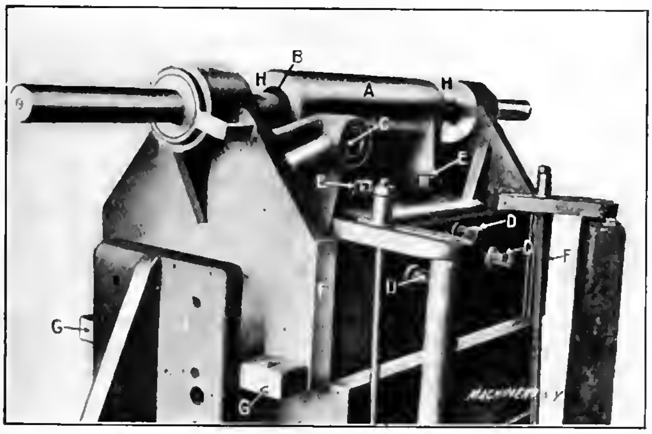


Fig. 127. Common Type of Medium Size Boring Jig.

The placing of the set-screws *D* at different heights is one of the features of the jig; this makes it possible for the jig to take tail-stocks of various heights for different sizes of lathes, raising blocks being used for the smaller sizes. The raising blocks are located exactly as the tail-stock itself, so that the work placed on them will come in the same relative position to the uprights of the jig whether the work rests directly on the jig bottom or on the raising pieces. The two finished strips *F* are provided for facilitating the making of the jig, and the lugs *G* for the clamping down of the jig to the boring machine. The jig, however, can also be clamped to the boring machine table as shown in the illustration. At *H* is a liberal clearance between the work and the jig, allowing ample room for insertion of facing cutters, reamers, and boring tools. Ribs are provided for strengthening the jig, as shown.

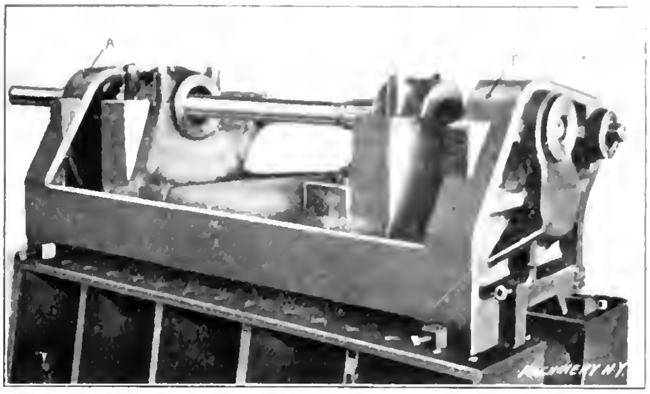


Fig. 128. Large Size Boring Jig made from a Solid Casting

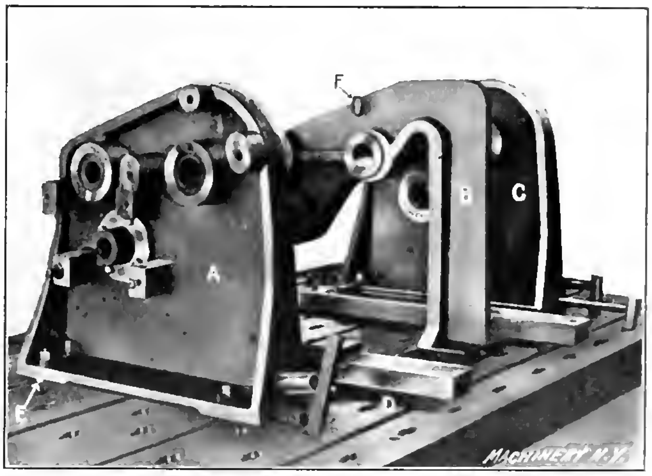


Fig. 129. Boring Jig consisting of Base-plate and Separate Removable Upright carrying the Guide Bushings.

The half-tone Fig. 128 shows a large size boring jig made from a solid casting. In this case the work to be bored out is the head of a lathe. It is located and clamped to the jig in a similar way as that mentioned for the tail-stock; clamping it to the jig in the same way that it is fastened to the lathe bed insures that the effects of possible spring will be less noticeable. Opinions differ as to whether it is good practice to make up a jig of the size shown in one piece, the distance between the standards *A* and *B* being from four to five feet, or whether it would be better to make loose members located on a base-plate as shown in Fig. 129. The writer advocates the making of one piece jigs of as large sizes as possible because, with loose members as shown in Fig. 129, there is no assurance that the standards are located correctly in relation to each other or to the work to be bored, and it involves more or less work to get the jig in order. The jig

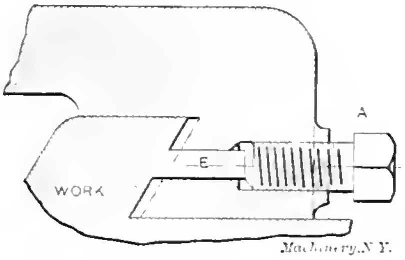


Fig. 130. Means for Holding Work against Locating Side of Dove-tail Slide of Boring Jig in Fig. 126.

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* Address: Borlänge, Sweden.

in Fig. 128 does not need to be as heavy as would be inferred from the illustration, because a large portion of the bottom can be cored out.

The boring jig illustrated in Fig. 129 consists of four parts; the upright members A, B, and C, and the base-plate D, which may be used for all jigs of similar construction. This type of boring jig is used only for very large work. In the case illustrated, large lathe heads are to be bored. The work is located on the base-plate between the two members A and C. The member B is only used when the distance between A and C is very long, so that an auxiliary support for the boring bar is required, or when some obstacle prevents the bar from passing through the work from one of the outside members to the other. As a rule these members are located on the base-plate by a tongue fitting into one of the slots as shown at E. The members are brought as close as possible to the work, sufficient space, of course, being permitted for the cutting tools to be inserted. The standards are cored out and ribbed and lugs provided so as to give the bearing bushings long and substantial support. Good results will be obtained with this type of jigs provided they are carefully set upon the base-plate. At F in the member B is shown a boss; this is provided with a tapped hole for a hook or eye-bolt for facilitating the moving of the jig member by an overhead crane. The other members have tapped holes on the top for the same purpose.

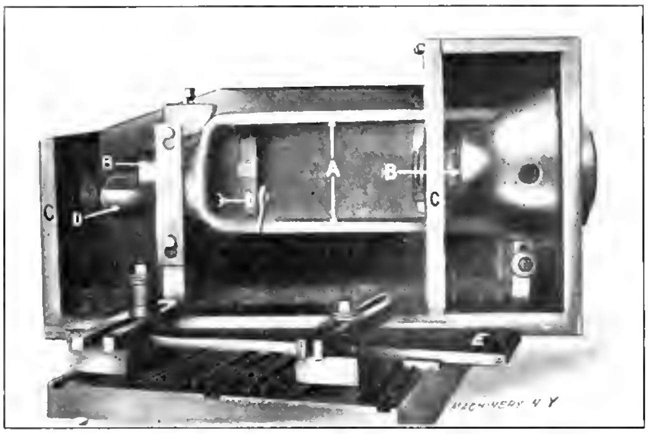

Fig. 131. Wedge-piece for aligning Work for Boring Holes with the Axes at an Angle.

The jigs in Figs. 126, 127, and 128 are ordinarily used on boring lathes, but the one shown in Fig. 129 may also be used in combination with a portable driving and feeding arrangement, one type of which is shown in Fig. 135. The lugs and finished bosses on the side of jig member A, which do not carry bushings, are used for connection to this drive and feed mechanism.

Fig. 133 shows a boring jig of the loose member type provided with motor drive for the boring bars. The members are mounted on the base A, located by the tongue B, and clamped down by T-bolts. The work C, a lathe head, is placed on the extension piece D. The boring bar is driven from the motor by means of a worm and worm-wheel, the bar being [illegible] is shown in Fig. 135. In this engraving, A represents the work, B and C the jig members, D the motor which is connected to the pulley E, which, in turn, through a worm-shaft F and the worm-wheel W, drives the boring bar G; this latter is keyed to, but at the same time is a sliding fit in, the worm-wheel. The bar is fed forward by the feed-screw H which passes through the stationary nut J fastened to the base-plate. The motion of the screw is actuated from the bar itself through a train of gears. The gear K is keyed to the screw and driven by the gear L which is mounted on the same stud as the star-wheel M which is turned by the pin N attached to the connecting head O; this latter rotates with the boring bar, but the screw H is a free-running fit in O, and simply has a thrust washer at its end to take the feed thrust. More or less feed can be arranged for by using more than one pin in the connecting head. The pin or pins can be pulled back when the feed is not required. The gears and star-wheel are mounted in the bracket P which follows the bar and which is prevented from turning by the rod R fastened to the bracket. The bar can be pushed back by using a wrench or crank at the end of the feed screw.

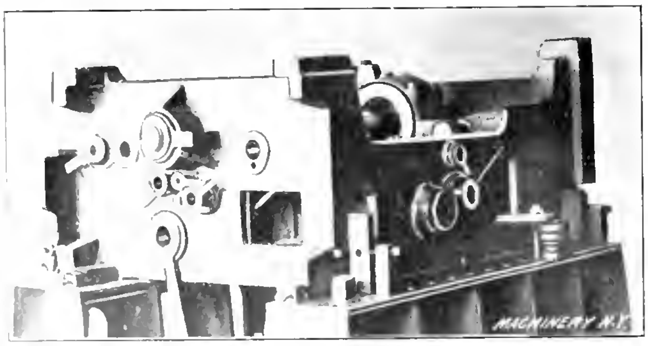

Fig. 132. Combined Drilling and Boring Jig used with a Horizontal Drilling and Boring Machine.

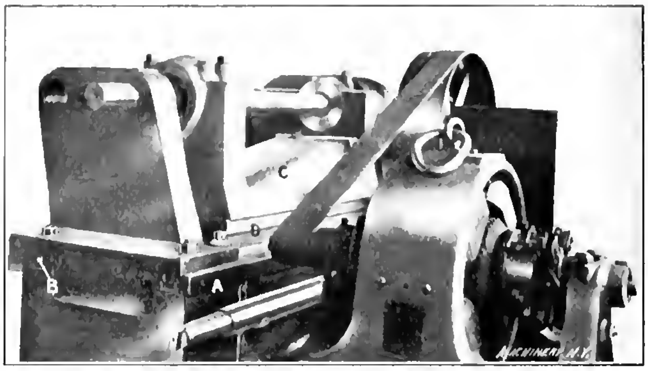

Fig. 133. Boring Jig with Portable Motor-driven Drive

The feed arrangement shown, has proved very serviceable and reliable. A separate and portable drive, of the type indicated, is quite necessary for large boring jigs as there are few machines large enough in the ordinary shop to handle such heavy work.

In Fig. 131 is shown a boring jig for boring out the top frame A of radial drills. The design of the jig is simple but effective; the hole B is parallel with the finished side C of the jig and is bored out after the jig has been brought up square against a parallel and strapped to the machine table. The hole D is bored at an angle with the hole B, and the setting of the jig for the boring out of this hole is facilitated by providing a wedge-shaped piece E of such an angle that the jig will be set in the proper position when moved up against the wedge. If universal joints are used for connecting the boring bar with the driving spindle, the setting of the work at an angle could be omitted, although it is preferable even when using universal joints to have the boring bars as nearly as possible in line with the spindle. This eliminates a great deal of the eccentric stress, especially when taking a heavy cut with coarse feed.

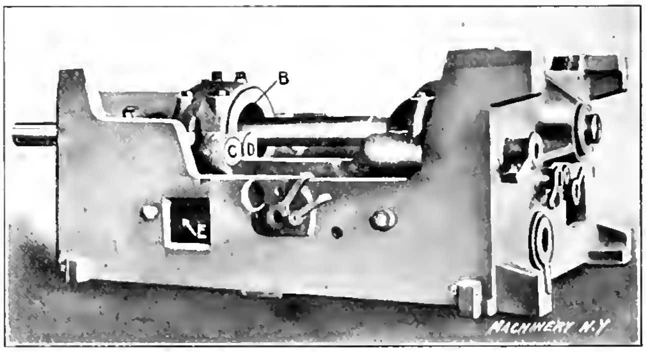

Fig. 134. Another View of the Jig in Fig. 132. Note that Holes are drilled or bored from All Sides.

Boring operations are sometimes carried out using parts of the machine itself as guiding means for the boring bars, and in some instances it is very essential that boring operations be performed in this way in order to obtain perfect alignment. In Fig. 136 is shown a line engraving of a machine bed with the head-stock solid with the bed. In the top view is shown a method for boring out a hole at B by the use of two jigs C and D which are located on the V's of the machine and held down by hook bolts. If the hole B only passes

through the part *E* of the head this would be the preferable way of boring it. In some instances, however, the hole *B* may be required to be in alignment with the holes in a carriage or in a bracket as at *F* and *G*. These holes, of course, can then be used to great advantage as guiding means. Should the holes be too large to fit the boring bar, cast iron bushings can be made to fit the holes and the bar. In the elevation and end view of Fig. 136 is shown how a cross-slide carriage and apron *I*, which has a hole *J* in line with the holes in bearings *K*, *L*, and *M*, and travels between *K* and *L*, can be bored out by using the brackets *K*, *L*, and *M* to guide the boring bar. By keying the traveling part *I* close to the bracket during the boring operation, as illustrated, accurate results will be obtained. It is evident that two of the bearings could be bored out by using the finished bearing and the traveling part *I* as guiding means. Arrangements of this kind usually save expensive tools, and often give better results.

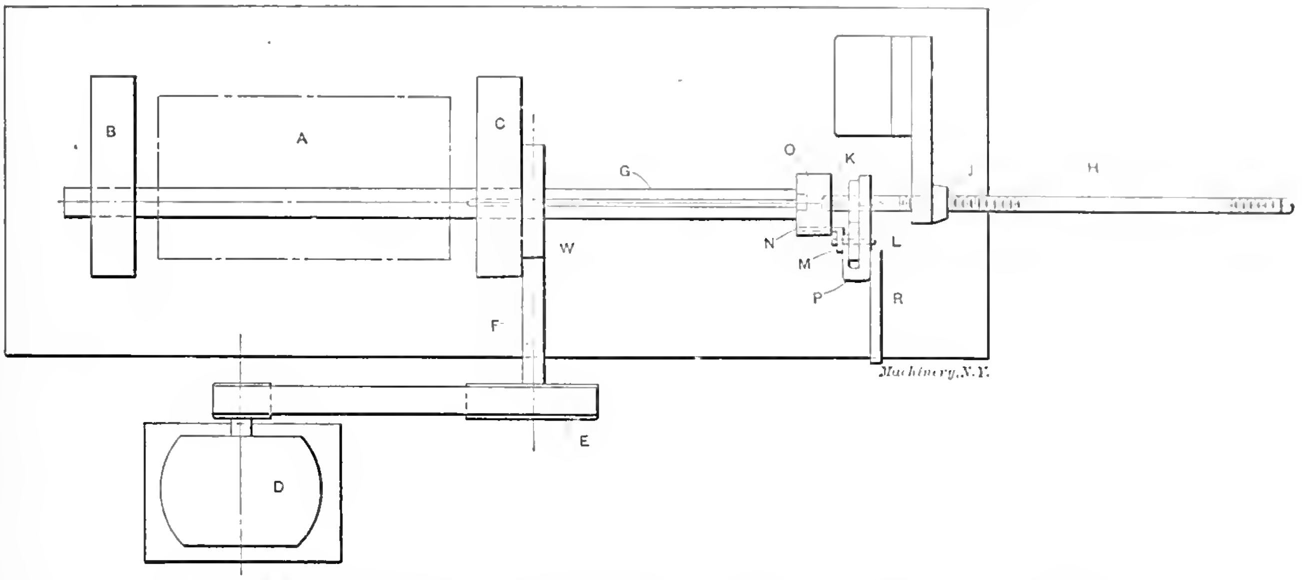

Fig. 135. Diagrammatical Outline of Arrangement of the Drive and Feed of the Boring-bar of Jig in Fig 133.

Combination Drill and Boring Jig.

Jigs for performing both drilling and boring operations are frequently used to great advantage. In designing such jigs, however, judgment must be displayed not to arrange for combination jigs when the operations can be more easily performed in two separate jigs. Sometimes it is advisable to have a jig for the boring alone, and then to use the bored holes for locating the work in a separate drill jig. In other cases it may be better to do the drilling first and locate the work for the boring operations from the drilled holes. The designer should decide which method would be preferable, considering, in the first place, the factors of the time required and the accuracy of the work. To give any definite rules for this work is not possible, but it may be said that combination jigs should be used only when the drilled and bored holes are somewhat near the same diameters. When the holes are of widely different diameters two jigs are preferable. If a few screw-holes of small diameter for holding a collar or bracket, for instance, located around a large bored hole, were to be drilled with the same jig used for the large hole, the jig when used on a small drill press would be entirely too heavy to manipulate. It is likely that in such a case a small separate drill jig could be attached directly to the work. In other cases, however, it will prove a distinct saving to combine the boring and drilling jig in one.

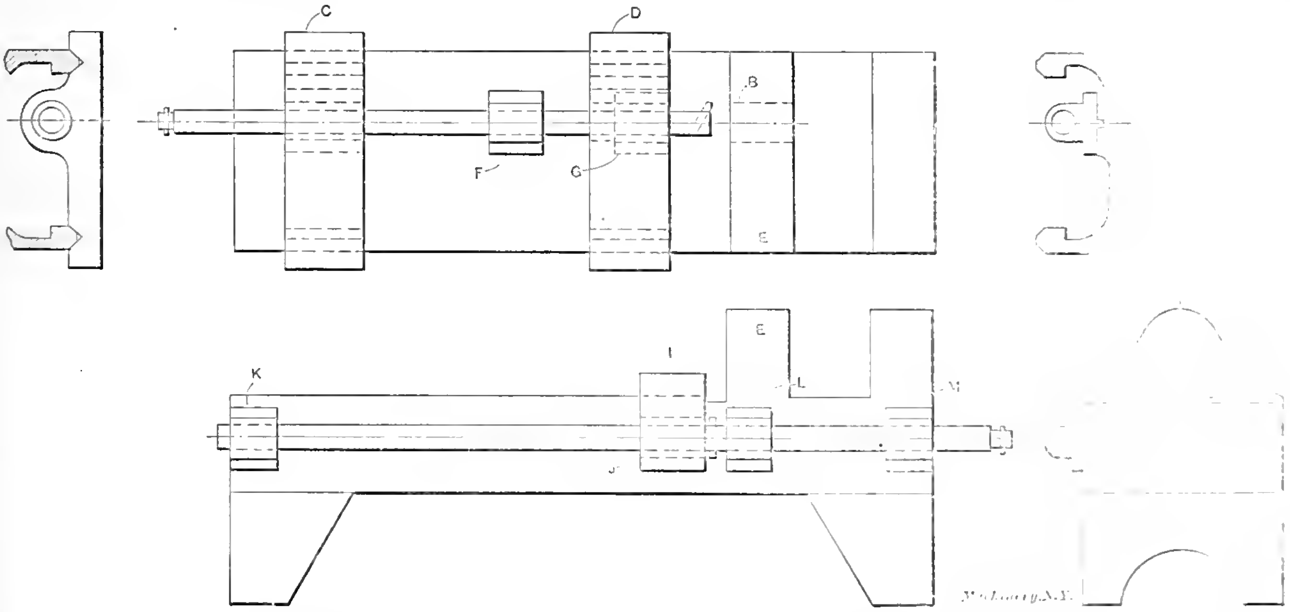

Fig. 136. Examples of Boring where Parts of the Machine being built are used as Guiding Means.

In Figs. 132 and 134 is shown a combination drill and boring jig of large size. The work *A* in Fig. 134 is a head-stock for a lathe with a number of holes to be drilled. The large holes *B* at both ends of the head-stock are cored as usual, and allow the boring bar to enter for taking the roughing cut. The holes at *C* and *D* are opened up by drills previous to the boring operation. As there is considerable distance between the end of the head-stock and the uprights of the jig, long bushings are used to give the drill a good bearing close to the work. The small holes which are drilled and reamed are shown in Fig. 132. Both the drilling and boring operations may be performed on a horizontal boring and drilling machine. As the horizontal drilling and boring machines usually have adjustments in all directions, the only moving of the jig necessary is to turn it around for drilling the holes on the opposite sides.

SHOP PHOTOGRAPHY.[*]

H. P. FAIRFIELD[†]

I have read with much interest the article by H. C. Estep on "Shop Photography," which was published in the December issue of MACHINERY. He speaks of his experience with films and makes a statement about glass plates and halation which has not been borne out in my case or in any case of which I know. Negatives entirely free from halation are as easily and truly made upon glass plates as upon films. The only condition necessary is to give the proper exposure. If this is done, a perfect negative results which is free from deep shadows, halations or false high lights on any good make of glass plates or films. Proper exposure must, as in any case, be reinforced by exact and scientific development, and this can be obtained by using the tanks and developer powders sold by the Eastman Co. Mr. Estep's article conveys the idea that the so-called films are peculiarly free from halation troubles. My point is that there are no differences in this respect, whether using glass plates or films, and that when given the right amount of exposure and scientific development, either will give a perfect negative free from halation under the most adverse conditions. While the proper amount of exposure given a plate is not the whole of photography, by any means, it is a considerable factor in any case and perhaps the hardest single item to correctly gage. Mr. Estep's method of teaching exposure by obtaining a "standard" is along the lines of the best practice.

As to what causes halation, I do not know, but I have figured it out that its *effect* is made *visible* on the negative by over-development when trying to bring out detail in the shadows, as the darker parts of the picture are termed. Take, as an example, an interior with windows on one or even two sides, of which it is desired that a view be taken looking directly at these, as shown in Fig. 1. The camera is thus facing the source from which all the illumination is coming and all objects in front of the camera have their deepest shadows facing the lens. The operator is naturally misled by the glare from the windows in his eyes, and forgets that the shadow sides of the objects (machines for example) are reflecting into his eyes, or the lens, very little light indeed. Under this influence he invariably misjudges the time of exposure, undertiming the plate or film and really obtaining no image of the shadow areas on the sensitive plate. When the plate or film is placed in a normal developing solution, the windows and adjacent areas being strongly lighted, develop, as it is termed, in their proper time, while the darker or shadow areas have not reflected sufficient light to affect the sensitive plate or film, enough to register a distinct image in the time it takes to develop the strongly lighted areas. Usually, in such cases as this, the operator prolongs development with the hope that he can get something to show where, practically speaking, the light has made no impression upon the plate. Pushing development in this manner builds up or thickens the strongly lighted areas on the negative, and, in the case of windows and adjacent strongly lighted areas, obliterates practically all the detail. If the operator can be made to believe, at the beginning, that such a plate is hopeless, and if he will discard it and obtain one with a correct exposure, much will be gained. Dr. John Nicol, who for years has been editor-in-chief of the *American Amateur Photographer*, has repeated a thousand times in that publication this motto: "Expose for the shadows—the high lights will take care of themselves." The sensitized coating of the negative, upon which the light impresses the image, is alike in like grades for either plates or films. The usual supports for the coating are glass plates in one case and a flexible support of celluloid or paper in the other, the coating remaining the same, and exposure being the same whichever is used.

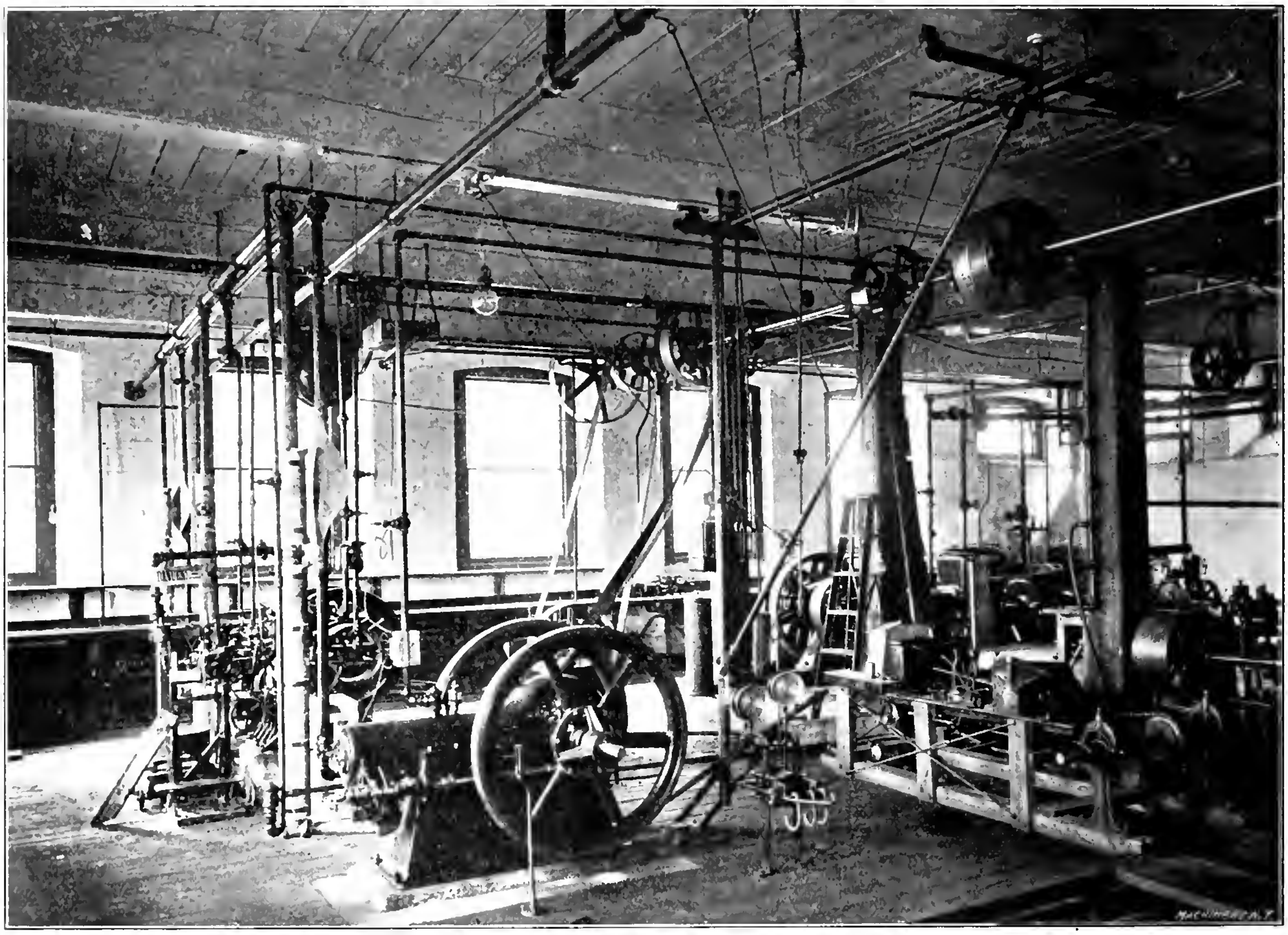

Fig. 1. Type of Interior which is often Under-exposed, the Exposure being made for the High Lights instead of the Shadows.

A word as to what I mean by scientific development. Several firms, notably the Eastman Co., have carried on elaborate experiments to learn all that could be learned regard-

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[*] For additional information on this subject, see the following articles previously published in MACHINERY: Industrial Photography, [illegible], 1909; Shop Photography, December, 1908; Correcting Perspective in Photography, February, 1908, and other articles there [illegible].

[†] [illegible] Worcester Polytechnic Institute, Worcester, Mass.

ing the action of developers and the correct timing of development. This has been done under the direction of expert chemists and manipulators, and when under such conditions results are published, they can be taken as reliable. The tank method of development can be performed in an ordinary tray, but is more neatly and pleasantly done in one of the modern plate or film tanks. The principle is this: Given a developer of a certain strength, its action on the plate should be limited to a definite interval of time. Action continued beyond this stated time not only does not result in any increase of detail, but actually thickens, halates and fogs the results thus far obtained. Experiments scientifically carried out have determined what this time should be for various developers when in solution as directed. Given such a known developer, some suitable sort of a tank to hold the plates and solution, means for measuring time, a thermometer for indicating temperatures, and all there is in the negative must be obtained. An accurately and properly timed exposure, a developing solution of known strength, at a correct degree of temperature allowed to act upon the negative a scientifically determined period of time is "It." In Fig. 2 is shown a half-tone reproduction of a print taken from a 5x7 negative made during a bright sunshiny day on a standard glass plate of the ordinary sort, unbacked or doctored in any manner. The plate was developed in the Eastman plate tank. The windows shown are of Southern exposure and were left exactly as shown in the picture.

Fig. 2. Negative made on a Standard Glass Plate during a Bright Sunny Day. Note Absence of Halation.

Fig. 3. Another Splendid Interior in which Every Detail is brought out without Halation around the Windows.

To anyone taking up the work, I would say that the best apparatus, materials and supplies are none too good; therefore get the best that can be afforded. This is especially true in lenses. No one using a modern Goerz or Zeiss anastigmat will ever use any other if he has the price. An anastigmat lens has nothing to do directly with halation, but is recommended as essential to the best technical work as its corrections are more perfect than the so-termed rectilinear lens. Indirectly, as such a lens can be used at a larger aperture than the cheaper lens, its use often results in a better timed negative and therefore greater freedom from "soot and whitewash." While it is a pleasure to use almost any camera outfit, the best is none too good if serious work is contemplated.

While I wish to make the point that there is no halation necessary if exposure and development are properly timed, it is seldom that the operator's judgment tells him just what is best in the exposure. For this reason, it is always wise to avoid conditions which are likely to give adverse results.

* * *

"DON'TS" FOR THE BLACKSMITH.

GEORGE T COLES *

Don't be afraid to strike the iron while it's hot.

Don't take two heats to do what you ought to do in one.

Don't hang hot tongs in the tong-rack.

Don't use a hot chisel to cut cold stock.

Don't use a cold chisel as a hammer—it may fly off the handle and hurt somebody.

Don't abuse your helper—it isn't his fault all the time.

Don't forget to make your bolt-heads standard size.

Don't use your hand hammer for a bob punch—it's dangerous.

Don't borrow your neighbor's tools—make your own.

Don't alter your tongs for every job; make new ones—it pays.

Don't forget to fix your tongs when you break them.

Don't forget to use the square—your eye won't do.

Don't watch the other fellow's fire—attend to your own.

Don't watch the "boss"—watch your fire.

Don't forget to see that your tools fit your anvil—it saves time.

Don't work with hot tongs; cool them off—you'll be surprised at the results.

Don't forget that a little salt in your fire helps things wonderfully, sometimes.

Don't forget to anneal your flatters and fullers once in a while—it's time well spent.

Don't use a high carbon steel for your tools; a cheap grade is better and lasts longer.

Don't forget to take your time hardening a die—it pays.

Don't get the corners of the die hotter than the body—if you do they may come off.

Don't hammer cold steel—it's hard work, and besides, it's bad for the steel.

Don't have any "cold sets" in your forgings—cut them out before they do harm.

Don't abuse the dies of the steam hammer—your work will look bad.

Don't roll your work at the steam hammer—'twill make it hollow.

Don't be reckless around the steam hammer—it's dangerous.

Don't forget that the scale around the steam hammer is the best flux for welding.

Don't use your flatter or fuller at the steam hammer—it's dangerous.

Don't scrap the short ends—they come handy sometimes.

Don't forget to take the frost out of the steam hammer the first thing in the morning.

Don't forget to give her (the steam hammer) steam slowly first thing in the morning.

Don't forget to let her (steam hammer) run open for a few minutes first thing in the morning.

Don't forget to use a little graphite and cylinder oil on the guides—it make the hammer run easier.

Don't forget to oil up the hammer once in a while, and remember that an automatic oiler is best.

Don't forget that a steam trap is the latest attachment to a steam hammer.

Don't nick and break good carbon steel when making tools—it injures the steel.

Don't melt lead or babbitt in your fire if you expect to do any welding—it will cause trouble.

Don't forget when forging to allow 10 per cent for waste.

Don't criticise the other fellow's work—do your own quickly and well.

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FEBRUARY, 1909.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE EXPERIENCE OF PURCHASING AGENTS.

The recent experience of a foundry company in marketing a specialty is an example of present-day problems in distribution, and as the facts involved throw some light on the results produced by removing the purchasing department of an industrial undertaking too far from the influence of the mechanical department, it may be worth while placing on record. The foundry firm in question is making a special casting used on railway cars, which is made in such a manner that a great deal of the work in fitting is saved when the part is applied to the car. In obtaining orders for these castings, it has been found that it is very easy to introduce them with small companies where the master mechanic directs the purchase of materials; but when it comes to the large companies which have special purchasing agents, who as a rule are unfamiliar with mechanical requirements, it has been found difficult to introduce this product of the company. The casting spoken of is of a very special type, is cast in a somewhat different manner from ordinary castings, and must therefore necessarily be more expensive, pound for pound, than are regular castings. The purchasing agent who lacks mechanical experience, however, measures the value of castings simply by the weight, and expects to pay so much per pound for castings, irrespective of the manner in which they are produced and the purpose for which they are intended. The mechanical man, on the other hand, especially if he be in charge, and responsible for the economical results obtained, would immediately realize, in a case such as here referred to, that the casting, as made, possessed a distinctive value because of saving a considerable amount of labor expense and trouble in fitting to the car in the shop.

This example illustrates one of the defects in the organization of large industrial concerns where the influence of mechanically trained men is not directly felt in the business office, and where the management, therefore, is entirely in the hands of men whose whole training has been confined to office work and to whom mechanical features have not the same significance as to men who have been trained in the productive departments. At the present time, undoubtedly, this defect of administration is growing, due to the formation of large corporations which replace the smaller individual concerns. In the former, the man of business training, as a rule, entirely overshadows the mechanic, and this is by no means always to the best interest of the firm. Many thousands of dollars are lost yearly by large industrial concerns on account of the lack of appreciation of mechanical requirements in the purchasing department.

* * *

HABITS OF WORK.

Several years ago the writer visited a well-known engineering school, and naturally included the machine shop or "mechanical laboratory," in which the students were instructed in the elements of machine construction and operation. The class at work at the time was building a universal grinding machine from castings furnished by the manufacturer. Among the parts being machined was the platen, which was being planed by one of the "boys." He was "nursing" the job by taking an insignificant cut with an almost microscopic feed. At the rate the planing was proceeding, half a dozen cuts would have been required to finish the surface, and the time of each cut would have been about three times the normal.

In response to a comment that the cut and the feed were rather below the average machine shop practice, the guide volunteered the information that the boy was employing this expedient to keep the machine going until the instructor could reach him, without endangering the job. It was apparently the common practice to proceed in this leisurely manner in order to avoid mistakes. The instructor thus could keep in close touch with the state of each boy's job, and nothing was likely to go far astray between his visits. The plan, of course, was commendable from one point of view: that is, avoiding mistakes and spoiling work, but it was a very serious defect, as any practical mechanic will immediately concede. While the boys received practical instruction in the manipulation of machine tools and production of finished machine parts, they did not acquire another kind of instruction in a matter equally as important, and that is, speed of performance.

A graduate from this or any other engineering school conducted in a similar way, would find in going into a manufacturing plant that he was in a strange world. The changed conditions would virtually make him a stranger to the work with which he should be quite familiar. He would be unable to do commercial work satisfactorily until he had acquired considerable experience, and would be incompetent to direct the work, even as a sub-foreman, simply because he has no conception of commercial speeds.

A more serious fault of such methods of instruction is that the learner cannot do his work as well as though it were done at his best speed. This may seem strange to those who have not given the matter thought, but it is a fact confirmed by numerous observations that the best work is that done rapidly and with care. In mass production it is much easier to make 99 out of 100 parts meet all the requirements of a rigid inspection system than if each part were made slowly and individually. In passing, it may be remarked that mass production is one part of the secret of the extraordinary accuracy of the Swedish gages that have excited the wonder and admiration of the whole mechanical world.

The value of habits of industry acquired under the system of training that teaches quickness and dexterity as well as skill, is admirably treated by Mr. Gantt in his paper "Training Workmen," read before the December meeting of the American Society of Mechanical Engineers. "Habits of work are comparable with habits of thought in engineering," and inferentially an engineer's training should include the right habits of work as well as the right habits of thought if he is to direct industrial operations.

* * *

From observations of manufacturing cost in many machine shops, Mr. James Hartness, president of the Jones & Lamson Machine Co., Springfield, Vermont, has concluded that for the purpose of estimate, it may be taken that one-third the cost is labor, one-third material, and one-third shop burden. Lathe work is usually one-half the machining or one-sixth the total cost of production.

MACHINE TOOLS AND THE TARIFF.

The advanced development of the machine tool industry in this country, and the use of ingenious cost-saving appliances as well as the greater skill and productiveness of American workmen, have enabled our manufacturers of certain kinds of tools, which are turned out in large lots, to so reduce costs that they have been able to market a considerable portion of their product abroad in competition with foreign machines, which until recently have been produced in small lots only. This class of American manufactures would be the least affected by a moderate reduction in our tariff; but very heavy tools which are made largely of cast iron, many of them special tools, need more protection. There are many cheap and cumbersome machines made by English, German and other European manufacturers, which could hardly be sold in this country at any price; but, on the other hand, most of our best tools are now accurately copied by foreign makers; and, unless our manufacturers were protected, could be sold in this country at prices which would completely demoralize the American machine tool industry. Progressive foreign manufacturers recognize the superiority of American methods and are rapidly adopting them; and all they really need to compete on even terms with our own manufacturers, anywhere, is a larger market, which means larger production.

For fifteen or twenty years American machine tools have been sold all over Europe in competition with foreign makes, at virtually the same prices as in this country; and our export trade increased rapidly up to 1907. During that year, although we had then begun to feel the effects of foreign imitations, most of our leading machine tool builders were from six months to a year behind in their deliveries. The development of our machine tool industry has never been so great as during the period above referred to, and within that time the number of manufacturers and the output increased three or four fold. The steady and rapid development of this industry naturally resulted in stronger competition among our manufacturers, and in remarkable development in the capacity of our machine tools. No sooner did one manufacturer place an improved machine on the market, than his competitor set to work to better it; and often produced one at the same price which would turn out more work at less cost. The automatic screw machine is a type of labor-saving tool of distinctly American origin. One of these machines easily turns out from five to twenty times the product of an ordinary engine lathe, at a cost for direct labor attendance, in some cases, of less than one-tenth that of the latter. Many other machines of the screw-machine type have been perfected, which have completely revolutionized the manufacture of small parts, effecting savings fully as great. Almost without exception these machines are being copied by European makers, who, of course, are under no expense for originating, developing and perfecting them, yet under a lower duty they could and would undersell the originators in this market, on account of the difference in the cost of labor. How great this difference is is shown by the following tables:

Foreign.	Machinists.	Tool-makers.	Handy-men.
Italy	8 to 12	12 to 16	9 to 10
Switzerland	15	20	10 to 12
Germany—			
Munich	13	17	10
Saxony and the Rhine Valley.	15	20	11 to 12
Berlin	14.5 to 17	19 to 22	11 to 13
Magdeburg	14.5	19	8.5 to 10
Great Britain	15.5	20	9
France	Machine tool industry still in its infancy.		
United States.			
New York City	33	39 to 44	16 to 28
Philadelphia, Pa.	31 to 37	32	16
Providence, R. I.*	26	28 to 35	18 to 25
Hartford, Conn.	32	37	20
Cleveland, O.	25 to 30	30 to 35	18 to 25
Cincinnati, O.	27	32	20 to 30
Milwaukee, Wis.	25 to 40	30 to 40	17½ to 25

* On piecework these rates may be increased 30 to 40 per cent.

The United States will always be the greatest market for our machine tools, and while the cultivation of foreign trade should continue to be of prime importance, in considering the tariff on such products we must be careful not to sacrifice the kernel for what might prove to be the husk.

MACHINERY'S EDUCATIONAL WORK.

The editorial policy of a journal like Machinery takes cognizance of the several important functions the publication performs in its relations to a multitude of readers, among whom there is a wide disparity in age, experience and ability. Machinery is a trade journal, publishing the general news of the trade it represents, which is one function. It is a technical journal, presenting the technical news of the trade, which is another. It is a forum for the discussion of questions of importance to the trade, technical and commercial. It is also a journal of education for students of machine design and shop practice, and we state without hesitation that this function is the most important of all, and is the one which chiefly characterizes and distinguishes Machinery.

The school of engineering likely to graduate men best equipped for the practice of engineering is the one which, in teaching fundamental principles, does not fail to train its students in the ability to detect these amidst unfamiliar details and in novel and unforeseen circumstances. When a man can do this, and can apply the fundamental principles of his vocation to creative work, he is trained. This is what technical schools are for, and this is the ultimate distinction between the trained and untrained man. One gropes for his principles, finally reaching them through costly experiment; the other goes straight to the heart of the matter, sees the principle and applies it.

In this sense Machinery is essentially a school of engineering. Every accurate and adequate account of a piece of mechanical work done in field and shop and drafting-room, is a lesson in mechanical practice and an elucidation of the principles involved. All experience is educational, or would be, if properly classified and logically arranged. Machinery collects, as it were, the mechanical experience of the month, discards what is unimportant or merely incidental, condenses and classifies the remainder, and endeavors to so arrange and adapt the matter that it becomes logically and properly a permanent part of the body of approved mechanical knowledge. This important educational function of the technical journal is well recognized by educators, one of whom happily designated Machinery as "a progressive textbook for mechanics."

And in the sense that Machinery is a progressive textbook, there is a weight of responsibility to a great body of readers, including men at the very top of the engineering profession, who read to keep in touch with the latest developments, expecting to find them reliably chronicled here; and that much greater number of machinists and draftsmen who also wish to keep up to date, but to whom an account of the latest developments would, in many instances, be of little educational value unless presented in such a manner as to supply any deficiencies in technical education or practical experience. Take for example the series "Jigs and Fixtures" now appearing, in which the treatment of the subject is very characteristic of Machinery. These articles are published primarily to describe the general practice, which presents many interesting and valuable features. Yet the whole subject is reviewed, the principles formulated; and when completed the series will comprise a complete treatise on jig and fixture design brought up to date. The series of articles on shop construction, which began with September, is another good example of this educational work. The problem of shop construction is analyzed, the general rules and principles clearly stated, and then, specifically, the actual details of construction for a plant of a certain size, intended to produce at low cost.

The Shop Operation Sheets which teach shop practice and incidentally the principles, are examples of this practical educational method, further exemplified in the "jig" method of instruction used so successfully by Mr. Renshaw, the originator, in his school in Cincinnati. The "jig" idea fits in well with our educational system and has been adopted here to be developed and given wider usefulness in conjunction with the rest of our educational material and equipment which includes Machinery, the Reference Series, Data Sheets and Shop Operation Sheets.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

It is stated in the *Daily Consular Reports* that the centenary of the re-establishment of national independence in Holland will be celebrated by a world's fair to be held at The Hague in 1913. It is stated that the grounds for the exposition have already been secured and a guarantee fund provided.

An application of the Lumière process of color photography, which appears to be both interesting and valuable, is described in a recent issue of the *Revue de Métallurgie*, where a number of microphotographs made in color by this process, are reproduced. The structure of metals is much more strikingly represented than with the usual black and white prints.

It is stated in the *Horseless Age* that the following composition is used extensively for typewriter levers: copper 57 per cent, nickel 20 per cent, zinc 20 per cent, and aluminum 3 per cent. These parts, even when the nickel on the surface is worn off, never rust. The alloy is very hard, but may be bent to a considerable extent without breaking.

According to the *Railway and Engineering Review*, experiments have been undertaken for several years with concrete ties in Italy, and the Italian government has now ordered 300,000 of these ties, or enough to lay about 100 miles of track. The ties are reinforced with small round iron rods and weigh 286 pounds each, of which 28 pounds is metal. The cost of the ties is $1.20 each. The ties will have creosoted oak bearing blocks.

The forests of the United States, according to reports of the Forest Service, now cover approximately 550,000,000 acres, while the original forests covered at least 850,000,000 acres. The government owns about one-quarter of the total forest area, which contains one-fifth of all the timber now standing. Those timber lands which are owned privately are generally more valuable than those of the government, but are far less carefully managed.

The first commercial wireless telegraph station conducted by the British post-office in connection with the regular British telegraph service, was opened on December 11 at Bolt Head, South Devon, on a height 430 feet above sea level. The range of the station is 250 miles, and it can be used for communication with all ships at sea fitted with wireless apparatus, as well as with the channel islands, in the event of interruption of the communication by the regular cables.

A brown color can be produced on all kinds of metals by the following process, described in the *Brass World*. The work to be treated is first bronze plated by a regular bronze solution of copper and zinc. When a good deposit has been produced, the article is rinsed and immersed in a solution of 2 ounces of liver of sulphur to one gallon of water. This solution is used cold. When the desired color has been obtained, the work is again rinsed and then scratch brushed. In this manner the whole surface is shaded down to a brown color.

An interesting use of electric light has been made by the city authorities in Chicago. The street sweepers on the more important boulevards in the city found their work hampered and rendered dangerous at night by carriages and automobiles. In order to relieve the danger, each man is provided with an electric lamp attached to his helmet, and fed from a storage battery in the sweeper's pocket. The entire outfit weighs less than a pound and, according to the *Scientific American*, the lamp will burn ten hours without recharging the batteries.

For several months the United States wireless telegraph station at San Francisco has received calls supposed to have come from Japan, where one of the most powerful wireless telegraphic apparatus in the world is installed. The distance the messages have been transmitted is 4,700 miles. Although the operators at San Francisco have been unable to reply owing to the smaller size of their apparatus, it seems probable that it will be possible before long to establish direct communication across the Pacific Ocean. The instance referred to marks a record for the transmission of wireless messages.

The price of aluminum has fallen considerably during the past year and according to *Chemiker Zeitung*, the price in Germany during the latter part of the past year was only 150 Mark per 100 kilograms, which is at the rate of only 16 cents per pound. It is interesting to notice how the price of aluminum has declined since 1855. According to the source mentioned the price in 1855 was $106.00 per pound; in 1856, $32.00; in 1857, $10.60; in 1886, $7.10; in 1888, $5.00; in 1890, $1.52; in 1891, $0.83; in 1895, $0.32; in 1900, $0.22; in 1905-1906, $0.40; in 1907, $0.43; in 1908, $0.16.

We are accustomed to speaking of the workless as "the unemployed," but the *San Francisco Star* long ago brought into use a truer word—"disemployed." For the merely unemployed, we need have no especial sympathy if they are poor, nor any extraordinary respect if they are rich; for "unemployment" means no more than idleness. But "disemployment" connotes all the agony of the worker in a period of hard times, when he can find no work to do. And as this condition comes from social maladjustment, the resulting lack of employment is best expressed as *dis*employment. It is enforced unemployment.—*The Public.*

In a talk before the Sphinx Club, New York, November 10, Dr. Harvey Wiley, Chief of the Chemical Bureau, Department of Agriculture, made a statement in regard to trade-marks that is worth the attention of all manufacturers using trade-marks. The Court of Appeals, District of Columbia, has handed down a decision in regard to trade-marks and advertising that will tend to check misrepresentation. The court will not protect any trade-mark about which false statements are made in advertising. If a manufacturer labels his goods properly and advertises them falsely, then by the decision of the court, he is not protected in his trade-mark rights.

Bare aluminum wire may safely be used in coils without any insulation except between successive layers, owing to the existence of a film of oxide on the surface of the aluminum. The film in its natural state, says the *Scientific American*, will resist 0.5 volt; but by exposing it to the air at a temperature of about 100 degrees C. it is possible to get rid of the hydrates contained in the film, and thus increase its resistance so that it will withstand a high voltage. The insulation between the layers of the coil should be non-hydroscopic, and the coils should be covered with insulating paint to prevent moisture from entering.

The United States Steel Corporation, recognizing the great economic loss caused by accidents to life and limb, is instituting a system of accident prevention, safeguards for machinery, and inspection of same in all its plants. It issued a call to all managers of plants for suggestions for methods and safeguards and received in response about 2,500 ideas. A very large proportion of these ideas was accepted, about 2,300 being found feasible. The managers of the corporation recognized the fact that it is not sufficient to install safeguards and methods designed to prevent accidents alone, but that it is also necessary to provide an efficient inspection system by which these safeguards and methods would be maintained. It is a sorrowful fact that workmen themselves are the greatest enemies of accident preventive devices, especially when they interfere in the slightest with machine operation. Another point affecting safety appliances that is important in a corporation having constituent plants operated in competi-

tion as are those of the U. S. Steel Corporation, is that the individual plants are not charged directly for the cost of maintenance, which is charged to administration expense. Under such arrangement no superintendent feels that his mill is being taxed for a feature that could be avoided and which he might fiercely antagonize were it charged directly against him. Charging this expense against a general overhead fund alters the complexion of the charge entirely, from the individual manager's viewpoint. It is gratifying to note that America's greatest corporation has recognized its responsibility in reducing the appalling loss of life and maiming of employes in industrial work. Its example should be very helpful in leading other concerns to give the matter the attention that its importance demands.

TRAIN DISPATCHING BY TELEPHONE.

The Atchison, Topeka & Santa Fé Railroad has announced that it will soon operate its entire main line, from Chicago to the Pacific Coast, by telephone instead of by telegraph. Contracts have already been let for a part of the needed installation, which will cost about $2,000,000. The Union Pacific has already installed 123 miles of telephone betwen North Platte, Neb., and Sidney. The New York Central has been dispatching by telephone between Albany and Syracuse, and is extending the system to Buffalo. The Erie has been for some time doing the greater part of its dispatching in the New York suburban district this way. The Great Northern is installing a thousand miles of 'phones, and the Pennsylvania is trying out this system.

The availability of the telephone for train dispatching was discovered when the railroads found that an immense volume of complex business was being successfully handled by telephone between city freight offices, receiving docks, and freight yards, involving the telephoning of contents of way bills and slips containing many figures. When the National and State laws limiting the working hours of railroad telegraphers to nine and eight hours, put added operating expenses on the roads, and the unions would not agree to the employment of apprentices to help keep down the cost, the railroads began to try out the telephone in dispatching, with the result that it is coming into general use. Any person of ordinary intelligence can send and receive orders by telephone, and some of the best tower men to-day are disabled trainmen put at this work.

There is no question of safety involved. The universal use of block signals has taken from train dispatching the work of preventing collisions, and dispatching is now purely the management of traffic. The telephone has been found more efficient than the telegraph for this.—*New York Times.*

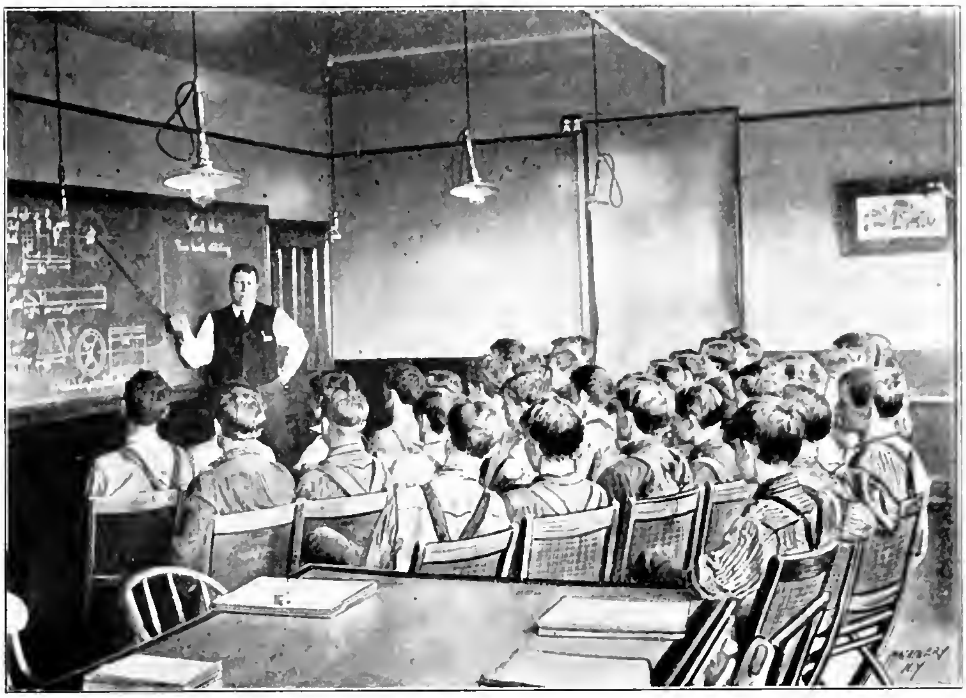
EDUCATING APPRENTICES AT DRIFTON.

In an article on educating apprentices, contributed to *Mining Men* (September, 1908) by Mr. William Lloyd, superintendent of the Lehigh Valley Coal Co.'s shops at Drifton, Pa., the author wrote in part as follows:

"I have found by experience that in a force of about forty apprentices there are about 25 per cent who will avail themselves of the usual opportunities for self-education, about 50 per cent can be persuaded by their employers to attend night school—if the employers are progressive enough in educational matters to make some effort in that direction—and the other 25 per cent cannot be prevailed upon to take these advantages under any circumstances. It was just to take care of the last mentioned that gave me the first thought of our school. About two years ago I had the honor of being appointed on the board of directors of the Mining and Mechanical Institute of Freeland, that splendid school for boys and men which was founded by the late Eckley B. Coxe. It was through my connection with this school that I was enabled to more fully realize the advantages of a school for the boys at the shop.

"In building up our force of apprentices I made it a rule to have each one promise to attend the night school at the Mining and Mechanical Institute. I found that some were regular pupils already, and there were some who could be persuaded to attend, while—as I said above—a certain percentage would not take this splendid opportunity to better their condition. One reason I found for some not wishing to start, was that their early education had been almost entirely neglected, so at the ages of sixteen or seventeen years they were ashamed to start; thus the only solution was compulsory education; in other words, we make going to our school a part of their work, for which they are paid.

"Years ago my experience with mechanics in nearly all trades convinced me that there is a very small percentage who can make an intelligent free-hand sketch, so we started by making free-hand sketching one of the leading features in our school; and it is remarkable what talent some of the boys show in this study. I know of no trade in which a man is not better off if able to intelligently put his ideas on paper. Therefore, in the near future we expect to teach the boys to write letters such as a mechanic is called on to send to the works when out erecting machinery. This I know to be very important, for a great deal of time is lost and serious mistakes sometimes occur, because such letters do not intelligently convey the man's ideas to the shop superintendent.



Instructing Apprentices at the Lehigh Valley Coal Co.'s Shops, Drifton, Pa.

"We have started on a plan of lectures by the foremen of the different departments. Our idea in doing this is that the apprentices of each department may thus have some knowledge of how and why some things are done in the other departments. Besides this, we intend to give the boys special instructions pertaining to their respective trades. For instance, the machinist apprentice will be instructed in the principles of valve setting, lining up and erecting machinery, etc.; the foundry apprentice will be instructed in the principles of mixing and melting iron and other metal combinations that go in engine and pump construction, also the reasons why different sand is used in some jobs and not in others.

"The question may be asked: 'Does it pay to take this interest in the boys?' I have always believed that it would, and I am now sure that it does. We not only get more and better work out of the boys while they stay with us, but we feel when they leave that we have done our best to make good men of them, and that we are sending out mechanics who are above the average."

TOOL-HOLDER ADJUSTABLE FOR HEIGHT.

La Machine Moderne for January 1, 1909, illustrates and describes a simple tool-holder of adjustable height, which appears to be of very convenient design. It is made in two forms, as shown in Figs. 1 and 2; the first has a spring holder for the blade, while in the second case the blade is grasped solidly, this being the only difference in the two tools.

This device consists of three members: an outer sleeve *A* split as shown for clamping; an inner sleeve *B*, bored eccentrically, and also split for clamping the tool-holder proper *C*, which is hollow, to permit carrying long bars of cutting steel. In adjusting the tool for height, it is loosened in the tool-post, and sleeve *B* is rotated by a spanner wrench or pin inserted in the holes drilled in the periphery of its flange. The rotating of this sleeve raises or lowers its eccentric bore, and thus raises or lowers the tool-holder contained in it to the proper height. All the members are clamped together and set by the tool-post screw.

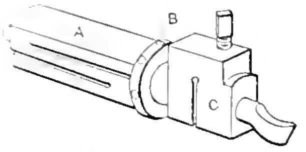


Fig. 1. Spring Tool-holder, of Adjustable Height.

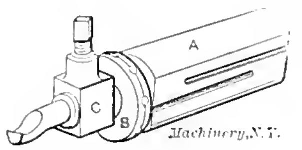


Fig. 2. Similar Tool, with Blade solidly held.

The point of the blade may be fashioned as a turning tool, side tool, threading tool, etc. The device appears to be especially useful for threading on small work, where the center adjustment should be made with great care. The fact that the tool-holder itself can be rotated to any angle, may be taken advantage of in steep pitch screws to set the cutting tools at the proper angle to give equal top rake on both cutting edges. The device may also be conveniently used for centering drills, reamers, boring tools, etc., with the axis of the lathe.

THE APPLICATION OF MOTORS TO MACHINE TOOLS.

Dexter S. Kimball, in *The Sibley Journal of Engineering*. March, 1908.

The introduction of electrical distribution and the electric motor gave to engineers of large plants a solution to a problem that had for a long time been very troublesome. The old method of power distribution with its wide belts and large shafts was quickly recognized as far inferior to the new method of distributing power electrically, running the various lines of small shafting by motors belted to them. By an easy extension of this system the larger tools were soon belted to their own individual motors, and the advantages so gained were evident to all, and up to this point engineers were fairly well agreed. But engineers soon came forward with the claim that great economy could be obtained by attaching a motor to every tool, and doing away with all belts and line-shafts. On this point, however, opinions were not so unanimous, and a discussion arose as to the relative merits of the two systems, and many tests were made to determine which was the most economical way, these comparisons generally being drawn between the so-called *group system* and *individual motor system*. It was clearly shown that conditions exist where either or both systems have a place, and that again conditions may exist where neither are desirable, as in cases where heavy machinery is to be operated close to the prime mover. The plant must be very small and compact, however, when electric distribution cannot be used to advantage, and in large plants it is indispensable. It is also now conceded, by engineers in general, that large and portable tools can be best driven by individual motors.

That the individual drive has not met with more favor was due in the past mainly to two causes, *viz.*, imperpect motors, and the general attitude of machine tool builders. When motors were first introduced in this work, electrical designers had not studied the peculiar problems presented, and as a consequence the first motors were not very satisfactory. The machine tool builder, on the other hand, saw at once that the motor was going to impose a new set of conditions on these machines, compelling him eventually to alter his patterns; and many makers naturally did much to discourage what some of them characterized as a fad.

As might be expected, the combinations designed under these circumstances were fearful and wonderful. A standard gas engine fastened to an ordinary carriage would not make a very good automobile; yet in comparison it would show up well with some of these early efforts. These difficulties, however, are now being rapidly overcome, and it is possible to buy almost any machine tool, motor driven in some way, although not always in a very desirable manner.

The engineer confronted with the problem of connecting up his electrical system of distribution to his medium size and small machines will be governed largely by the following considerations in making his decision as to the method to be used: 1. First cost of installation. 2. Maintenance and depreciation. 3. Provision for extension. 4. Sectional operation. 5. Flexibility as to location of tools. 6. Efficiency of system. 7. Positive application of power.

It may be well to consider these points in detail.

1. Without question the first cost of individual driving is considerably greater than group driving, and unless it can be shown that the individual drive has great advantages in other ways which offset this important item, it should not be considered. This is often a very difficult thing to do, and first cost will remain a drawback to the motor drive for small tools till different conditions of manufacturing reduce the costs considerably from where they stand at present.

2. On the second point we have as yet not a great deal of data that the writer is aware of; but his experience has been that the cost of maintenance and the depreciation was somewhat less in group driving. In the group drive the great item of expense is that of belting, which is costly and wears out rapidly; on the other hand, when motors do need repairing the repairs are costly, so that, on the whole, there does not seem to be much choice. Reliable data on this point would be of great service.

3. Regarding the third point, the individual drive has all the advantage. No system has ever been devised that provides so easily for extension. Changes in arrangement are also more quickly and easily made with the individual drive.

4. Here, again, the advantage is all with the individual drive, particularly with large tools which may be required to run overtime. Further, the breaking down of an individual motor does not affect but the one tool.

5. On this point the individual drive has an advantage that is particularly important. Machines so driven can be placed wherever desired, and in case of large tools, ideal conditions are obtained for overhead handling devices. In the case of small tools, greater convenience can be obtained, and tools can be placed in the middle of the room without cutting out the light. Incidentally, the elimination of belts greatly decreases the dust.

6. It has been found by actual measurement that there is little to choose between group and individual driving as far as efficiency is concerned.

7. The seventh and last point is the one on which the individual drive has its greatest claim to superiority, and which has done more for the individual drive than anything else. It was soon found that where motors were directly geared to the machine, a greater output was possible on account of the elimination of the slip in the belt, and the consequent driving of the work up to the limit of the cutting tool. This, of course, greatly reduces the time of the operation, and, as the cost of the time is two-thirds the total cost of the product, it is easy to see what a saving could be effected. The introduction of the new high-speed steels added still more to the necessity of positive driving, and it has been well demonstrated that where heavy cuts are to be taken the positively geared motor will show a great saving of time over the belt drive.

Herein, also, lies the solution of the problem so confusing at present to the engineer who is trying to find out just how far he can carry the individual motor drive idea and make it pay. In the case of large tools it will be seen at once that the solution is plain, and a careful consideration will show that the individual drive can be successfully used down to

a point *where a belt of convenient size will have no trouble in driving the cutting tool up to its limit.* Rules which fix some particular limit to the minimum size of motor to be used, or the minimum size of machine to which a motor should be attached are very misleading, as it depends entirely on what the tool is intended to do. For instance, a group of 16-inch lathes in one shop may be required to only take off a very light chip, and a group drive is satisfactory. In another shop these lathes may do heavy work, so that a motor drive will pay handsomely. There is no trouble, as a rule, in driving small drill presses up to the limit of the drill by means of group drive, and these are driven successfully in this manner; the same being true of small tools in general. At present it will not pay, outside of the advantages of better light and cleaner surroundings, to drive vêry small tools individually.

Summarizing what has been said above, we may state our conclusions as follows:

	Group Drive.	Individual.
1. First cost	Considerably less	
2. Maintenance and depreciation	Probably less	
3. Provision for extension...		Much superior
4. Sectional operation.......		Much superior
5. Flexibility as to location..		Much superior
6. Efficiency of system......	No great difference	
7. Positive application of power		Much superior

Having decided what tools to drive individually and what to group drive, the next question is the matter of motors and the methods of connecting them to the machines. Here, again, a great difference of opinion exists. In order to get a clear idea of what is needed in a motor for this work it will be well to look at the requirements of the tools themselves.

Machine tools may for this purpose be classified into the following groups:

(a) Machines requiring a constant speed. In this class come punches, shears, fans for ventilating purposes, and also the shafting of group drives. The torque may vary with the demand for power.

(b) Variable speed machines requiring maximum power at minimum speed. In this class are lathes, boring mills, and most machine tools where automatic regulation is needed. Here the cutting speeds are practically constant for a given metal, but the cuts are larger on the larger work.

(c) Variable speed tools requiring heavy starting torque, as cranes, sheet iron rolls, etc., where regulation of speed is by hand.

(d) Machines requiring a torque increasing with the speed, as blowers and fans which give variable blast. This class is rather unimportant.

Of course there is no trouble in meeting the requirements of the constant speed machines, but the problem of variable speed is difficult. If a good mechanical speed changing device were to be had, the problem would be easy to solve; but so far none has been produced that will answer the purpose. Many have been made that will give any speed between the limits of the mechanism, but they all depend on friction, and hence to carry the work required must in most cases be very large and cumbersome; while those that are positive in their action give only several speeds between the limits. Of the latter type a number are now on the market which can be used with success in many places.

When the electrical side of the problem is considered, a choice of two distinct systems of distribution is presented, namely, the alternating current, and the direct current systems, both of which have a place under proper circumstances in this work.

It may be said at the outset that when the alternating current system of distribution can be used, it is preferable, as the wiring is smaller in a large system, and the generators and motors simpler and more reliable. It has, however, its limitations, as will be seen, as far as machine tool driving is concerned.

The alternating current system offers two kinds of motors, the synchronous and the induction motor. The first is not self-starting and, except in a few cases, has no place in machine tool driving. Where heavy line-shafts are to be run for some length of time and provision can be made for starting, a synchronous motor is an excellent thing in connection with induction motors, as it tends to steady the line and help the power factor. In small sizes, however, it is not suitable for machine tool driving.

The induction motor is self-starting, and, like the synchronous motor, tends to run at constant speed. It is by its nature not a variable speed machine, although it can be made so in several ways, none of which, however, have so far proved adequate to the demands of machine tool driving. It has been successfully used on cranes and similar devices, the speed variations being obtained by putting resistance in the secondary, and variable speed induction motors are now on the market controlled in this manner. One plant at least has been fitted out with induction motors, where several changes of speed were obtained by varying the frequency, with fair success. But as yet, the induction motor cannot be considered as equal to the direct current motor for variable speed work, though considerable experimental work is now being done that may change the situation.

If the plant under consideration is to contain constant speed machines principally, the induction motor in connection with a mechanical speed-changing device will generally prove to be the best, and where all the machinery is of constant speed type it is much preferable.

The direct current system offers three kinds of motors, their combined characteristics covering much more closely the requirements of the case than do those of the alternating motor, and there is little doubt as to the greater adaptability of the system for general machine tool driving. These motors are: 1. Series wound motors. 2. Compound wound motors. 3. Shunt wound motors.

The series motor is a variable speed motor with great starting torque. It can be controlled throughout its whole range of speed and would seem at first glance to be almost ideal for lathes and boring mills. It is, however, very uneconomical, as the control is obtained by resistance in its circuit. It also requires an expensive controller on account of the heavy current to be handled and must be controlled by hand, as its speed varies inversely with the load, and under light loads it will run away. It is an excellent motor for cranes, elevators, sheet iron bending rolls, etc., and occupies a very important place in the equipment. It therefore covers the requirements of the tools under class (c).

The compound wound motor is suitable where small variations of speed are needed coupled with a large starting torque. It will, of course, give constant speed when set for any set of conditions within its range.

The shunt motor is, in its standard form, a constant speed motor. When set to run at a given speed it will not vary appreciably under varying load up to its capacity. It can be made to vary its speed in a number of ways, those which are most used being one of the following three: by varying the current in the armature; by varying the strength of the field; and by varying the voltage applied to the armature terminals.

These characteristics make the shunt wound motor most suitable of any for the purposes of machine tool driving and by means of these methods of control, either singly or in combination with each other or in combination with gearing, most of such work is now accomplished.

Summarizing the above conclusions, we may state them as follows:

Class of Machine.	Alternating Current Motors.	Direct Current Motors.
Constant speed torque varying with load.	Induction motor. Synchronous motor.	Shunt or Compound wound motor.
Variable speed, maximum work at minimum speed, automatic regulation.	Induction motor with mechanical speed changing device.	Shunt wound motor with or without change gears.
Variable speed. Heavy starting torque. Hand regulation.	Induction motor.	Series wound motor.
Variable speed, torque increasing with speed.		Comp. wound motor.

FRENCH COMBINED HORIZONTAL AND VERTICAL MILLING MACHINE.

La Machine Moderne in the issue of January 1, 1909, described a new milling machine recently brought out by the Société Française de Machines-Outil, the new French machine tool building firm of which we have made mention from time to time. Like the Ingersoll combined horizontal and vertical milling machine (described in the new tools department of the March, 1908, issue of MACHINERY), this tool is provided with two spindles, one vertical and the other horizontal, which may be used separately or simultaneously, though there appears to be no provision made for axial adjustment of the spindles.

"One of the refinements much sought after in the construction of milling machines is a combination of two spindles, one vertical and the other horizontal, permitting the easy transformation of the machine from a vertical to a horizontal miller, or *vice versa* as occasion requires.

"Different solutions of this problem have been offered. Among others, certain American builders make an attachment carrying a vertical spindle, which can be mounted on the horizontal spindle; but when so used the horizontal spindle is out of commission. Furthermore, each change in the method of operation necessitates the mounting or dismounting of the attachment, which, in order to be portable, is generally of light construction.

"To escape these inconveniences, the Société Francaise de Machines-Outils has designed the machine shown in Figs. 1 to 8, which only requires a simple rotation of the vertical head to change from vertical to horizontal milling. It should be noticed also that when the vertical head is turned back out of the way it presents a particularly strong support for the arbor in the case of horizontal milling. Among the different kinds of machine tools, in the design of a milling machine especially should a new company take account of the established reputation of certain foreign makes at present on the market, and of the difficulty of turning in its own direction the prejudices of the French consumer. The builders have, therefore, laid out a definite catalogue of the desirable qualities of such a machine, which can be summed up in the following list: First, rigid construction; second, easy manipulation; third, silent and positive drive; fourth, single drive for the spindle and the feeds; fifth, change of feed independent of the change of speed of the spindle; sixth, a large number of spindle speeds and rates of feed; seventh, large bearing surfaces; eighth, careful workmanship.

"The drive, which is of the single pulley variety, transmits to the spindle 16 speeds in geometrical progression, by means of trains of gearing shifted by a hand-wheel, whose eight positions each give eight speeds; these can be doubled by the operation of a lever whose central position stops the machine. The speeds are indicated on a dial in full view of the operator. The proper speed for the spindle can be found by consulting a diagram furnished by the builders. All the mechanism for changing the speeds is contained within the column, and the different speeds are applicable both to the horizontal and vertical spindles. The vertical spindle can be disengaged when it is not desired to use it.

"This machine is furnished in the plain and universal forms —that is to say, with or without a swiveling table. The table is carried by a cross slide or saddle, which is supported on a strong knee, sliding vertically on large bearings at the front of the column.

"The feed mechanism is constructed with a change gear device similar in construction to that of the speed change— that is to say, 16 feeds can be obtained by the manipulation of a hand-wheel and levers, as seen in the illustration. The feeds, horizontal, cross, and vertical, are independent of the spindle and are reversible. The drive of the feed gear box is derived from the main drive. The different movements have automatic stops throughout in all directions, as well as positive stops for hand feeding. All the feed screws are provided with graduated dials. The knee, as well as the saddle and table, can be locked in any position by screws independent of the gib screws. A safety coupling is provided to prevent the breakage of important parts in the case of abnormal stress.

"The screw for the vertical adjustment of the knee is of the telescopic form, to obviate the necessity for cutting an opening in the floor. Especial care has been taken in the lubrication of the working parts within the column. The driving and feeding mechanisms, all of the bearings therein contained, and those of the spindle, are oiled by a pump which draws its supply from a reservoir in the base of the machine. The supply of lubricant for the cutters is furnished in a similar way, by means of a second pump and reservoir, separate from the first.

"Mention should also be made of the care taken to have all the mechanism accessible, for the sake of facility in cleaning and repairing. The engravings shown herewith (Figs. 3 to 8) show clearly the variety of work to which the swiveling head lends itself, including as it does, the particularly interesting operation of helical milling on a plain machine. This machine is being built in several styles and sizes."

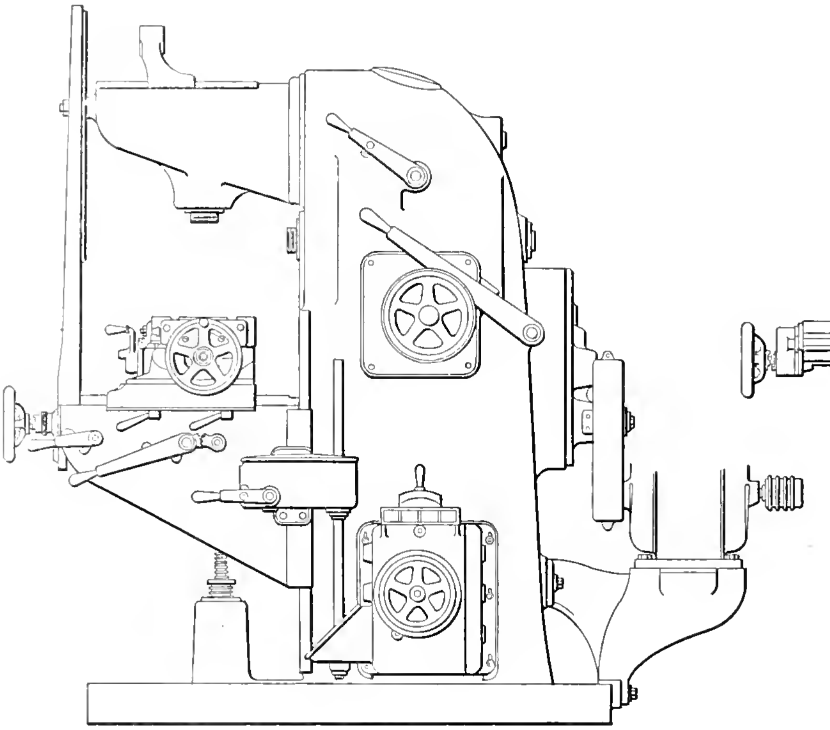
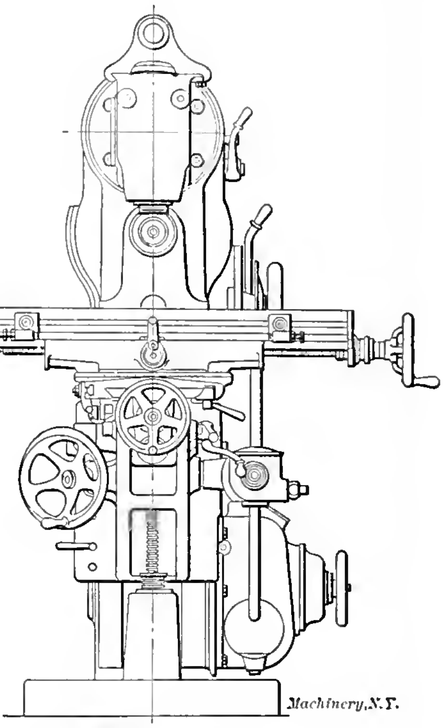


Fig. 1. Side Elevation of Combined Horizontal and Vertical Spindle Milling Machine, made by the Societe Francaise de Machines-Outils.



Machinery,N.Y.

Fig. 2. Face View of Machine.

STRESSES IN WIRE ROPES DUE TO BENDING.

Abstract of Paper by R. W. Chapman, in the Proceedings of the Australasian Institute of Mining Engineers.

Unwin states that a wire rope used over a pulley or sheave is subjected to three different stresses. Firstly, there is the longitudinal tension due to the weight suspended by the rope and the weight of the rope itself; secondly, the tension and compression stresses in the part of the rope resting on the pulley, due to the bending of the rope in a curve; and in the third place, there is a stress due to the centrifugal action at that part of the belt which is bent over the pulley. This last stress, of course, can be disregarded whenever the speed with which the belt moves over the pulley is moderate. The author of the paper here abstracted examines in detail the stresses due to bending only.

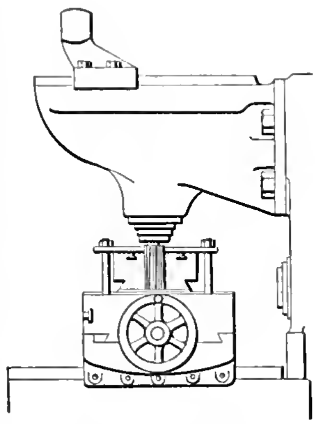


Fig. 3. Machine arranged for Plain Vertical Milling.

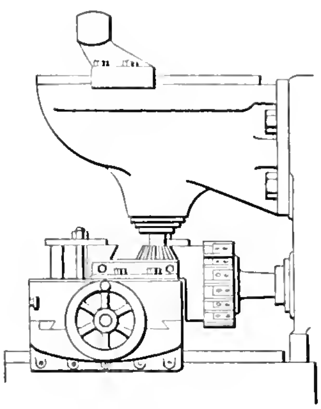


Fig. 4. Machine using Vertical and Horizontal Spindles Simultaneously.

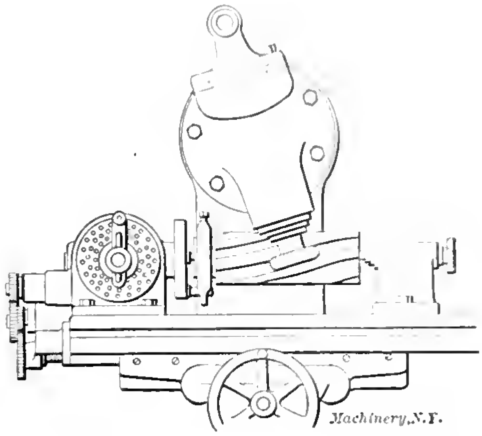


Fig. 5. Vertical Head Swiveled for Helical Milling.

The difficulties met with by investigators in trying to ascertain exactly the stresses in wire ropes bent over sheaves, is due to the fact of the complex structure of the wire rope, being made up, as it is, of spirally twisted strands, which in turn are composed of spirally twisted wires, it being difficult to say exactly what happens when this doubly twisted structure is wound around the drum or sheave. The difficulty is generally evaded in ordinary practice by the simple device of adopting a large factor of safety for a rope, usually one from eight to ten, a factor which experience has shown is sufficiently large to cover the bending strains set up when the rope is passed over sheaves of ordinary size. When, however, we add the stress due to the bending of the rope to the stress produced by direct pull, we find that the actual factor of safety is usually more nearly four than ten, and often the bending stresses in the rope are so large compared with the simple tensile stresses that neglecting them may lead to disastrous results.

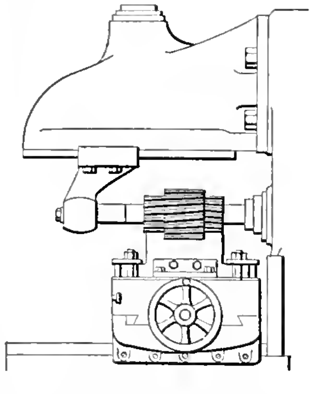


Fig. 6. Vertical Head Reversed to provide Outboard Support for Arbor in Horizontal Milling.

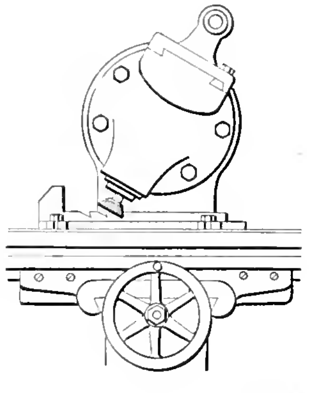


Fig. 7. Head Swiveled for Angular Milling.

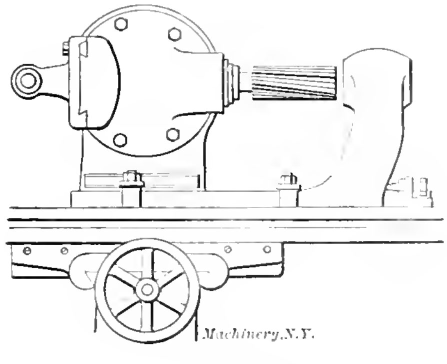


Fig. 8. Head Swiveled to Horizontal Position for Reaming, etc.

Empirical Rules for Size of Sheaves.

It has always been recognized that the bending of a wire rope over too small a sheave injures the rope, but as it is also desirable to reduce the size of the sheaves to a minimum for constructional reasons, the diameters of the sheaves are commonly made as small as is considered permissible. Various empirical rules have been given by different makers and writers for determining the minimum size of drum over which a rope may be wound. One maker states that the diameter of sheaves and drums should be about 30 times the circumference of the ropes used. Another rule says that the diameter of the sheave in feet should be $0.7C^2$, where C is the circumference of the rope in inches. Mr. H. W. Hughes in "Text-Book of Coal-Mining" states that the diameter of the pulley should not be less than 100 times that of the rope wire. Another writer gives the rule that there should be one foot diameter of pulley for each ⅛ inch diameter of rope; or, for instance, an 8-foot pulley for a one-inch rope. All these rules, however, are imperfect, because they take no account of the size of the component wires, and from practical experience we know that the smaller the diameter of the wires, the more flexible is the rope and the smaller may be the diameter of the sheave over which it may be bent.

A rule, to be of any reasonable value, should take into account the gage of the wire composing the rope. Such a rule is given by Mr. Bucknall Smith, in the *Mining Journal*, June 6, 1896, where he states that the diameter of the smallest pulley permissible should be at least 800 times the gage of the wire used. J. B. Richards, in *Mines and Minerals*, April, 1904, however, states that records show that the proper diameter of a sheave should be 115 times the diameter of a rope having 19 wires to a strand, and 185 times the diameter of a rope having 7 wires to a strand. Finally, another rule is given, deduced from practice, stating that a 6-strand, 7-wire rope requires a pulley whose diameter is equal to ten multiplied by the rope circumference squared; and a 6-strand, 19-wire rope requires a pulley whose diameter is equal to four multiplied by the square of the rope circumference. It will be noticed that there is a considerable variation of opinion expressed in the above rules, and while they may be useful for deciding approximately upon what experience has shown to be the proper size of pulleys to use for a given class of rope, they do not aid in determining the actual stresses placed on the rope by bending over pulleys of any given diameter.

Formula for Stresses in Wire Ropes due to Bending.

The author of the paper here abstracted therefore sets out to deduce mathematically a formula, giving the stresses caused by bending ropes over sheaves of given diameters, and he comes to the conclusion that the stress in pounds per square inch set up in a wire rope equals

$$\frac{E\,d}{D}\cos^2 a \cos^2 \beta$$

in which formula

E = modulus of elasticity of material, from which the wire is made,

d = diameter of component wire, in inches,

D = diameter of sheave, in inches,

a = angle made by the component wires with the axis of the strand, usually about 18 degrees,

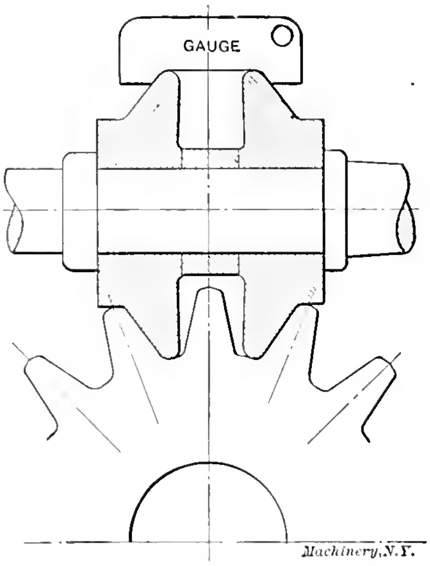
β = angle made by the strands in the rope with the axis of the rope, usually about 18 degrees.

[It will be found that the values obtained by the use of this formula are considerably greater than those obtained by Mr. James F. Howe in the article on "Bending Stresses in Wire Rope" in the June, 1907, issue of MACHINERY, engineering edition. The difference is due to the fact that Mr. Howe simply assumes a rather low constant modulus of elasticity for the rope as a whole, while the author of the present paper introduces the actual angles made by the wires and strands, thus, it would seem, arriving at a more definite and correct result.—EDITOR.]

* * *

CHAIN DRIVES.

The advantages of chain drives as compared with belt drives, for certain service have frequently been pointed out. The chain drive is positive, and high tension of the chain is not required to make it grip the sprocket, as in the case with belts on pulleys. There is, therefore, an entire absence of slip, and the power is used more economically. Chain drives can also be made to occupy less space than a belt drive, and give efficient service at center distances too short for belts but too long for gearing. The troubles met with in belts in hot or damp places, are also well known to all mechanics. These difficulties are eliminated in the chain drive. One objection to chain drives has been that they are noisy, but the noise can be largely obviated by properly designing the chain and the sprocket. The size of the sprocket is a question which influences the noise of the drive. Other things being equal, the smaller the number of teeth, the greater the noise made by the drive. The action of the chain is smoother and more uniform on a large sprocket than on a small one. This principle applies to all chain gearing and should be taken into consideration when laying out a drive. In extreme cases a sprocket with only seven or eight teeth may be used with a roller chain, but eleven or twelve teeth should be considered as the minimum in all cases where smooth running is essential. Generally, even the best designed driving chains, such as the Renold silent chain, should not run more than 1,250 feet per minute. When this limit is passed some special means of lubrication should be adopted. The roller chain is generally used for speeds from 600 to 900 feet per minute; and the block chain for speeds up to 600 feet. When designing a chain drive, inclined or horizontal positions should be chosen, with the tight side of the chain on the top.



Testing the Setting of the Cutters for Cutting the Teeth in a Renold Silent Chain Gear.

In the accompanying Data Sheet Supplement, formulas are given for obtaining the various quantities in regard to length of chain, diameter of sprocket, etc., required in determining upon a chain drive, both for the Renold silent chain, the roller chain and the block chain. The highest ratios desirable between the driving and driven sprockets are, for the silent chain, 1 to 6, and for the roller and block types 1 to 7½. The maximum and minimum number of teeth advisable are for silent chain 15 and 90, for roller chain 8 and 70 and for the block chain 6 and 60. The pitch of the chain is measured from center to center of rivets, the pitch of the wheel being approximately at the tops of the teeth. An odd or "hunting" tooth should be used in the pinion when possible in order to distribute the wear evenly on the sprocket teeth. It is advisable to have the center, on which one of the sprockets is mounted, adjustable, in order to be able to keep the chain at the right tension.

Ordinary chain drives should be lubricated at least once a week, and the lubricant should be free from any tendency to gum. A thin oil may be used first to penetrate the joints, and then a thicker oil that will not be thrown off by the centrifugal force. The lubricant is best applied with a brush to the inner side of the chain while running the chain slowly on its sprockets. The chain should be lubricated oftener than once a week when used under severe conditions, as in the case of constant running night and day, fluctuating loads, when running in dusty places, etc.

It is interesting to note the manner in which the teeth in the sprockets for the Renold silent chain are cut. The tooth space is first cut from the solid blank by a stocking cutter. The teeth are then finished by cutters working in pairs, as shown in the accompanying illustration. For the same pitch three different pairs of cutters are required. These cutters are very nearly the same in form, the only difference being that they make the tooth slightly deeper for the smaller wheels. The cutters are set to a gage, as indicated in the illustration. The center line of the gage should be set exactly central with the sprocket to be cut. When cutting steel or phosphor bronze, and especially if the teeth are cut from the solid directly by the finishing cutters, it is advisable to set the dividing head so as to cut alternate teeth, or even teeth further apart than every second tooth, the inaccuracy due to local heating being thereby avoided.

Tables will also be found in the Supplement for malleable chains as made by the C. O. Bartlett & Snow Co., Cleveland, O. A table is also given for the shape of the teeth in the sprockets, for the various numbers of chain.

* * *

The following case-hardening mixture is recommended in the *American Engineer and Railroad Journal.* Put in a two-inch layer of charcoal, broken into about one-inch pieces, and pack it down in the bottom of the box used for the case-hardening. Then sprinkle about one pound of common salt over the charcoal, and one pound of pulverized sal soda over the salt. Then one pound of powdered resin is placed over the sal soda, and one pound of black oxide manganese over the resin. The material to be case-hardened is now laid on this, care being taken not to place the pieces too close together or too close to the sides of the box. Between the pieces, charcoal is filled in and well packed, care being taken to have about two inches of charcoal between the different pieces, if they be large. Now the sprinkling of the compounds on the work is repeated in reverse order, so that a two-inch layer of charcoal is placed on the top of the box. Sprinkle a little salt on the top of the charcoal, then put the cover on the box, calk with clay, and place the box in the furnace from ten to fifteen hours, heating it to a bright red. Then cool it in cold, clear water.

ELECTRICAL WELDING.

In a recent issue of MACHINERY (October, 1908) was shown a photograph of a number of examples of high-speed steel tools electrically welded in the shops of the Thomson Electric Welding Co., of Lynn, Mass. Little or nothing was said about the process itself or the range of its application. This article has been prepared in the belief that there is enough of interest and importance in electric welding to make a more detailed description of it profitable. While the process was invented several years ago, improvements are constantly being made in its application.

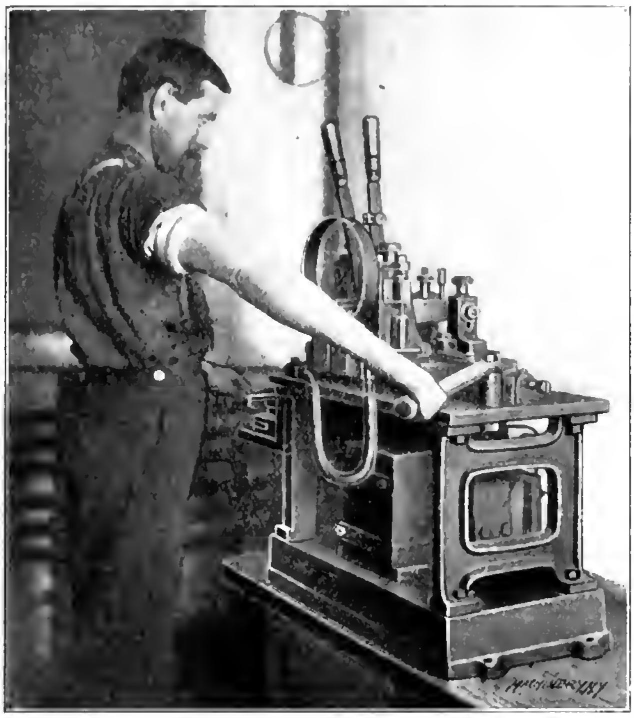


Fig. 1. Welding a Steel Ring in a Hand-power Machine; Section, 1 1-2 x 1-16 inch; Current, 10,000 Watts per 1 1-2 second.

The Principle of Electrical Welding.

The process consists, primarily, in holding the pieces to be welded between clamps, which form the terminals for an electrical circuit of very high amperage. When the surfaces to be welded are brought into contact with each other, these parts, themselves, complete the circuit, the current being transmitted directly through the work. The current strength is such that the resistance to its passage at the point of contact generates a welding heat. If the surfaces are not finished so that they come squarely into contact with each other, the reduced conducting section where the contact is made will heat rapidly to a high temperature, and flow, allowing the two parts to be pressed together into closer contact, until the whole area is at a welding heat. The heating action is thus progressive, being generally from the inside of the metal out, instead of being from the outside in, as with all other heating processes.

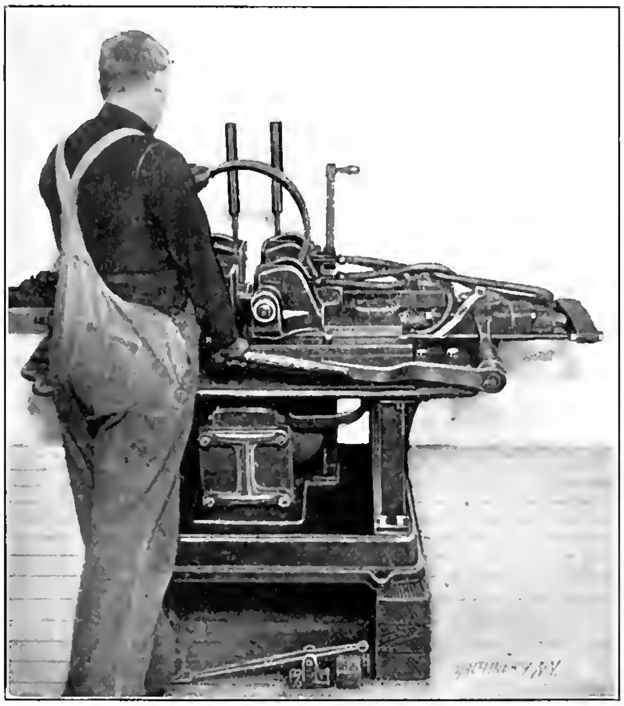


Fig. 2. A Large Machine, operated Hydraulically. Section welded, 3 x 5-8 inch; Current, 70 K.W. for 50 seconds.

Simple Welding Machines for General Use.

A simple type of machine for this process, adapted particularly to the welding of hoops, is shown in Fig. 1. The machine consists of a transformer; the electrodes between which the two ends of the work to be welded are clamped; means for pressing together the surfaces to be welded; and the necessary electrical connections, switches, etc.

The purpose of the transformer, which is mounted in the base of the machine, is to change the high potential alternating current as it is received from the shop dynamo or the commercial circuit, to the low potential, high amperage current required for welding. As it is the strength of the current in amperes that taxes the capacity of the conductor, it is necessary to transform the current into one of high amperage (and consequently low voltage) in order to over-tax the conductor at the point where it is to be heated to the desired temperature for welding. The two secondary terminals of this transformer form the support for the clamping device in the jaws of which the ends of the hoop to be welded are held. Each of these jaws is clamped to the work by cams operated by the handles shown projecting upward at the top of the machine. The two jaws are, of course, insulated from each other, so that the only path for the current is through the work.

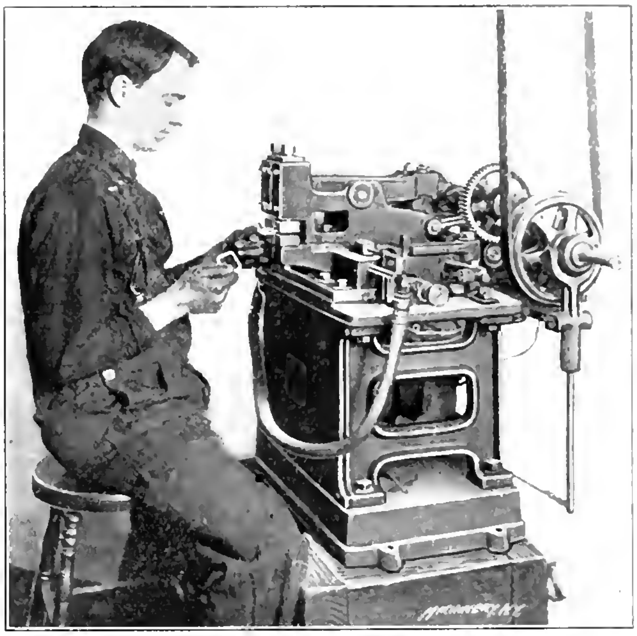


Fig. 3. A Small Automatic Machine for Welding Belt and Harness Buckles, etc.

The lever at the right hand of the operator is used for pressing the two ends of the work together. The current being thrown on, heat develops at the point of contact, owing to the high resistance to the passage of the current found there. As these points of contact are softened, the continued pressure applied by the workman forces the parts closer together, bringing them into more intimate contact. The heat developed finally so softens the work that its resistance to the pressure applied by the operator is suddenly relieved, the soft metal being squeezed out from between the joints as the jaws come together. It is important at this juncture to shut off the current immediately, to prevent over-heating and burning. This is done by an adjustable micrometer stop which, by making an electrical contact and energizing a magnet, throws open a switch in the primary circuit. The clamps are then loosened and the work removed. These various operations are matters of seconds only, and on work of me-

dium size the output is practically limited only by the rapidity of the operator's movements.

The machine just described might be spoken of as being, in a measure, a general purpose machine. Another general purpose machine for larger work is shown in Fig. 2. This is adapted either to the welding of hoops, as shown in the engraving, or the welding together of rods, bars, and general machine parts. It is adapted to work so large as to make direct hand operation impracticable for pressing the two ends of the work together. For this reason a hydraulic jack is incorporated in the machine. The workman is shown with his right hand grasping the pump lever of this jack. The release valve is seen mounted on top of the cylinder. The clamping jaws are each operated by two levers, one for opening and closing them through a considerable range of movement, and a second one for firmly tightening the work under great pressure. A fixed stop is provided on an extension arm at the left to furnish an abutment for the work against the pressure of the jack when welding bars, rods, etc. In this machine, owing to the size of the sections to be welded, the heating action is somewhat slower, so that the operator can throw off the current with the foot switch shown, when the pieces reach a welding heat. In the case of the small work used on the previous machine, the heating is so rapid that the switch has to be thrown automatically to prevent burning the metal. In both of these machines the parts in contact with the work are water cooled.

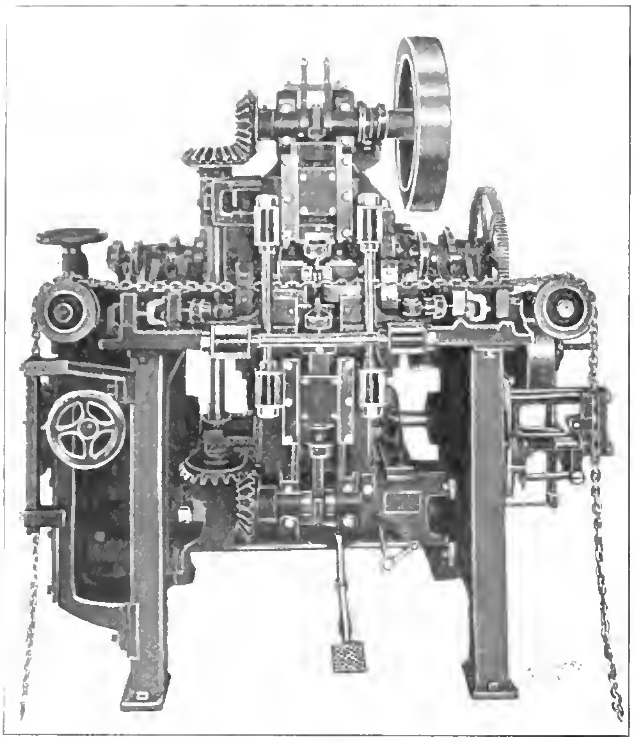


Fig. 4. Front View of Automatic Machine for Welding Chain Links.

Advantages and Disadvantages of the Process.

For work to which it is applicable (and its range of work is surprisingly large) the electrical welding process presents certain well-defined advantages. In the first place, as has been described, the heating is from the interior of the work out, instead of from the exterior inward, as is the case with any outside application of heat by coke fire, gas furnace, or similar means. This gives assurance that the whole section will be properly heated and properly welded. This is not possible in the case of large sections heated from the outside. Uniformity of heating is assured by the fact that if at any point the temperature is higher than at other points of contact between the parts, the increased heat increases the resistance, forcing the current into the cooler sections, and thus equalizing the temperature until it is uniform throughout the whole area. The process is almost instantaneous on small sections, and on larger work requires but the merest fraction of the time required with the old processes. The metal, while heating, is in the full view of the operator, instead of being concealed by flame or fuel. The weld is homogeneous, being of the same material throughout, uniting in intimate contact. By suitable electric controllers the metal can be held at any temperature desired for any length of time, and the heat increased and decreased as well.

The method applies to a great range of kinds and forms of metal, including those which could not hitherto be effectually brazed. Metals of widely dissimilar character can also be united. The process is under close control, so far as accuracy of dimensions is concerned, owing to the fact that the parts are kept in accurate alignment by the clamps, which may be given any shape necessary to hold regular or special work. Another point of importance is the extreme economy in the use of heat. This is localized at the point desired, and very little of it is lost by radiation, or is used in heating anything else except the work. The apparatus is clean and free from dust and dirt in its operation. There is, as well, no blistering or scaling of the work, the heat being confined to the welded joint. The slight fin or swelling produced at the junction may easily be broken or ground off, leaving a smooth, flawless surface. The current may be generated by dynamos, specially designed for the purpose, installed in the shop, or may be taken from a city light supply, if the latter is of the alternating current type, at from 100 to 400 volts.

The disadvantages which might be mentioned in connection with the process are chiefly those which are closely connected with the advantages. One of them is the great rapidity of action of the machine, which would tend to keep it idle the greater part of the time, except in shops where there are great quantities of welding to be done. For firms which have a moderate amount of work of this character, it is best to send their work to companies making a specialty of the process, rather than to install the necessary machines. Another point that might perhaps be considered as a disadvantage, is the fact that special electrodes or clamping jaws are required for many forms of work, whereas welding in a forge requires only tools of universal application and of the simplest kind. The holding jaws required for electrical welding, however, are very simple, being in their nature something like the special chuck jaws often used for holding work in milling machine vises.

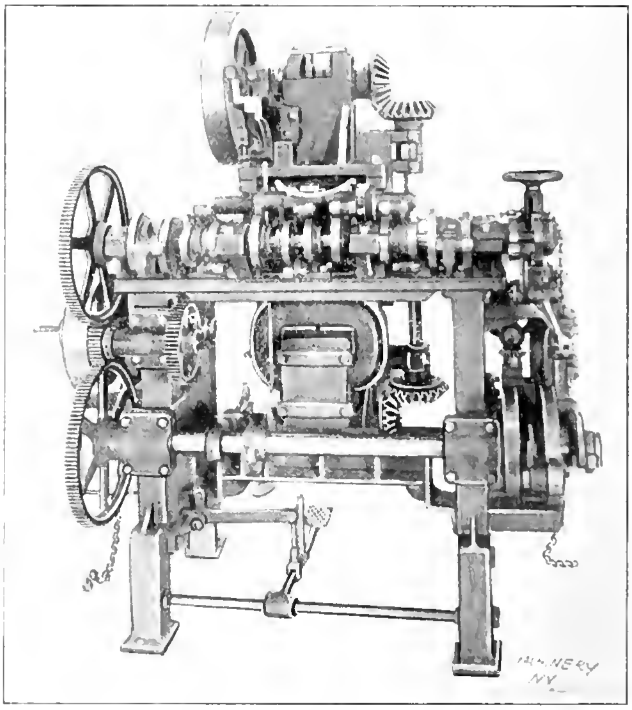


Fig. 5. Rear View of Chain Welding Machine.

Automatic Machinery for Electrical Welding.

One of the noticeable features of this method of welding is its applicability to special work. The Thomson Company builds special machinery, some of it of a high degree of complication, for manufacturing a wide range of metal products. We show two or three examples of such machinery. In Fig. 3 is illustrated a machine intended to be used in such work

as welding belt and harness buckles, rings, etc. It is exactly identical in its operation with the machine shown in Fig. 1, except that the clamping and the pressing together of the ends of the work is effected by cam movements. The throw-out of the current is automatic, as before. The switch is thrown in again by a cam instead of by hand. The clamps are water cooled. In making each weld, 3,000 watts are used for a second. All the boy has to do is to feed in the buckles, which drop out of themselves after being welded.

Figs. 4 and 5 show front and rear views, respectively, of a highly complicated chain welding machine. This machine simply welds the joints, the chain having been formed, assembled and closed by automatic machinery. It is fed through the clamps or dies by the hand of the operator, all of the other movements and the control of the switch being automatic as in the previous case.

Another special application is in the making of wire fencing, and wire mesh for reinforcing concrete. In this case cross wires are automatically laid on strands of continuous wire, spaced suitable distances apart and firmly joined to them by welding at the points of junction. This makes a fence which is in its completed form one solid piece, instead of being held together by twisting the wire or soldering. The operation of "spot" welding is employed in many cases for joining sheet metals to each other, such as for fastening handles, spouts and other attachments to cooking utensils, etc. In this case it takes the place of riveting. The two metals are joined together under the contact points, being fused into homogeneous contact.

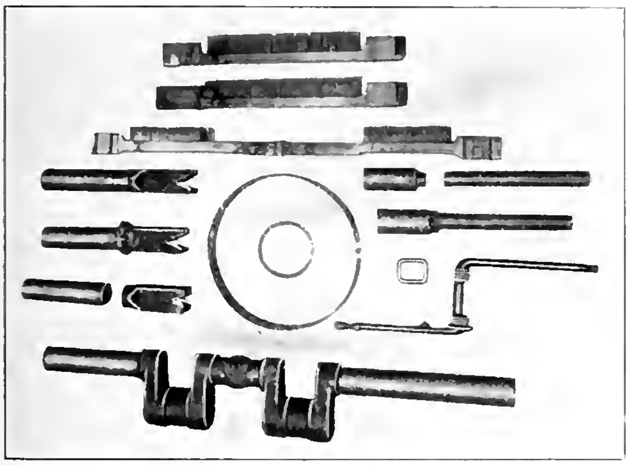


Fig. 6. Examples of Electrical Welding.

Fig. 6 shows a number of examples of the work produced by this process, which will serve to give some idea of its range. The three upper pieces are combs of a kind used in working wool. In the machines in which these are used, the hard service given them crystallizes them and causes them to break. They are easily repaired by adding new ends, or (in the case of the double ones) by rejoining them together at the middle. This can be done by this process and still keep the piece to accurate dimensions. The tools shown at the left are used for stone cutting in pneumatic or steam hammers. The breakage of these pieces is another case of crystallization under continued impact. They can be repaired, as shown, by welding the broken pieces or by putting on a new soft steel shank, at a fraction of the cost of forging and forming a new tool of high carbon steel. The two hoops in the center are similar in character to the work shown in progress in Figs. 1 and 2. The counterbore blanks at the right are similar to the work shown in the article in the October issue. A harness buckle and a welded bicycle crank are also shown. The large two-throw crank was built up from commercial forgings. It is possible to use these in building two, three, four, or other multiple throw cranks, with the throws set at any desired angle with one another, thus making costly special forgings unnecessary.

This process of electrical welding is controlled by the Thomson Electric Welding Co., which is prepared to do jobbing work, to lease standard machinery, or build special machinery, as may be required for doing work of any kind that can be done by this method.

BROACHING A DOVETAIL KEYSEAT IN A TAPER HOLE.

T SQUARE.

It was desired to broach a dovetail keyseat in the crank-shaft hole of a large quantity of bicycle cranks. The cranks were of nickel steel and had a 10-degree taper hole, with a minimum diameter of 17/32 inch, to be broached to receive a flat key, 3/8 inch wide by 1/16 inch thick, dovetailed to a 10-degree included angle. When the keys were driven into place in the cranks, the latter were required to be interchangeable on the crank-shafts, which were slabbed off on one side of the taper end to correspond with the key in the crank, and fitted with an ordinary check-nut to retain the crank.

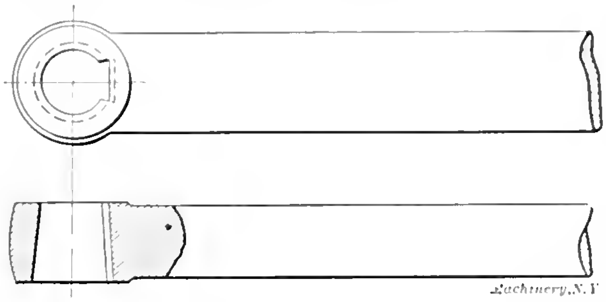


Fig. 1. View of the Broached Work.

To fit a key in this manner and insure interchangeability and a simultaneous fit on both key and crank, requires a nice degree of accuracy; and considering this, and the toughness of the steel, as well as the necessarily limited diameter of the broach, it was expected that the operation would prove expensive. Subsequent experience with the use of the device here illustrated, however, proved otherwise, as thousands of the parts were broached most successfully at a remarkably small cost. Fig. 1 shows the piece to be broached. Fig. 2 shows a machine steel plate, planed on the bottom and sides to fit the die-bed of an ordinary 8-inch stroke drawing press, and planed on the top to an angle of 5 degrees. After the planing operation a hole was bored at right angles with the top surface, to receive a tempered guide bushing *A*, which was pressed into place. The guide hole for the broach was then put through at right angles with the bottom of the plate. Thus it will be seen that when the crank is placed in position over the guide bushing and brought into contact with the stop pin *B*, the surface to be broached will be parallel with the line of travel of the broach.

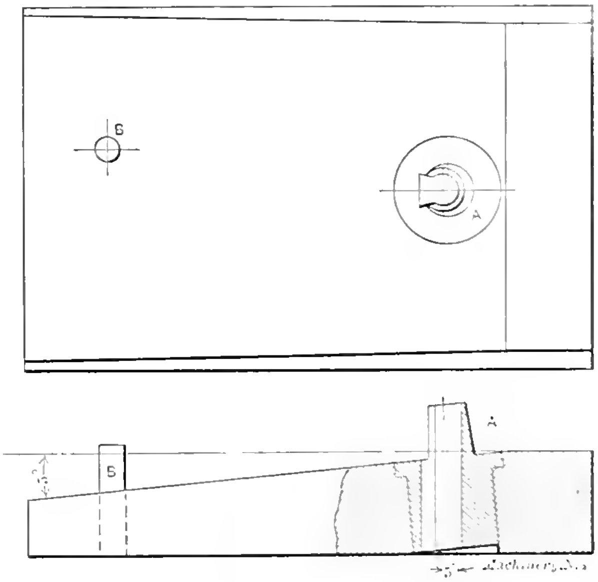


Fig. 2. Fixture for Holding the Work.

Fig. 3 shows one of a series of three broaches which are required to complete the cut. These are made to slide freely through the guide bushing *A* (Fig. 2), and are held in the proper position in the holder *D* by means of a locating piece *C*. As the press reaches the limit of the downward stroke, the broach, which has ceased cutting, simply drops through

the bust [illegible] to the hand of the operator, who then inserts broach number 2 into the holder as the press reaches the upward limit, thus making it unnecessary to stop the machine to insert the tools. Great care should be experienced to keep the teeth of broaches of this kind free from chips, which can easily be accomplished by the operator passing his fingers downward over the face after each removal from the guide bushing, and before depositing in the pan of oil.

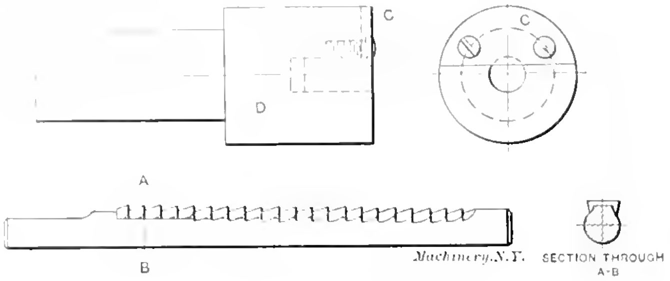


Fig. 3. The Broach and its Holder.

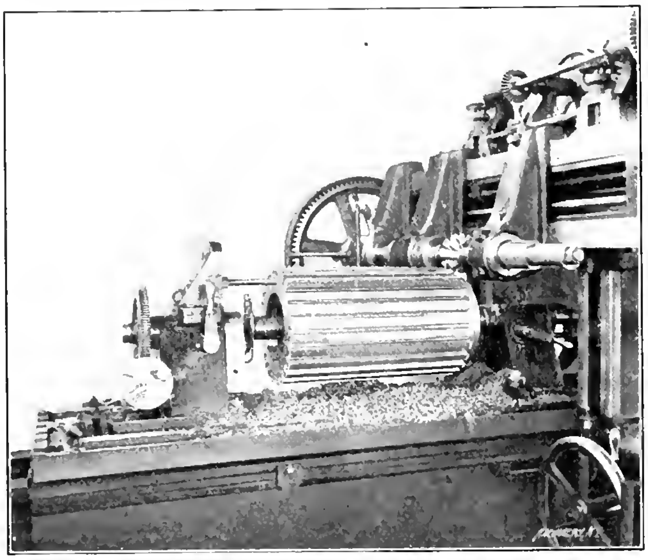
In tempering broaches of the shape used in this operation, the best results can be obtained by slowly heating the piece, face downward, in a charcoal fire. When heated face upward, the piece will invariably bend, making the face concave, and as they require to be reasonably hard, it is a difficult matter to straighten them.

* * *

CUTTING A LARGE SILENT CHAIN PINION.

C. M HAMERSLY.*

At the Link-Belt Co.'s Philadelphia plant the problem of cutting 26 teeth of 2-inch pitch in three forged steel blanks each $16\frac{1}{2}$ inches diameter, 27 inches face, with a hub on one end $14\frac{3}{4}$ inches diameter by 2 inches wide, making a total width over all of 29 inches, proved too much for the automatic gear machines, owing to the exceptionally long face.



Cutting Long Face Pinion for Renold Chain on Slab Milling Machine.

The difficulty was finally solved by performing the operation on a Bement, Miles & Co.'s 24-inch horizontal slab milling machine, using a pair of heavy index centers constructed by the company, especially for this class of work. The illustration shows the blank after it had been stocked out, and with the finishing cutter forming two teeth at the same time. In cutting the teeth 350 pounds of metal was removed. The blanks weigh 850 pounds each, and have a 10-inch bore.

These pinions form part of three silent chain drives of 350 H P. each, that are to transmit power for a wire-drawing bench at a plaut of one of the large steel companies, each drive consisting of a wide-face pinion connected to two large gears by two strands of 2-inch pitch Renold silent chain, each strand 12 inches wide.

* * *

The reason why men who mind their own business succeed is because they have so little competition.

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* Address, Link-Belt Co., Nicetown, Philadelphia, Pa.

INCLINED PLANE SHOP CAR ELEVATOR.

The accompanying half-tones, Figs. 1 and 2, and the line engraving, Fig. 3, illustrate an interesting appliance installed in the shops of the firm of H. Bollinckx, 117 Chaussée de Mons, Brussels, Belgium. There is a difference in the level of two departments in the firm's works, and some difficulty and loss of time was experienced in transporting material from one to the other. Due to the fact that the work was of a varying nature, and some of the pieces to be transported very long, the ordinary elevator did not suit for bringing the material from the lower to the upper level, or *vice versa*. For this reason, an inclined plane car was installed on which the regular shop cars could be placed and raised or lowered to the levels of the different shops, as required. The platform of the inclined plane car is provided with rails for this purpose, as

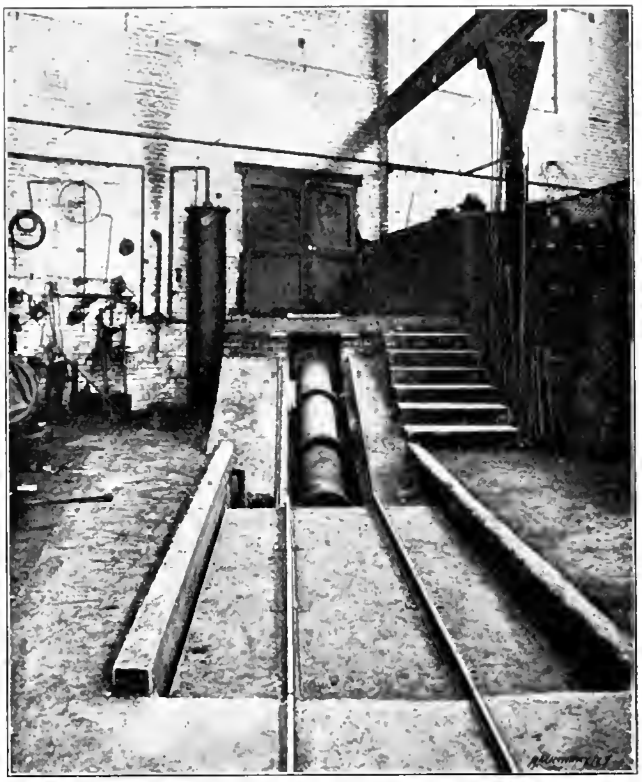


Fig. 1. Shop Car Elevator at Lower Level of Travel.

Fig. 2. Inclined Plane Shop Car Elevator at Upper Level of Travel.

shown in Fig. 1, where the car is located at the lower level of its travel. In Fig. 2 the inclined plane car is shown in its upper position, level with the floor in the other shop, and with a shop truck, loaded with a casting, on it. The platform of the inclined plane car is supported by a framework *D*, mounted on wheels and traveling on an inclined track. The power for the motion of the car is transmitted to it through the cylinder *E* which is filled with water and is connected with the tank *C*, shown at the left-hand side of the upper platform. The tank *C* is connected with the compressed air system of the shop by the piping *F*, thereby obtaining the required pressure on the water. The piping *A* connects the tank *C* and the cylinder *E*, and the valve *B* on the piping *A* is provided so that the inclined car can be made to stay wherever it is stopped. This is very important in order to prevent the car from sliding down again when it has arrived at the top level. When the car is again required to descend, the compressed air is let out at *H*, the valve *B* between the cylinder and the tank is opened, and the car descends in about thirty seconds. The valve *B* is opened by raising the counterweight *G* on the lever of the valve. When the inclined car has reached the lower level, the operator simply drops the counterweight, and the valve is shut automatically. At this time the air valve may be again opened so that the water in the cylinder *C* is under pressure, ready for the next lifting of the car to the upper level. The valve *B* being shut, the pressure cannot be transmitted from the tank *C* to the cylinder *E* before the valve *B* is again opened. The pressure of the air is kept at about seventy to seventy-five pounds per square inch. This gives a total lifting power of 22,000 pounds.

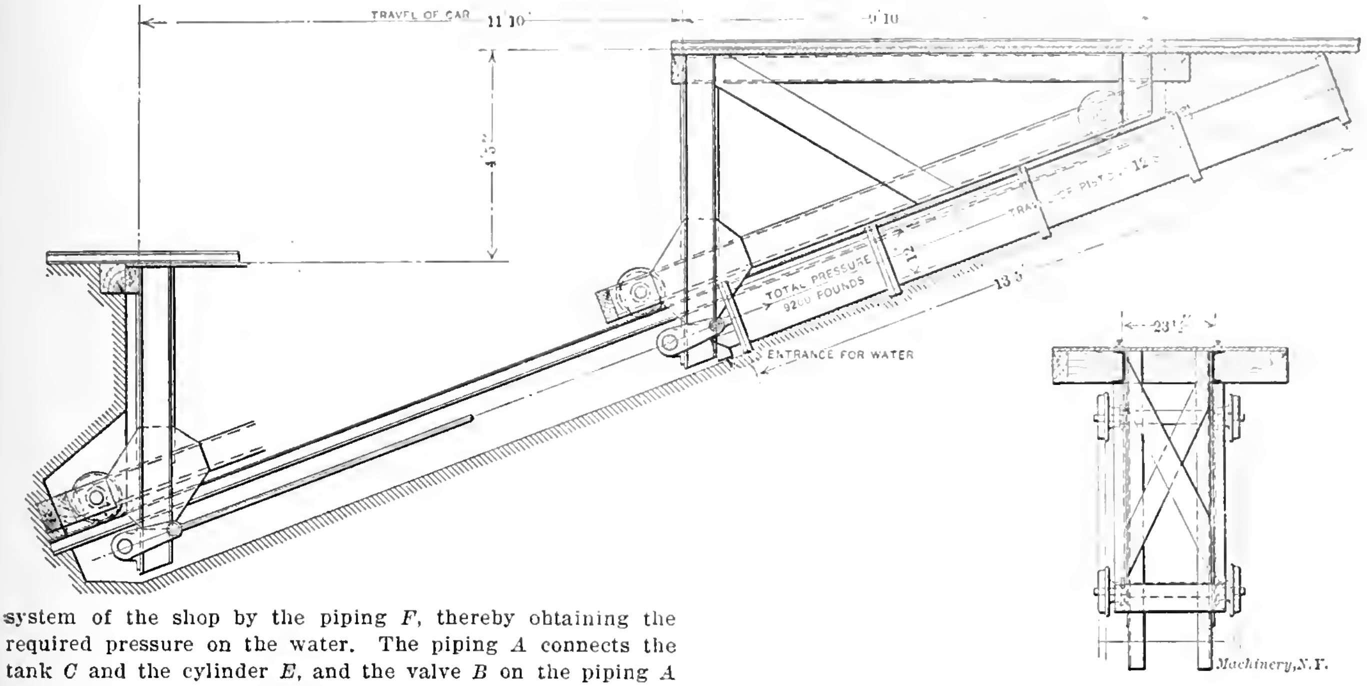
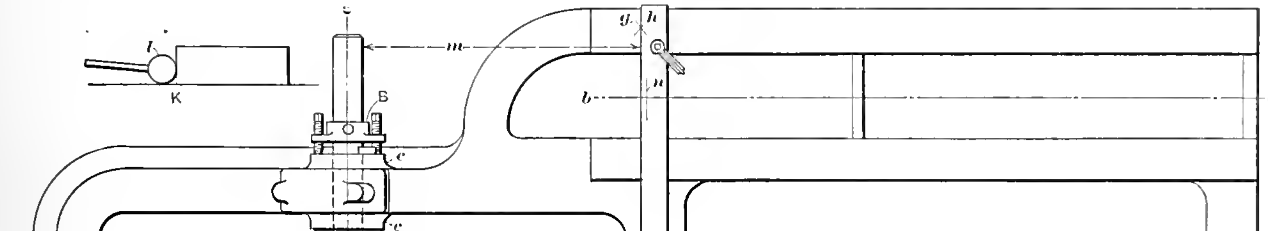


Fig. 3. Elevation and End View of Shop Car Elevator.

MACHINE SHOP PRACTICE.*

BABBITTING THE PILLOW-BLOCKS OF A DUPLEX BED

Babbitt metal is used very extensively on many kinds of machinery as a lining for the bearings, instead of the more expensive bored box, which requires considerable care in fitting. With this metal it is possible to line bearings quickly, and its extensive use is due to the resulting economy, rather than to the anti-friction qualities which it possesses. The temperature at which it becomes molten is low, and, consequently, it is easily melted over a common forge fire. By the use of a babbitting mandrel, the diameter of which is equal to, or slightly greater than, the journal of the bearing, the operation of boring is eliminated. For bearings which are large and important, however, the mandrel is often made smaller than the finished bearing, and the latter is bored after the metal has been expanded and compressed. It is common practice when babbitting two-part bearings, to expand the metal by beating it with the peen of a hammer, but owing to the lack of room, this method cannot be employed when the bearings are solid, especially if small and of considerable length. The same result is obtained in such cases, by forcing a tapered arbor through the bearing in a broaching press, or by other means, the size of the arbor being such as to leave



Plan of a Duplex Bed, showing Method of setting the Babbitting Mandrel when Lining the Pillow-blocks.

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* With Shop Operation Sheet Supplement.

sufficient metal for reaming or boring. Still another method which has proved satisfactory in practice, is to bore the bearing to within about 1/32 inch of the finished size, replace the boring tool with a cylindrical piece of steel having polished spherical ends, and feed the latter through the bearing. The length of the tool should be sufficient to compress the hole to within reaming size. As is well known, there are on the market a number of alloys known as babbitt metal, some of which are of inferior quality. If care is taken, however, to obtain a high grade metal, small and medium-sized bearings may be lined with it, and in use will prove satisfactory, without any peening or stretching, as the shrinkage of such metal in cooling is comparatively slight.

Obviously, before the metal is poured into the bearing, the mandrel must be set in correct relation to the other parts of the machine. When there are surfaces which have previously been finished, such, for instance, as the guides for the cross-head, these may be used to advantage in setting the mandrel. If much work of this kind is being done, what are known as babbitting jigs should be made. These are simply fixtures which bear against or fit into any finished surface or hole with which the mandrel must be aligned, and which hold the latter in the correct position while the babbitt is being poured. In the present article, the method of setting the mandrel, and babbitting the pillow-blocks of a small duplex vacuum pump bed, will be presented. This pump is of the type having forked connecting-rods which straddle the steam cylinders. The cross-heads are located between the steam and air cylinders, and are supported entirely by the piston-rods, instead of by guides; therefore the top of the bed and the sides of the pillow-blocks are the only finished surfaces available in this case.

Before the bearings are babbitted, the machine work on the pillow-blocks and caps should be completed, and, as both parts of the bearing, in this case, are to be lined at one time, the caps should be fitted and bolted into place. Steel liners about 1/16 inch thick should be inserted beneath them at points *d*, so that when the bearings have become worn, the play may be taken up by lowering the cap *A*, which is easily done, simply by inserting thinner liners. The anchorages for retaining the metal in the bearings, if they are not cored into the casting, should also be cut or drilled in. The babbitting mandrel is then set in place in the bearing, in the position which is subsequently to be occupied by the shaft. This mandrel is the exact size of the shaft, and the type here shown is provided with a clamping collar *B* which holds it in position, and two adjustable collars *C* and *D* which retain the molten metal.

In setting the mandrel, there are three requirements which must be considered: the center line *c—c* of the crank-shaft must be at right angles with the center line *a—a* of bed, and parallel with, and, approximately, at least, the required distance above the top surface of the latter. It is desirable that the shaft, when in place, be concentric with the bosses *e*, and, therefore, we shall assume that sufficient metal was removed from the top surface of the bed to make the distance *h* approximately the drawing dimension. This being the case, we have only, when setting the mandrel for height, to adjust it until the collars *C* and *D* are concentric with the bosses. The next step is to set the mandrel parallel with the finished surface of the bed. Locating points for accomplishing this quickly and accurately, may be provided by finishing small spots *f* beneath the bosses at the time the casting is planed; each spot, of course, being machined at the same setting of the tool. The mandrel is then set by calipering from these spots to the flanges of the collars *C* and *D*, which should be of the same diameter. If, however, such spots have not been provided, the same result may be obtained by holding a straight-edge, long enough to reach out to the mandrel, on the surface of the bed, first on one side and then on the other, and calipering the distance between the mandrel and the straight-edge.

If the bed was properly set when planed, the sides of the pillow-blocks will be parallel with the center line *a—a*, but as these surfaces are small, they cannot well be used for squaring the mandrel with this line. A line at right angles with the line *a—a*, however, can easily be scribed while the bed is on the planer, by placing a pointed tool in the tool-post, lowering it just enough to graze the finished surface of the bed, and feeding it across. The mandrel may then be set parallel with this line by the use of an inside micrometer gage having a bent point, as shown at *E*. This is a convenient and accurate method, but if no such line has been made, a long straight-edge *F* may be set at right angles with the line *a—a*, and used instead. To accomplish this, a wooden centering piece is inserted between the pillow-blocks, and a point *G* located midway between their inner surfaces. A point *H* is also located midway between the center lines *b—b*, if the central point used in setting the bed on the planer is not visible. Then, with a pair of long trammels, arcs *g* and *h* are scribed from the centers *G* and *H* respectively, and the edge of straight-edge *F* is set to coincide with the intersection of these arcs. The mandrel may then be set parallel with the straight-edge. As the former is above the latter, a gage equipped with a special leg, as shown at *K* in the engraving, will be found convenient for accurately measuring the distance between the two. This leg simply consists of a short cylindrical piece *l* (drilled to receive the gage wire) which bears against the surface of the bed and straight-edge, and insures the same vertical contact against the latter. As will be seen by referring to the engraving, this gage can only be used, in this case, at points *m* and *m*, where the straight-edge is in contact with the bed. If the mandrel is shorter than the one here shown, lines *n* and *o*, equidistant from the edge *F*, can be scribed with a pair of hermaphrodite calipers, and a gage *E* used to set the mandrel from these lines. Of course, after each horizontal adjustment, the mandrel is tested for parallelism from the spots *f* or with a straight-edge, as explained. The middle collar *C* should not be set against the boss *e* and tightened, until after the necessary adjustments have been made.

Prior to pouring the babbitt into the bearings, the latter should be heated somewhat to prevent the molten metal from being chilled when it comes into contact with the casting, as this would make the metal sluggish and doubtless result in an imperfect lining. It is also the practice to smoke, or cover with paper, those parts of the mandrel which are to come into contact with the metal, when babbitting solid bearings, to facilitate the removal of the mandrel from the bearing when the metal is cooled; but for two-part bearings, such as herein illustrated, this will not be necessary. As before stated, both the pillow-blocks proper and their caps are to be lined at one pouring of the metal. To accomplish this, liners *r* of cardboard, a little longer than the length of the bearings, are inserted between the caps and the pillow-blocks to prevent the metal, when it is poured into each of these parts, from uniting; the bed is then turned on its side, so that the mandrel stands in a vertical position, and the metal is poured from the ends of the bearings. When the bearings are being scraped, as described on the Shop Operation Sheet accompanying this issue, the shaft itself, or a special scraping-in mandrel should be used as the hot metal is apt to spring the one used when babbitting. A portable forge, preferably with a coke fire, is desirable for heating the metal, as it can be brought to the place where the work is being done. When the fire is some distance from the work, the metal is often over-heated, to prevent it from being too cool for pouring, and the effect of high temperatures on metals of low fusibility is always harmful. The method of testing the temperature of the metal (given in the Shop Operation Sheet accompanying this issue) by heating it sufficiently to char a pine stick, is perhaps as reliable and practicable as any—at least it has the merit of simplicity, which should prevail as far as possible in connection with all shop work.

* * *

During the month of October the "surprise tests" on the Pennsylvania Railroad, numbered 22,831, and with the exception of 82 cases, the employes obeyed the rules to the letter. Of these tests, 3,365 were for the observance of block signals set in unexpected ways, and the percentage of those observing these signals was 99.1. To ascertain the thoroughness with which employes observe emergency signals, such as fusees, torpedoes, etc., 3,357 trains were tested, and in 99.6 per cent of the cases the rules were obeyed perfectly.

APPLICATION OF LIFTING DEVICES TO ASSEMBLING WORK.

ALFRED SPANGENBERG.*

In assembling work, the operation of scraping the sliding or revolving machine elements to a fit, necessitates their being lifted and turned over a number of times. When the pieces are too heavy to be lifted by hand, the importance of providing efficient lifting devices is much greater than is usually apparent. Very frequently the time consumed by the scraper hands in trying the pieces together to find the bearing, and in waiting for the crane, exceeds, by quite an appreciable percentage, the actual length of time consumed in the operation of scraping.

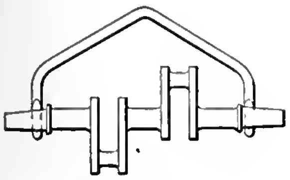

Fig. 1. Machine Steel Sling for Lifting Crank-shafts.

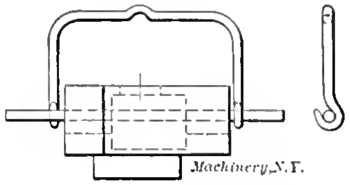

Fig. 2. Device for Lifting Turrets.

In many instances a properly designed lifting device is far superior to a chain or rope for handling the work, and in cases where a device can be designed to eliminate the use of both a chain and crane, a large saving in time can reasonably be expected. The main points to be considered in the design of an efficient lifting device are stated in the following rules:

1. The device must be safe and simple.
2. It must admit of being quickly attached to the piece to be handled.
3. Avoid the necessity of detaching the device when trying the pieces together.
4. In case the work has to be turned over to scrape the surface, balance the piece so that it will swivel easily and yet hang in a position to slide or lower onto the fixed member.
5. Make the device adjustable to allow for the varying center of gravity in similar pieces of work.

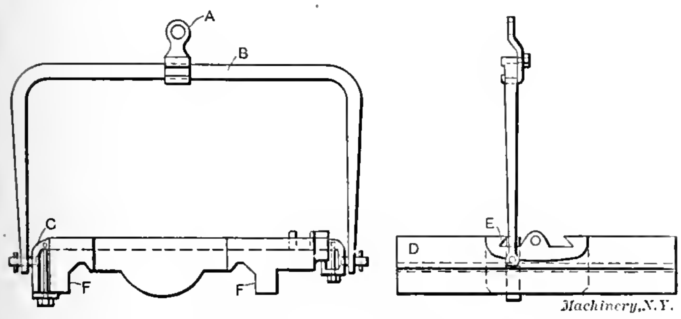

Fig. 3. Sling for Lifting Lathe Carriages, which is equipped with an Adjustable Crane-hook Eye.

6. If possible clamp the device to the work by making use of holes already in the work.
7. Admit of close adjustment for height.
8. Handle the work without the use of a chain or crane.

The accompanying engravings illustrate a number of lifting devices, and suggest their application to a variety of work. The function of the device illustrated in Fig. 1 is clearly indicated by the sketch. The device is made of round machine steel bent to the shape shown. Fig. 2 represents another application of a similar device for lifting turrets. The device is attached to the turret by means of a round bar passing through the holes in the turret. The ends of this bar are left long to serve as handles for revolving the turret on its carriage to find the bearing. A device of this character covers the fundamental principles laid down in rules 1, 2, 3, and 4.

The device shown in Fig. 3 is for handling a lathe carriage, and illustrates an application of rule 5. It will be observed that the eye *A* can be adjusted along the frame *B*. This is to balance the carriage and allow for the varying center of gravity in different carriages. The method of clamping the swivel bar *C* to the carriage is clearly indicated. The carriage is balanced lengthways so that the end *D* will be raised first, the object being to prevent the swivel bar *C* from slipping away from the angle *E* of the carriage. In some designs the sides of the carriage at *F* are a close fit on the lathe bed. In this case the carriage may bind when being lifted off the bed, and if a power crane is used there is danger of springing the carriage. The safety device shown in Fig. 4 overcomes this difficulty, and is so simple that little explanation is needed. The device is suspended from the crane hook by the link *G*. The hook *H* is for attaching the carriage by the device shown in Fig. 3. When lifting the carriage off its bed most of the weight is taken by the crane; the lever *I* is then pulled down until the spring pin enters the hole *J*, when the carriage is clear of the bed. The operation is reversed for lowering. By this method any tendency of the carriage to bind is quickly felt, and the danger above referred to avoided.

Fig. 5 illustrates a method of lifting a swivel by hand. Two round machine steel bars, about 12 inches longer than the swivel, are laid one in each angle and bolted together as indicated. The projecting ends serve as handles to lift the swivel. In case the swivel is lifted by a crane, a sling chain is passed around the handles to lift the swivel from its shoe; it is easily turned over by making a hitch to one of the bars.

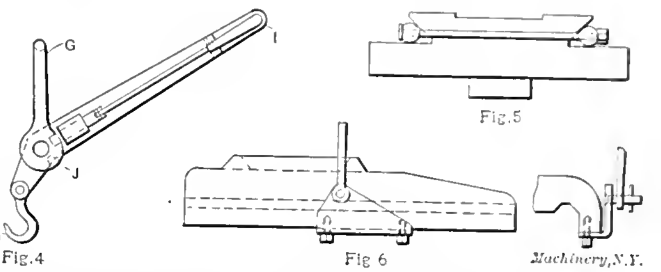

Fig. 4. Crane Attachment, for ascertaining whether a Piece being lifted from its Seat binds. Fig. 5. Device for lifting a Swivel by Hand. Fig. 6. Method of attaching a Lifting Device to a Turret Carriage.

The method of attaching a lifting device to a turret carriage is clearly indicated in Fig. 6. The point mentioned in rule 6 is observed in its design, and the holes already drilled in the turret carriage for the gibs are made use of for clamping the swivel plates.

The gravity tongs shown in Fig. 7 are very efficient for handling work of the character represented. They are so simple that no description is necessary.

For lifting a lathe face-plate for the purpose of screwing it onto the spindle, the method shown in Fig. 8 is very convenient and enables the work to be done quickly. The face-plate is lifted by the gravity tongs. The taper shank of the pin *A* fits into the spindle *B*, and the straight end is an easy fit in the hole of the face-plate. When the pin is lightly driven into the spindle hole, it supports the face-plate after it is released by the tongs. Being thus centered and free to revolve, the face-plate is easily screwed onto the spindle.

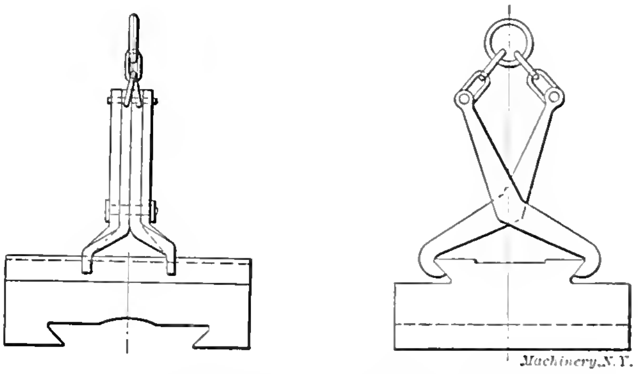

Fig. 7. Gravity Tongs for Handling Work such as illustrated.

Especially where head-stocks are built in lots, this method of screwing on the face-plates will save considerable time.

The function of the device shown in Fig. 9 is clearly indicated by the drawing. The device is an application of rule 7, and is for lifting turret lathe chucks when attaching them to the chuck gear. The T-slot in the chuck is made use of to clamp the device. The turnbuckle, with its right- and left-

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* Address: 951 W. 5th St., Plainfield, N. J.

hand threads, provides an easy adjustment for height so as to center the chuck with the gear.

In shops where the crane facilities are limited, the jib crane shown in Fig. 10, which is used in connection with an air hoist or chain fall, will be found very useful. With this outfit there is no excuse for not being "on the job." The ball thrust bearing A allows the arm to be swung easily when under load. The base can be clamped to a lathe bed, cross-rail, or any solid foundation, and the device used in connection with the lifting devices previously referred to.

Fig. 11 shows two views of a device designed by the writer, for fitting a saddle onto a boring mill or planer cross-rail. Rule 8 is observed. The object of the device is to provide a means for holding the saddle in a position to scrape, turn it over, and slide it onto or off of the cross-rail, without the use of a crane. Referring to the illustration, the frame *A* has four legs *B*, and is fastened to the cross-rail by the braces *C*. This frame serves the purpose of a track to guide and support the saddle *D* when it is off the cross-rail *E*. The saddle is carried by the strap *F* and rollers *G*, and when in position to be scraped, is held by the clamp *H*. By referring to the elevation shown in Fig. 12, of a similar device, it will be observed that the frame at *I* is cam-shaped. The object of this curve in the track is to keep the saddle from touching the end of the cross-rail while being slid on or off, making the operation easy and preventing a false bearing being made on the saddle, as would be the case if the saddle had to drag over the end of the cross-rail. Fig. 12 represents the end of a boring mill cross-rail lying on horses, in position to have the saddle fitted. In practice the edge *J* of the cross-rail would be elevated slightly so as to easily keep the saddle in contact with this edge when it is being slid along.

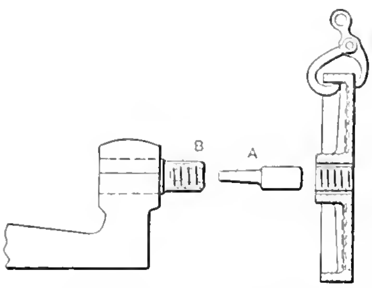


Fig. 8. Appliances which Facilitate placing the Face-plate on the Lathe Spindle.

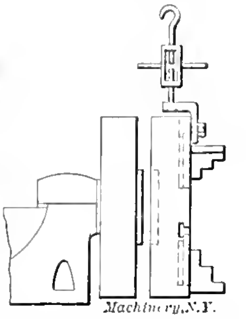


Fig. 9. Crane Attachment for Lifting Turret Lathe Chucks.

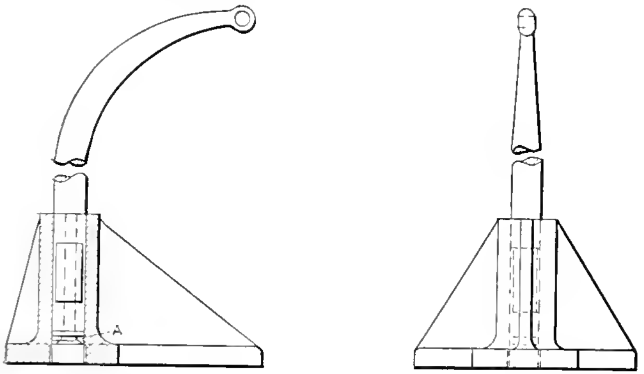


Fig. 10. Small Individual Crane provided with Ball Thrust Bearing.

When using a power crane, and lifter similar to the one shown in Fig. 3, for doing the work just described, trouble was experienced in obtaining the proper adjustment for height so that the saddle would slide easily onto or off of the cross-rail. This was to be expected, as the variation in height had to be within a limit of say ¼ inch, an adjustment not easily obtained with a power crane. The main advantage to be gained, however, by using the device illustrated in Fig. 11 was in not having to wait for the crane.' A similar device could easily be made for handling lathe carraiges when fitting them to the bed.

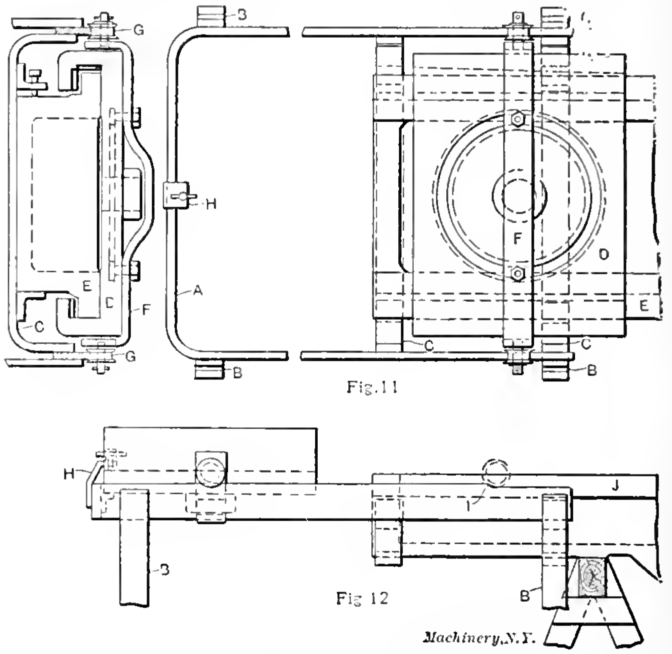
* * *

The United States exported $267,524 worth of aluminum in eight months during 1908.

CARNEGIE'S PROFIT-SHARING PLAN.

An equitable reward for labor—that is, a just share in the profits as well as the losses of an enterprise—may be impossible under present economic conditions, but there are many able thinkers who believe that it can be more nearly realized than is possible with any of the existing schemes of stimulating production, *i. e.*, piece-work, bonus, premium, "individualized efficiency," etc. The result of all the existing plans has been, sooner or later, to *fine* the worker for greater production by reducing wages. The consequence is that workmen have virtually set a limit of daily production in almost every industry beyond which they will not go.

Andrew Carnegie, in his new book, "Problems of To-day," makes the prediction that the wage system as it is at present maintained is doomed to extinction. He sees ahead to the time when the wage worker of to-day will be the partner in a profit-sharing system which will do away with all the recognized methods of rewarding labor. Mr. Carnegie's idea is that the profit-sharing system will extend so far that all branches of industry will adopt it. He advocates the guaranteeing to the workingman, of the minimum wage, solely to keep his mind easy and free for his work, but the wage should only be a part of the pay of the worker. He should have an interest in the business—a partner's interest—with the status of a share-owning official and a voice in the management. The workingman and the capitalist, under the universal profit-sharing system, will become one. He holds that the universal profit division system will not only benefit the workingman, but will be a great help to business and industry generally. With every employe a shareholder in the particular shop or establishment that claims his labor, most of the disputes between capital and labor would be prevented. There would be a feeling of mutual regard, which is now sadly lacking.



Figs. 11 and 12. Device used when fitting a Saddle to a Cross-rail, which enables the Former to be removed from the Latter and scraped, without the Use of a Crane.

"Thus we see that the world moves on, step by step, toward better conditions. Just as the mechanical world has changed and improved, so the world of labor has advanced from the slavery of the laborer to the day of his absolute independence, and now to this day, when he begins to take his proper place as the capital-partner of his employer. We may look forward with hope to the day when it shall be the rule for the workman to be partner with capital, the man of affairs giving his business experience, the workingman in the mill his mechanical skill, to the company, both owners of the shares, and so far equally interested in the success of their joint efforts, each indispensable, so that without their cooperation success would be impossible. I am convinced that the huge combination, and even the moderate corporation, has no chance in competition with the partnership which embraces the principal officials and has adopted the system of payment by bonus or reward throughout its work. The latter may be relied upon, as a rule, to earn handsome dividends in times of depression, during which the former, conducted upon the old plan, will incur actual loss, and perhaps land in financial embarrassment."

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

ACCURATE METHOD OF SETTING MILLING CUTTERS.

In a certain shop where gears are required to be cut within a limit of 0.00025 inch, the cutters are set in the following manner:

1. The cutter is centered over the arbor as nearly as possible, with a gage.
2. The blank is clamped to the arbor and a cut is taken through.
3. The blank is taken off the arbor and the cut is colored with copper sulphate.
4. The blank is *reversed* on the arbor and *not fastened.*
5. The cutter is run through the cut again and the points where the cutter touches noted.
6. The table is re-adjusted and the operations repeated until the cutter touches evenly on both sides.

The blank floats on the arbor when reversed and not clamped, and if the cut is not exactly central, the cutter will rub off the copper on one side of the cut at the bottom and on the other side at the top.

H. G. H.

CHANGING OLD LATHE TO INCREASE CUTTING VALUE.

We were blessed with a supply of old lathes that had small cutting power and light feed, and while they were probably good for certain work, they were not suitable for all our work, particularly for shaft turning, as frequently we had more than the customary amount to turn off on the ends; consequently it was decided to try to change one of our most promising looking lathes into one with some modern qualities. We wanted to make it as powerful as was possible under the existing circumstances, and this was accomplished as explained in the following:

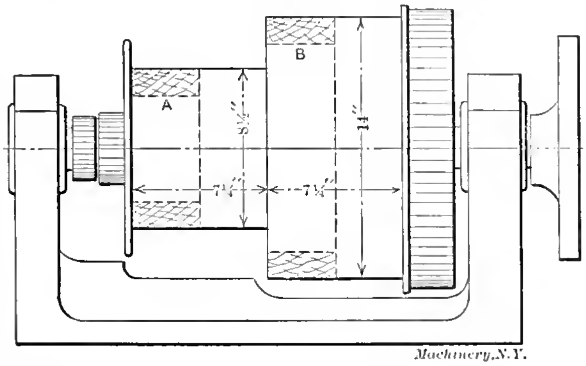


Fig. 1. Change in Cone Pulley to Provide for Wider Belt.

The lathe chosen for this change had the customary four-step cone pulley, driven by a 3-inch single belt, and the ordinary carriage feed. In order to get more pulling power, the width of the belt had to be increased, which was done by changing the cone pulley from a four-step to a two-step cone. This change was accomplished by rough turning the steps at *A* and *B*, Fig. 1, and forcing a solid wooden ring on at *B* and putting one on in halves at *A*. In order to get good holding power of the wood on the iron, three coats of shellac were applied, each one being allowed to dry before applying the other. The last coat was allowed to dry until it was in a sticky condition, then the wood was pressed on the pulley and further secured from turning by screws. The wood and iron surfaces were then thoroughly covered with thick paper. The counter-shaft cone pulley was changed in the same manner. This allowed us to get a 6-inch double belt on the cone pulley. A corresponding increase of power was made in the drive from the line to the counter-shaft. Fig. 1 shows the arrangement of the cone pulley after the change had been made, the dotted lines showing the original contour.

The tool-post had to be made stronger (for the present one would not take the cut that the 6-inch belt could pull) and Fig. 2 shows how this was easily and cheaply accomplished. All parts, except the screws, are cast iron, and did not cost very much to make. The holder has two tool slots which allow a wide range for the tool without the necessity of changing the position of the post. The tool-post can be raised or lowered easily by the ¾-inch adjusting screw *A*, and the slot cut in the lower flange allows the post to be clamped by the set-screw *B* and securely held in any position desired by the operator.

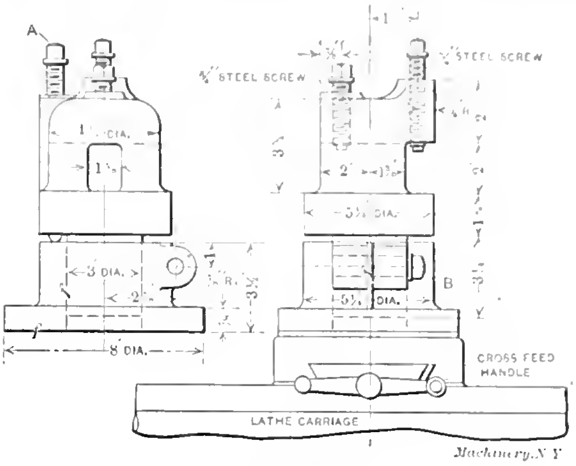


Fig. 2. The New Design of Tool-post.

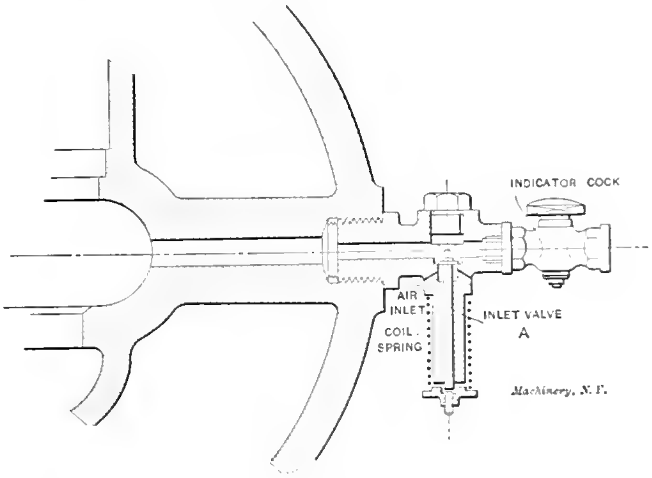
The change was made for a comparatively small cost, and it increased the cutting value over 100 per cent, and paid for itself in a short time.

O. JAMES.

Providence, R. I.

AIR INLET VALVE FOR INDICATOR PIPES OF INTERNAL COMBUSTION ENGINES.

The difficulties met with in taking indicator diagrams of internal combustion engines operating on low grade gases, due to ignition taking place during compression, have often been discussed in the technical papers. The journal *Haeders Zeitschrift* which is devoted to accidents, lately cited several cases where it was impossible to take diagrams because the pipe or passage which leads to the indicator, acted in the same way as an ignition tube. So far as the motors themselves are concerned, it is necessary to stop up this passage in order to permit the machine to operate normally.



Gas Engine Indicator Pipe with Air Inlet which prevents it from becoming Heated.

These inconveniences we have likewise experienced, but we have completely overcome them, thanks to our valve for admitting air, which is illustrated in the diagram shown herewith. During the suction of the mixture, valve *A* permits the outside air to enter and clear the indicator passage of all burned gases. As the tubes are full of pure air during the compression stroke, the mixture is prevented from entering, and, furthermore, the air cools the passage to the indicator

very effectually. This valve can be employed with very good effect also for cooling any closed cylinder space which heats too rapidly, or a corner where the hot gases have a chance to remain confined and thus produce premature ignition. The device can also serve to cool the valves without water, introducing the air through the stem.

Société Anonyme des Moteurs a Gaz A Bollinckx.

Huyssinghen, Belgium.

WINDING SPRINGS WITH INITIAL TENSION.

There are many spring winding devices, but it is seldom one sees anything for winding springs with initial tension, and, in fact, many mechanics would be "up against it" if given a job of this kind. One of the simplest and most effective devices that I have seen for this work, was made by W. A. Bright, foreman of the Decatur Novelty Works.

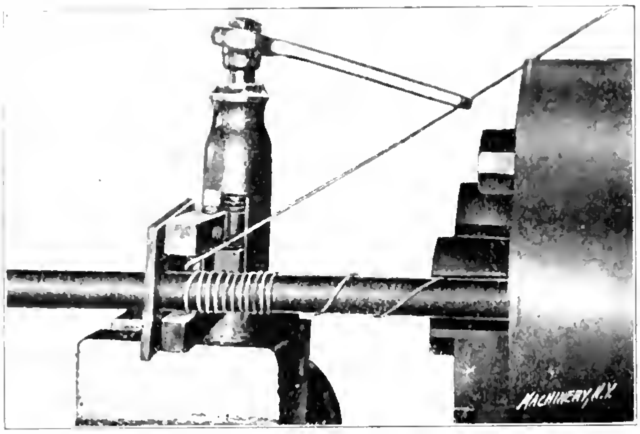


Fig. 1. Method of Winding Spring with Lathe running Forward.

For the sake of clearness, and to show the way the wire runs when winding, I have used a piece of coarse string and have wound it on the mandrel with the coils apart to show the direction of the spiral. Fig. 1 shows how a spring is wound with the lathe running forward, the wire being fed from the operator's left as he stands in front of the lathe. Note the way the cord is run half around the guide pin, and how it is shoved over against the last coil by the pin as it comes around the mandrel on the first turn. Fig. 2 shows the way wire is fed from the back, which Mr. Bright considers the handiest. When winding in this way the lathe is reversed, and the wire is given about a three-quarter turn around the guide pin as it feeds on the mandrel. In winding a spring in this way, the lathe carriage must be fed along so as to give it a lead of a few thousandths inch over the winding of the wire, in order to prevent the wire from climbing upon the coil.

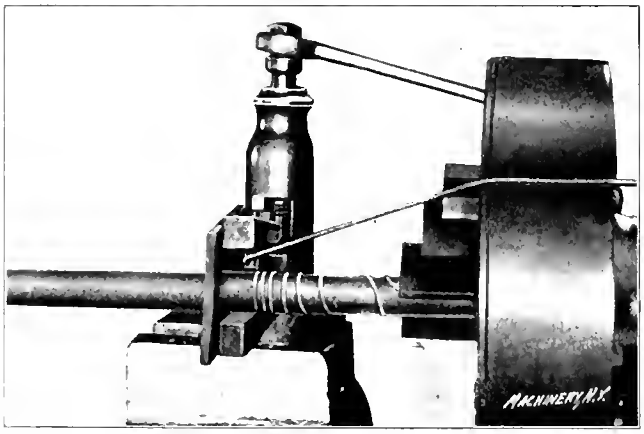


Fig. 2. Winding Spring with Lathe running Backward Note that Wire makes Return Bend around Guide Pin.

Two of the springs wound in this way are shown at *A* and *B*, Fig. 3, and the amount of initial tension is shown by the spring at *C*. This spring is of 14 gage wire, 3/8 inch in diameter, and 3 inches long. The scale registers 24 pounds and the coils have separated so little that it is impossible to insert a common business card. The large spring *E* registered 50 pounds on another scale, with no sign of separation. The device shown at *D* is the same as shown in the lathe in Figs. 1 and 2. The spring *E* is inserted in an exceedingly handy jig for forming the loop on the end. The construction of this jig is too clearly shown to need explanation.

Decatur, Ill. Ethan Viall.

ECONOMICAL DESIGN.

The work of the draftsman, though primarily concerned with the correct layout of mechanisms for performing certain predetermined operations, does not end, by any means, when this layout has been brought within the limits of machine construction, or rather within the realm of mechanical feasibility. When the arrangement has reached this stage, it is absolutely necessary that every detail of the mechanism be carefully considered with reference to its manufacture. Slight modifications in the design of the details often make a big difference in the cost of manufacture, and modern conditions demand that this phase of machine design be very carefully considered.

The engraving shows a sectional plan of a lathe apron, designed by the writer, which will perhaps more fully illustrate what is meant by the title of this article. *A* is a straight-face worm gear driven by the worm on the splined lead-screw. *B* is a friction gear which, by means of a tumbler gear (not shown), may be connected at will either to the gear *C* or the cross-feed-screw pinion (not shown). The gear *C* is keyed to the mild steel rack pinion *D*. *E* is the hand feed-shaft pinion; *M*, the apron; *H*, the apron cover bolted to the front of the apron; *F*, the lead-screw half-nut; *L* the cam for engaging the lead-screw nut, and *G*, the lever for operating the cam. All the bosses *K*, on the apron cover, are the same height so that they may be machined on the planer in quantities. A measuring block is used to set the tool to the proper height. One setting of the tool sizes the whole lot, whereas, if these bosses were faced on the drill press, there would have to be twelve measurements made (including those for the two shafts not shown) to insure an accurate job. Similarly, all the faces *J* on the inner side of the apron *M* are in the same plane. These faces also are machined on the planer and the dimension *N*, that is, the distance from the face *J* to the apron cover seat, obtained from a suitable measuring block.

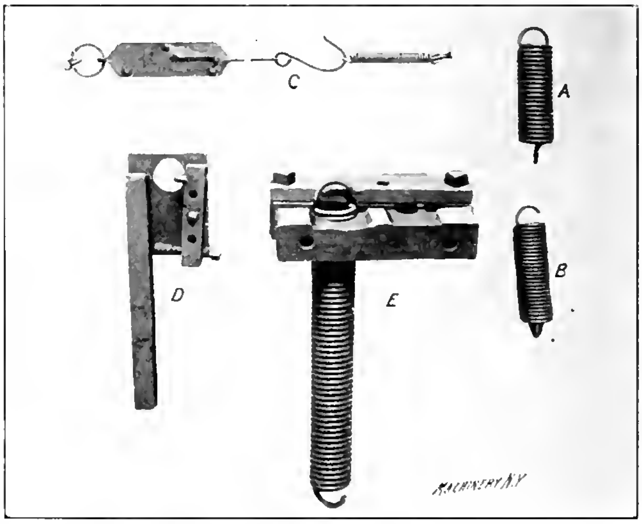
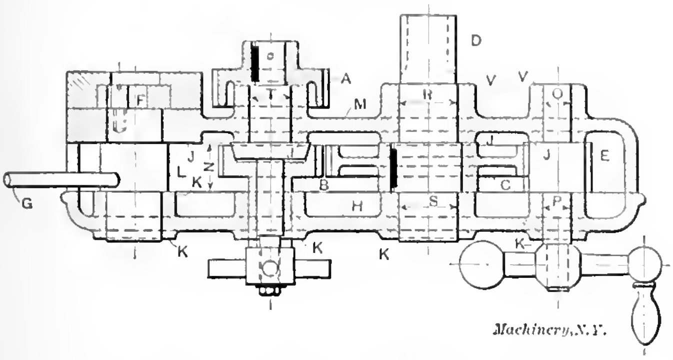


Fig. 3. Sample Springs and Device for Guiding the Wire as it is wound on the Mandrel.

It will be seen that practically all facing on the drill press is done away with; in fact, there is only one boss on the whole carriage that is faced on this machine and that is the one for the worm gear *A*. With the exception of the faces *V*, which are not machined at all, all faces are machined on the planer.

Another operation which is perhaps even more important, is the drilling of the holes for the various shafts. There are twelve bearings in the carriage, altogether—six in the apron and six in the cover, that is, six shafts each with two bearings. Before any of the bearings are drilled, the cover is bolted to the apron, after which the whole carriage (the apron and carrriage are cast together) is mounted in a jig

on the drill press. The special feature which I want to point out is that both bearings of each of the six shafts are equal in diameter; thus *O* is the same size as *P*, *R* the same as *S*, and so on. This is of great importance when drilling the bearings, as the drill may be fed straight through both apron and cover in every case. This is a great convenience and saves considerable changing of drills and jig bushings, which would be inevitable if the two bearings of each shaft were not equal in diameter. Another advantage is that ordinary reamers may be used to ream the bearings, where otherwise special double ones would be necessary to insure correct alignment of each pair of bearings.



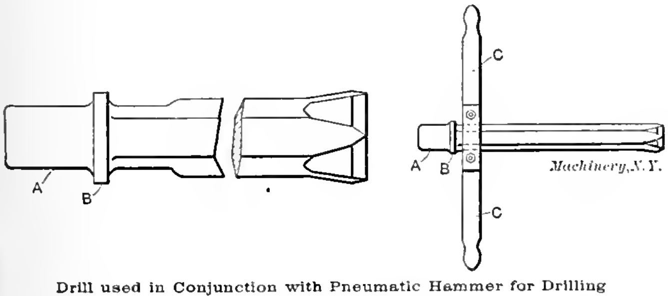
Example of Design in which the Method of Manufacture was considered.

There is still another advantage with this design in that none of the shafts, with the exception of *T*, require fastening endways, the apron cover attending to this. Suppose that the pinion *E* were made separate from its shaft and keyed on; if the shaft were put in from the front, the bearing *P* would require to be larger than *O* to allow the key to be passed through, and if the friction of the keyed joint was not depended on, a collar or some other fastening would be required to hold the shaft endways. With the arrangement shown, however, each of the shafts is largest in diameter between the two bearings, so that the shoulders thus formed do away with all end movement. Of course, this is an incidental feature of the design, but, nevertheless, it is a useful one.

Keighley, Yorkshire, England. ALBERT CLEGG.

INTERESTING USES OF THE PNEUMATIC RIVETING HAMMER.

The writer had occasion to set a bed-plate on an old concrete foundation and the thought of drilling eight $2\frac{1}{2}$-inch anchor bolt holes about 3 feet deep, by the old-fashioned method of sledge-hammer and stone drill, set his mind to work. The outcome was the making of a stone drill such as shown in the accompanying engraving. The shank *A* was turned to suit a pneumatic riveting hammer, and hardened. Two handles *C* were also provided and bolted under the collar *B*, as shown. It required two men to operate the drill, one to run the hammer while the other turned the drill back and forth about a quarter of a turn. The result was that the holes were drilled in less than three hours, which is only a fraction of the time usually required for the same work by the old method.



Drill used in Conjunction with Pneumatic Hammer for Drilling Anchor Bolt Holes.

Another interesting use of the pneumatic riveting hammer, is to drive out fitted bolts that have become tight by rust or other causes. The instance in this line to which the writer refers was the removal of connecting-rod strap bolts on a small locomotive. These bolts were driven in from the top, and when it was necessary to take them out it was impossible to move them, and as a fair blow could not be given with a sledge, this method was abandoned. A 10-ton hydraulic jack was then tried, and while it would lift one side of the engine, the bolts would not stir. The pneumatic hammer with the ordinary button-set in it was next applied, and the result was that the bolts were removed in less than a minute each.

R. S. F.

IMPROVEMENT IN FEMALE CENTERS FOR FLUTING SMALL TAPS.

The improvement in female centers shown in the accompanying illustration is intended to be used when fluting taps 3/16 inch in diameter or smaller, provided with male centers. In Fig. 1 is shown the ordinary half center, as usually employed, which is expensive to make, and which is not very satisfactory, as it does not hold the tap as securely as a solid center. Besides, these centers wear out quickly, and the cost of maintenance therefore becomes considerable. In Fig. 2 is shown an improvement which possesses several advantages. The centers themselves are located in a circular washer or disk, having a projection on one side, which fits into a recess in a shank, which in turn fits into the tailstock. These round disks are made from tool steel but are not hardened, while the shank is made from machine steel. The object of not hardening the disks is to avoid the risk of breaking the fluting cutter if it should happen to run into the disk when fluting very small taps. The disks are provided with six holes, and as soon as one wears out, the disk is simply turned around to the next hole until all six are worn out. The disks are held to the holder by an ordinary fillister-head screw. In order to bring the hole used as a center in line with the spindle, the bottom hole is provided with a small pin which fits into a corresponding hole in the holder. One of these center disks will last five times as long as the center shown in Fig. 1, and as it costs no more to make, the advantage gained is obvious. CHARLES E. SMART.

Greenfield, Mass.

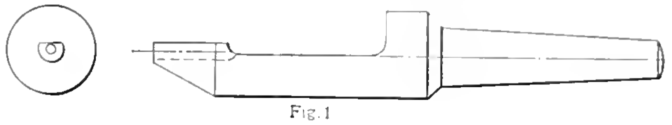


Fig. 1

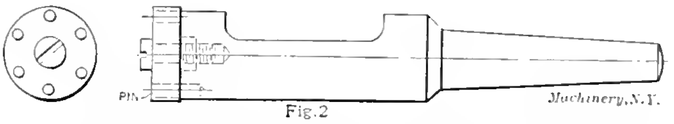


Fig. 2

Figs. 1 and 2. Ordinary and Improved Forms of Centers for Holding Small Taps when fluting them

INDEXING IN DEGREES AND MINUTES.

Here is a kink that may be of interest to some brother tool-makers or machinists. Some time ago I had a job that required to be indexed in degrees and minutes, and this is the way it was done: Taking a B. & S. indexing head, I used the 54-hole division on the plate, which gave me 1 degree every 6 holes, or 10 minutes to one hole. I then made a plate, as shown in the engraving, where *A* is a stud that fits any of the 54 holes and serves as a pivot for the plate. The 9 holes are located so as to divide the space between two holes, of the 54-hole circle, into 10 equal parts, each part being equivalent to 1 minute on the work. With this arrangement, I was able to index any number of minutes.

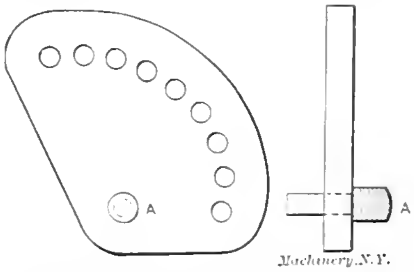


Plate for Dividing the Space between Two Holes on the Index Plate so as to obtain Minute Divisions.

New Britain, Conn. J. MATHIEU.

[An index plate having a 54-hole circle is special on Brown & Sharpe machines, but a regular 27-hole circle could also be

used for indexing 10 minutes. Obviously, the number of holes for indexing one degree would be one-half that of the former case or 3 degrees; therefore it would be necessary to double the number of holes in the dividing plate to obtain one-minute divisions.—EDITOR.]

UNIQUE METHOD OF FINISHING CYLINDERS.

The cylinder and piston shown in Fig. 2 are used on a gas machine for automatic block signals. They are made of bell metal, and the piston was required to so fit the bore of the cylinder that sufficient gas, under 40 pounds pressure, would leak past it to bring the pressure in a receiver of given size, up to 30 pounds, in 10 minutes. This job was a very expensive one, as a variation of a thousandth of an inch one way or the other would mean that the requirements would not be fulfilled. Originally these cylinders were bored and then lapped to size with vaseline and powdered glass. By this method about three out of every ten stood the test. I was given this job to perfect, and as it was the first work that I had done in this particular shop, I felt somewhat uneasy, but went ahead with it nevertheless. Twenty-five cylinders were first bored on the lathe with a boring-bar, to within from five to ten thousandths of an inch of the finish size, which is 2½ inches. The cylinders were then pressed on mandrels and turned on the outside. While doing this I thought of a scheme for finishing the bore which would not only make it possible to do the work quickly and accurately, but which would produce a smooth surface as well. The plan was to enlarge the cylinders to the finish size by forcing hardened tool steel plugs through them, each plug being slightly larger than its predecessor. Four tool steel plungers, 12 inches in length and varying in size from 2.441 to 2.500 inch, were turned, hardened, and ground and the ends rounded to prevent the cylinders from being roughed. A press, as shown in Fig. 1, was then made for forcing the plungers through the cylinders. Its construction is so simple that little explanation is necessary. The cylinder *A* was clamped between two plates *B* having annular recesses into which the cylinder flanges fit. The four steel plungers *C*, beginning with the smallest, were then forced through the cylinder by a 10-ton hydraulic jack. The bores of the cylinders, when finished by this method, were as smooth as a gun barrel and the required size.

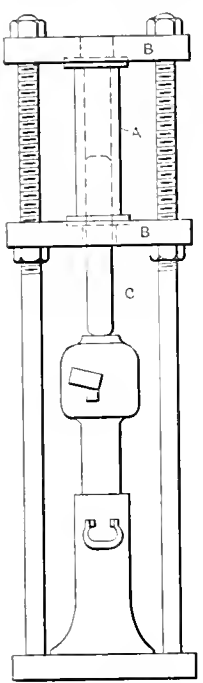


Fig. 1. The Press equipped with a 10-ton Hydraulic Jack.

The next thing was to determine how much to grind the pistons under size to give the amount of leakage required. By experimenting, this was found to be three-fourths of a thousandth. All of the pistons were then ground to the same size by the aid of a micrometer. This method of doing the work was so successful that twenty-four out of twenty-five of the pistons and cylinders stood the test. Before testing, part of the hole through the piston, which was drilled in for the arbor, was plugged with babbitt. The piston was then placed in the cylinder and the ends of the latter tightly closed. The gas, under 40 pounds pressure, was then admitted to one side of the piston and the time noted. If, after a lapse of 10 minutes, the gage connected to the opposite side of the piston by a short length of pipe, indicated 30 pounds, the relative sizes of piston and cylinder were correct.

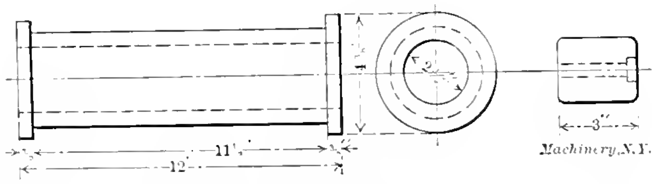


Fig. 2. The Cylinder, the Bore of which was finished by forcing Hardened Steel Plugs through, as illustrated in Fig. 1.

Plainfield, N. J. JOSEPH R. WEANER.

POWER TAPPING.

In ordinary shop practice hand tapping has been most commonly used, but in recent years, with the improved tapping machines, tapping attachments, and collapsible taps, power tapping has in many instances taken the place of the hand tapping method. Of course, in some cases it is impossible to do anything else but tap a hole by hand.

The great disadvantage of tapping by hand is the time consumed. While cutting a thread with a tap is not a difficult job, it requires care in the manipulation. To tap a hole by hand requires two or three taps. The first tap is the taper tap. This starts the thread and care must be taken when starting this tap to keep it parallel with the hole to be tapped. Then the plug tap is used which completes the thread. If the threads go to the very bottom of a "blind" hole, the third tap is used, which is called the bottoming tap.

SPEED OF STANDARD TAPS.

Diameter of Tap.	Cast Iron.	Wrought Iron.	Diameter of Tap.	Cast Iron.	Wrought Iron.
3/16	340	265	1	72	57
1/4	295	230	1⅛	63	50
5/16	240	190	1¼	57	45
3/8	197	152	1⅜	51	41
7/16	170	122	1½	46	38
1/2	145	114	2	34	28
5/8	117	91	2¼	30	26
3/4	96	76	2½	26	23
7/8	84	65	..	..	..

When tapping by power one tap is all that is necessary. The tap is securely held in a chuck which guides it straight. In machine tapping it is found advisable to drive the tap by means of a friction tap holder or some other friction drive. The friction must be adjustable, so that enough tension can be secured to drive the size tap being used. If the tap should strike bottom or a hard spot in the casting it will slip.

To secure good results in machine tapping it is necessary to run the tap at the proper speed. Of course, speed depends a great deal on the metal being tapped and the condition of the tap. Under ordinary conditions, with the tap in good shape, speeds of 15 to 20 feet per minute have been found satisfactory. The following table gives the proper range of speeds for taps most commonly used.

Cincinnati, Ohio. A. C. PLETZ.

CRITICAL SPEED CALCULATION.

If the deflection of a revolving part is due only to the weight, the critical speed is always a function of the square root of the shaft deflection. Below are given formulas for calculating the critical speed for four different cases. In the formulas:

W_1 = weight of wheel in pounds,
W_2 = weight of shaft in pounds,
D = diameter of shaft in inches,
l = one-half the distance between bearings in inches,
$L = 2l$,
N = critical speed in R.P.M.

Case 1.—*Unloaded Shaft.*

$$N = c\frac{D^2}{\sqrt{W_2 l^3}}$$

Kind of Bearings.	Value of *c*.
Two flexible bearings	794,000
Two fixed bearings	1,775,000
One flexible, one fixed bearing	1,285,000

Case 2.—*Single load at center between bearings.*

$$N = c\frac{D^2}{\sqrt{W_1 l^3}}$$

Kind of Bearings.	Value of *c*.
Two flexible bearings	558,000
Two fixed bearings	1,116,000
One flexible, one fixed bearing	837,000

Case 3.—*Single load; load not at center.*

$$N = c\frac{D^2}{\sqrt{KW_1L^3}}$$

in which formula

$$K = \frac{a(L-a)\ (2L-a)\ \sqrt{2La-a^2}}{L^4},$$

if a = distance from load center to center line of farther bearing.

Kind of Bearings.	Value of c
Two flexible bearings	900,000
Two fixed bearings	1,800,000
One flexible, one fixed bearing..........	1,350,000

Case 4.—*Multiple Loaded Shaft.*

$$N = \frac{N_1\ N_2\ N_3}{\sqrt{N_2^2\ N_3^2 + N_3^2\ N_1^2 + N_1^2\ N_2^2}}$$

In which formula

N = critical speed of system,

N_1 = critical speed of unloaded shaft,

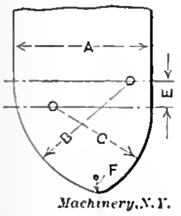
N_2, N_3 = critical speed of each load separate.

These formulas apply to steel shafts having a modulus of elasticity $E = 30{,}000{,}000$. E. A. LÖF.

Chicago, Ill.

STANDARD DRILL AND REAMER TABLES.

The accompanying tables give all the necessary data for laying out correct drill and reamer fluting cutters. The drill table stops at the 1¼-inch size. Larger drill cutters are laid out in the same ratio, approximately; *E* loses about 0.04 inch for every half inch in diameter that the drill increases until the dimension disappears; *C* also decreases as shown until it equals one-half of *B*. In making the formed tool, the outline of the cutter is laid out on zinc and a fly tool made, after which the formed tool is planed and finished.



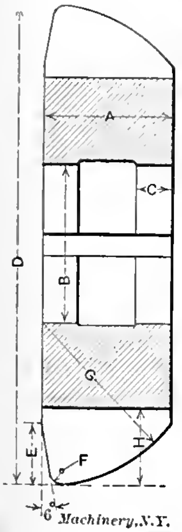
DIMENSIONS OF DRILL FLUTING CUTTERS.

Diameter of drill = D.

Size of Drills, D	A	B	C	E	F
up to 23/64	0.75*D*	0.700*D*	0.540*D*	0.18*D*	0.07*D*
3/8 - 7/8	0.75*D*	0.630*D*	0.540*D*	0.14*D*	0.07*D*
57/64-1 1/4	0.75*D*	0.625*D*	0.312*D*	0.10*D*	0.07*D*

DIMENSIONS OF REAMER FLUTING CUTTERS.

(Brown & Sharpe Standard.)



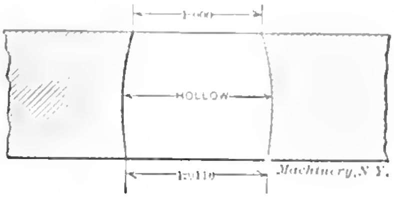
Number of Cutter.	D	A	B	C	E	F	G	H	Number of Teeth in Cutter.	Diameter of Reamer.	Number of Teeth in Reamer.
1	1 3/4	3/16	7/8	..	0.125	0.016	7/32	0.21	14	1/8 - 3/16	6
2	1 3/4	1/4	7/8	..	0.152	0.022	9/32	0.25	13	1/4 - 5/16	6
3	1 7/8	3/8	7/8	1/8	0.178	0.029	1/2	0.28	12	3/8 - 7/16	6
4	2	7/16	7/8	1/8	0.205	0.036	9/16	0.30	12	1/2 - 11/16	6–8
5	2 1/8	1/2	7/8	5/32	0.232	0.042	11/16	0.32	12	3/4 -1	8
6	2 1/4	9/16	7/8	5/32	0.258	0.049	3/4	0.38	11	1 1/16-1 1/2	10
7	2 3/8	5/8	7/8	3/16	0.285	0.056	27/32	0.40	11	1 9/16-2 1/8	12
8	2 5/8	11/16	7/8	3/16	0.312	0.062	7/8	0.44	10	2 1/4 -3	14

NOSMOT.

ECONOMICAL METHOD OF MAKING BLANKING DIES.

Die-makers are familiar with the fact that dies when hardened will swell in such a manner that the central portion of the metal in a hole will bulge out towards the center. In order to give sufficient clearance to a die in spite of this tendency, it is necessary to provide for a rather large clearance angle. This being done, it is evident that when the die has been ground down to a certain depth, the hole is very much larger than it was originally, and for many purposes the die must be discarded before it has been used up. The following method of making dies permits them to be ground down until but a small thickness of the steel is left, and as the writer has used the method successfully for the past four years, it may be of interest to others.

Take a die blank one inch thick and lay out the correct form on the blank, drill to the scribed lines, remove the core, and then finish the die with a clearance of about one third of one degree, or twenty minutes, which will give a clearance of about 0.0058 inch on each side at the bottom of the die. Now, scrape or file the center of the die hollow, as shown in the illustration. The amount removed at the center should be about 0.003 inch. Then harden as follows: Place a piece of cast iron or machine steel larger than the surface of the die on the top of a coke fire, and heat it to a cherry red. Then place the die with the face down on this cast iron or machine steel piece and heat until it is cherry red; then plunge the die in slightly warmed clear water, and keep it in the water until it becomes of the same temperature. Then remove it from the water and quickly place it on the fire again, and heat it until it is warm enough to melt soft string solder. Then dip it again, thereby finishing the hardening and tempering process. When the die is so hardened it will swell about 0.003 or 0.004 inch in the center so that the opening will not be any larger in the center than it is at the bottom, and the die may be ground and sharpened all the way down and used until too thin for service. Dies made in this manner will give better satisfaction and perform about three times as much work, or, in other words, last three times as long, as dies made with the ordinary 1 or 1½ degree clearance. The same hardening process should be followed in hardening punches.

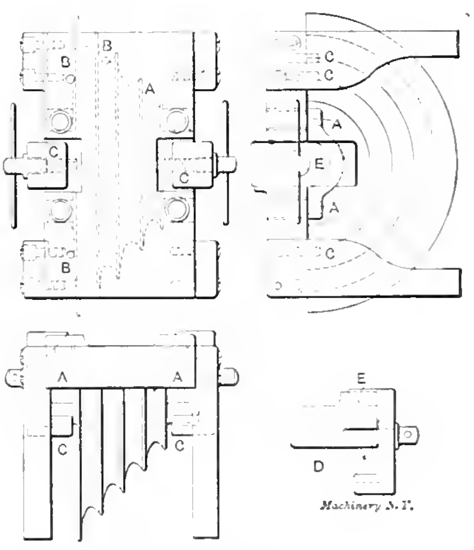


Method of making Blanking Dies which permits them to be ground off on the Face, thus insuring Long Life.

St. Louis, Mo. JAMES S. GLEW.

JIG CLAMPING DEVICE.

We had a number of cast-iron pulleys that were to be used in connection with special lacing machines, and these were cast in halves to make it convenient to fasten them on shafts that were located beneath the benches, in the factories where the machines were to be used.



Plan and Elevations of Jig with Work in Place.

A jig was made for drilling the four holes *A*. There is nothing remarkable about its general design, yet it possesses a neat clamping feature which is so superior to the usual method employed, that I considered it worthy of note. To set the casting preparatory to drilling it is placed against

the [illegible] pins *B*, one of them engaging a groove in the casting, which sets it in the proper relation with the holes in the jig. The clamps *C* are then tightened, the right side of the casting being clamped first to prevent it from shifting.

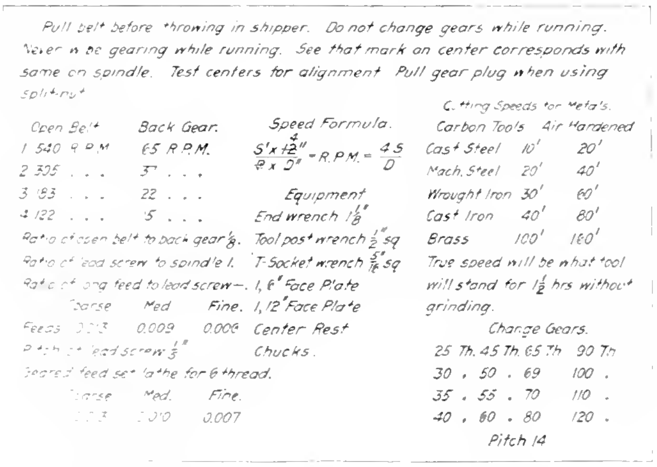
The working principle of the clamp is clearly shown in the detail *D*. As the clamp is drawn in it ascends the incline *E*, thus moving in the direction of the arrow and tightening against the hub of the casting. The clamps are made with a V which insures a firm hold. PEDRO.

HOLDER FOR DRAWINGS IN MACHINE SHOP INSTRUCTION.

The accompanying half-tone, Fig. 1, and the reproduction of an instruction sheet, Fig. 2, show a method which has proved successful in the instruction in machine tool work at the Saginaw High-school, Saginaw, Michigan. The instruction sheet in Fig. 2 gives all the most needed information regarding the machine on which the pupil is put at work, and is mounted directly on the end of the lathe bed, as shown in the half-tone. This arrangement has proved a [illegible] convenience, and a most effective means of keeping the needed information constantly before the student. Of course, the cutting speeds are only approximate, and are solely given as a basis of calculation. They are given in such a series as can be most easily remembered by the student. The drawing from which the student is to work is also mounted in the same way, above the instruction sheet, as indicated. The lower part of the board may be used as a desk where the student can carry out simple figuring relating to his work, and make notes and sketches if necessary. It might be added that this idea may be suggestive even for the ordinary machine shops. L. N. BRYANT.

Saginaw, Mich.

Fig. 1. Holder for Drawings and Instruction Sheets Mounted on End of Lathe Bed.



Pull belt before throwing in shipper. Do not change gears while running. Never [illegible] gearing while running. See that mark on center corresponds with same on spindle. Test centers for alignment. Pull gear plug when using split-nut.

	Open Belt	Back Gear.
1	540 R.P.M.	65 R.P.M.
2	305 . . .	37 . . .
3	183 . . .	22 . . .
4	122 . . .	15 . . .

Ratio of open belt to back gear $\frac{1}{8}$.

Ratio of lead screw to spindle 1.

Ratio of long feed to lead screw—.

	Coarse	Med.	Fine.
Feeds	0.013	0.009	0.006

Pitch of lead screw $\frac{1}{3}''$

Geared feed set lathe for 6 thread.

Coarse	Med.	Fine.
0.013	0.010	0.007

Speed Formula.

$$\frac{S'\times\overset{4}{\cancel{12}}''}{\pi\times D''}=R.P.M.=\frac{4\,S}{D}$$

Equipment

End wrench $1\frac{1}{8}''$

Tool post wrench $\frac{1}{2}''$ sq

T-Socket wrench $\frac{5}{16}''$ sq

1, 6" Face Plate

1, 12" Face Plate

Center Rest

Chucks.

Cutting Speeds for Metals.

	Carbon Tools	Air Hardened
Cast Steel	10'	20'
Mach. Steel	20'	40'
Wrought Iron	30'	60'
Cast Iron	40'	80'
Brass	100'	180'

True speed will be what tool will stand for $1\frac{1}{2}$ hrs without grinding.

Change Gears.

25 Th.	45 Th.	65 Th.	90 Th.
30 .	50 .	69	100 .
35 .	55 .	70	110 .
40 .	60 .	80	120 .

Pitch 14

Fig. 2. Sample Instruction Sheet for Machine Shop Classes.

ADJUSTABLE EXTENSION TOOL-HOLDER FOR PLANER AND SHAPER.

The accompanying line engraving, Fig. 1, and half-tone, Fig. 2, show the construction and use of an adjustable extension tool-holder which was made to meet the requirements of the operation shown in the half-tone; that is, the cutting of a ⅝-inch rack seat in the sliding head of a sensitive drill press. The construction of the tool is clearly indicated in Fig. 1, and the adaptability of this simple holder is easily seen, the machinist no doubt finding ample opportunity for using this tool for many purposes on planer and shaper work. The steel used for the tool itself is Novo high-speed steel. It will be noted that the clearance angle at the bottom of the tool is obtained by the angle at which the tool slot is cut in the holder. The tool-holder shown has given excellent results for heavy work, is exceptionally rigid, and, being provided with facilities for the adjustment of the tool, avoids unnecessary over-reaching. Tools of different widths and thicknesses may be applied to it. DIETZ.

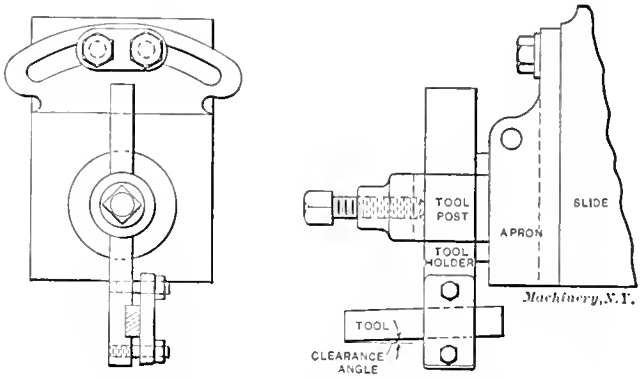


Fig. 1. Adjustable Extension Tool-holder with Tool.

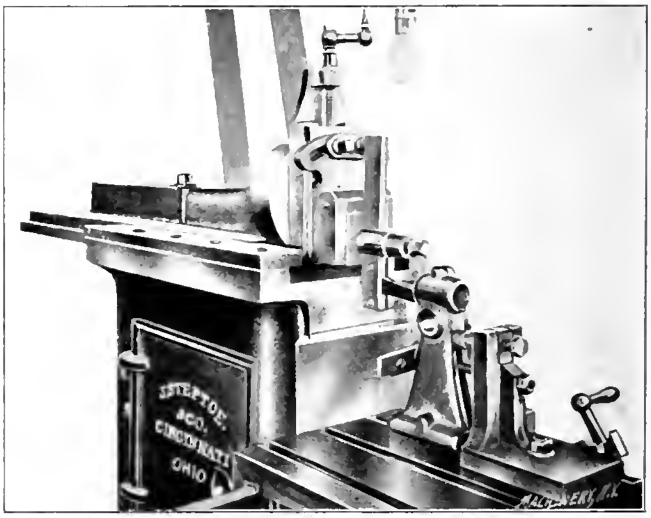


Fig 2. Class of Work to which the Holder is adapted.

TURNING SOFT RUBBER.

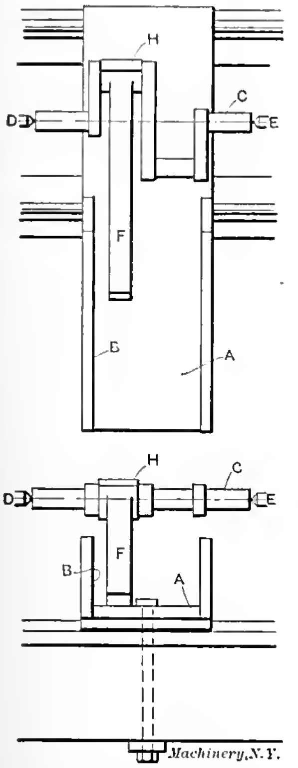
Replying to the question of "L. M." in the December issue of MACHINERY, relating to turning soft rubber, I would say that whenever the shape will permit, soft rubber can best be turned upon a wooden arbor, there being a tendency towards slipping when an ordinary steel arbor is used. A simple though excellent method of getting the hole for the arbor or of putting

holes in soft rubber for any purpose, is to notch the end of a piece of brass tubing whose outside diameter is the size of the hole desired. This piece of tubing is then used as a drill, and it will cut a clean hole slightly under the size of the tubing. When notched right, the end of the tubing should appear like the edge of a saw, although no clearance or setting is necessary. For a cutting tool, use an ordinary side tool ground with lots of clearance and to a *knife edge*, and this should be set the same as any side tool, but fed like a diamond point tool on a straight cut. After turning, the rubber may be smoothed by the use of sand paper or emery cloth. As regards lubrication, water may be used to good advantage, but the rubber should cut very good without any lubricant.

Lynn, Mass. Chester L. Lucas.

FIXTURE FOR TESTING PARALLELISM OF CRANK-PINS.

The accompanying sketch represents a fixture for testing the parallelism of crank-pins on the crank-shafts of air drills and small, high-speed gasoline engines. It consists of an angle-plate *A* that has grooves that match the ways of a lathe. This angle-plate is clamped to the bed of the lathe, and, by means of the lathe bed, the plane of face *B* of the angle-plate is held at right angles to the axis of the lathe. The crank *C* whose crank-pins are to be tested is placed between the lathe centers *D* and *E*, as shown, and the arm *F* is fastened to one of the pins. The opposite sides of *F* are parallel and perpendicular to the adjacent sides, and the end *H* is similar to the end of a connecting-rod. To test a crank-pin for parallelism, the crank-shaft is moved through different angles, and if the pin is parallel with the crank-shaft axis, arm *F* will be parallel with the face *B* of the angle-plate. If the pin is not parallel, the amount it is out can be detected with a pair of inside calipers.



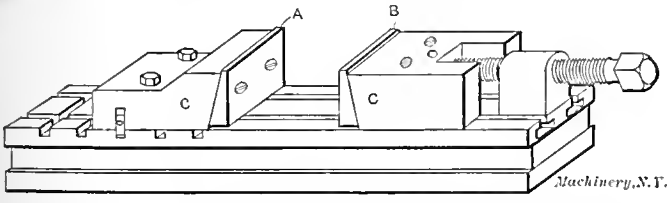
Plan and Elevation of the Fixture for Testing Crank-pins.

John B. Sperry.

Aurora, Ill.

A DRILL PRESS VISE.

The drill press vise shown in the illustration is "homemade," and one that I used for a number of years. The construction of the vise is simple, and it is almost indispensable for holding small work in the drill press. By referring to the illustration it will be seen that the jaws *A* and *B* are tapering on the back, and also that there is a slight space between them and the vise bed. The jaws are held up by springs, located within the blocks *C*, which bear against nuts attached to the jaws. These nuts fit into T-slots in the blocks *C* and keep the jaws in place. When a piece of work to be drilled is placed in the vise and the jaws are brought to bear on it, the pressure causes them to move downward, thus bringing the work down solid on the parallels with a positive downward pressure, whereas the ordinary vise jaws tend to spring or draw the work away from the parallels, even when it is rapped with the hammer. The jaws and their holders are square with the bed of the vise, and, as the vise is finished square all over, it can be used on the edge, end, or in the usual position.



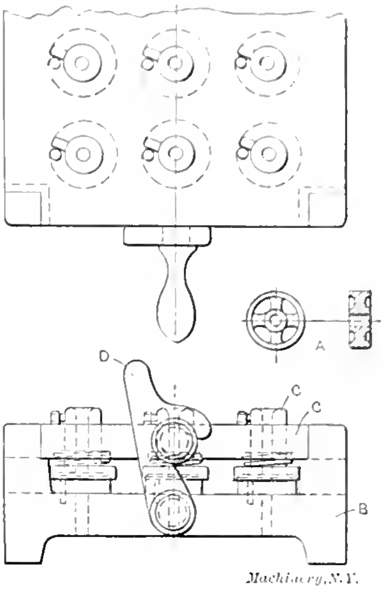
A Drill Press Vise with Jaws that move Downward when Work is clamped between them.

A. J. Delille.

Elgin, Ill.

MULTIPLE JIG FOR SMALL PULLEYS.

We have large quantities of the rough gray iron pulleys, shown at *A* in the engraving, to drill, and so made the jig, a half plan and end elevation of which is shown. This jig is used on a twelve-spindle multiple drill, and in the end view the work can be seen in position. The jig consists of the gray iron base *B* into which is fitted the gray iron cover *C*. The cover *C* holds twelve steel bushings with their ends cupped to center the work. A coiled spring is placed between the cover and bushing to take up any variation in the work. The cover is not hinged to the base as is common with jigs of this style, but is held by latches *D*. By swinging the latches off the handles of *C*, the cover may lifted off out of the way and the base emptied of the chips and work at one time. We found this jig very handy and accurate.

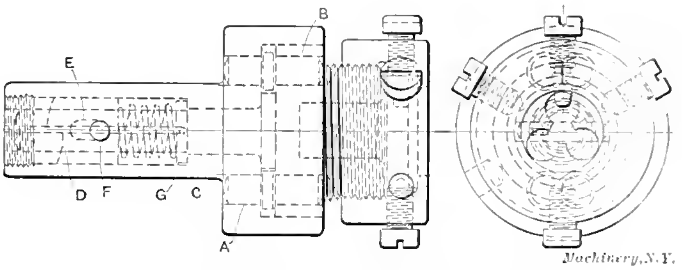


Jig for Drilling Small Pulleys in a Multiple Drill.

P. F. Setag.

RELEASING BUTTON-DIE HOLDER.

The accompanying illustration shows a button-die holder of the releasing kind designed to work on the Brown & Sharpe automatic screw machines. It gives especially good results where the spindle cannot be made to reverse accurately, or where the die is working up to a shoulder.



Improved Design of Releasing Die-holder.

At *A* and *B* are shown the releasing pins which hold the die rigid while the work is being threaded. The spindle reverses when the die is at a certain fixed distance from the shoulder, but before the spindle can complete its reversal, the holder threads right up to the shoulder. The pins *A* and *B* are then disconnected, allowing the spindle *C* to rotate freely.

The spindle is now rotating in the reverse direction when after one-half revolution of die holder the clutch teeth at *D* engage and allow the die to be drawn off the work. The slot shown at *E* is cut in one of the engaging clutches, and the pin *F* is a drive fit in spindle *C*. The diameter of the wire in spring *G* should be from 0.023 inch to 0.032 inch, depending on the pitch of the die used; a die with a fine pitch would not work well with a stiff spring. By the insertion of the washer *G* it will be noted that the spring rotates freely with the spindle and is not subjected to any twisting moment, as it would be if it were in contact with the shoulder in the stationary part of the tool.

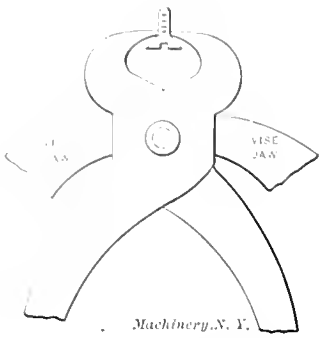
Thomas J. Norton.
Montreal, Canada. Douglas F. Hamilton.

SHOP KINKS.

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

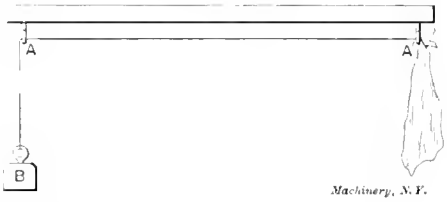
HOLDING SMALL SCREWS WHILE FILING OFF THE POINT.



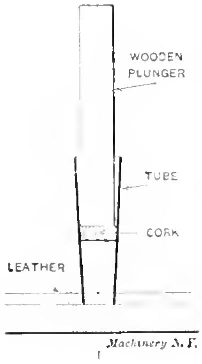
The kink indicated by the accompanying line engraving may be of interest and service to some of the readers of MACHINERY. Some short screws, with bevel heads, were a trifle too long, and were to be shortened by filing off the point. The engraving shows plainly the method of holding the screws while filing. Holding them in this way neither injured the heads of the screws nor the thread. C. F. EMERSON.

ATTACHING INK RAG TO DRAWING BOARD.

Although the ink rag may be one of the minor details in a drawing room, it is nevertheless universally used. The method of fastening it to the drawing board as shown in the engraving, is much better than the usual permanent fastening. A string passes through two screw-eyes *A*, one at the front, the other at the back of the drawing board. The ink rag is tied at the front end of this string, while at the other end is a small weight *B* which returns the rag, after being used, to its proper place at the left of the board. If the draftsman is at the right end of the board, he needs but to reach for the rag, use it and let go, which is ofttimes very convenient. WINAMAC.



METHOD OF INSERTING CORKS IN FRICTIONS.



The accompanying engraving illustrates a method of inserting corks in frictions. The friction in question was lined with leather, ⅜ inch thick, and corks ⅞ inch in diameter were pressed into holes ⅝ inch in diameter. The taper tube shown was four inches long, about one inch in diameter at the large end, and the small end just small enough to fit in the hole punched in the leather. The corks were first soaked in some fairly warm water, after which they were pressed into place with the wooden plunger indicated.

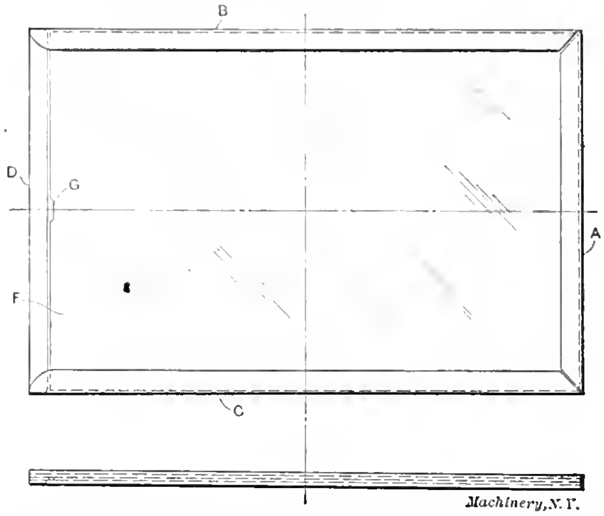
Aurora, Ill. JOHN B. SPERRY.

BLUE-PRINT PROTECTOR

A simple way of protecting blue-prints from being destroyed when sent out in the shop, or when otherwise handled to a great extent, is shown in the accompanying illustration. The protector consists of a sheet iron frame with the edges *A*, *B*, and *C* bent over as shown. The side *D* is left open for the insertion of the print. This side, however, is turned over and hammered down, forming a stop or holder for the print, preventing it from slipping out. On top of the print is placed a sheet of transparent celluloid *F*. A little notch is made in the celluloid at *G*, permitting of getting hold of the blue-print under the sheet for pulling it out. By using this protector many blue-prints will be saved from premature destruction. L. H. GEORGER.

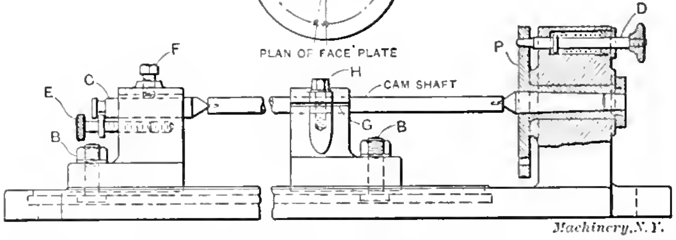
Buffalo, N. Y.

[The method proposed by our correspondent for protecting blue-prints may undoubtedly be of value in some cases, but for ordinary shop use it would be rather expensive, because large celluloid sheets are rather high priced. The cheapest and simplest way of protecting blue-prints is to mount them on bristol board, and varnish them with some kind of high grade varnish. There is one objection to this manner of protecting the prints and that is that if the varnish becomes scratched, it is then sometimes difficult to discern the figures and lines under the scratched portion. The same, however, holds true of celluloid covering as well. This covering will easily become scratched in the shop, and when celluloid is badly scratched it is equally difficult to see the object under it plainly, and at the same time it is impossible to restore it to its original condition.—EDITOR.]



GAS-ENGINE CAM-SHAFT KEY-SEATING FIXTURE.

This fixture is used for milling key-seats in the cam-shaft of a four-cycle, four-cylinder gas engine, with both exhaust and inlet valves on the same side, and actuated from one cam-shaft. The fixture consists of a cast iron base and head-stock, a movable tail-stock, and a steady-rest, which clamps the cam-shaft and holds it firmly in position while the cutter is milling the key-seat. A plan of the face-plate *P* is shown in the illustration. The slot *S* receives the tail of a dog, which is fixed to the cam-shaft. The indexing holes are laid out the required number of degrees apart, depending upon the angle of action of the cams. The angle a should be one-half the angle of action of the exhaust cam, plus one-half the angle of action of the inlet cam, plus one degree. This allows two degrees travel of the crank-shaft from the time the exhaust closes until the inlet opens. The face-plate is locked in position by the spring-plunger *D*, the end of which fits into tapered holes to insure a perfect fit. The center *C*, in the tail-stock, is operated by the screw *E*, and is flatted on top for the set-screw *F* which locks it. Both the tail-stock and steady-rest are held in place by the bolts *B* and *B*, which slide through the T-slot in the base. The bearing in the steady-rest, that the cam-shaft slides through, is slotted at *G*, thus allowing the bolt *H* to clamp the shaft. An ear is cast on each end of the base, and is slotted to receive the holding-down bolts; two are sufficient as the cut is light. W. A. SAWYER.



NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

IMPROVEMENTS IN THE NO. 2½ BATH UNIVERSAL GRINDING MACHINE.

A Bath universal grinding machine of an older type was described in the March, 1905, issue of MACHINERY. The improved design which we herewith illustrate has the same general construction. The table is mounted on a bed which is adjustable to any required angle about a bearing on the top of the base; the wheel spindle is mounted in a head vertically adjustable on a column at the back of the machine; the spindle is driven by a counter-shaft idler which adapts itself to the change in the position of the spindle pulley due to the vertical adjustment; and a very complete set of attachments is provided adapting the tool to grinding of any kind, from the sharpening of the cutters, reamers, etc., to cylindrical grinding, both external and internal, and surface grinding. The most noticeable improvements are the provision of improved automatic feeding apparatus for cylindrical and surface grinding, the new design of the wheel spindle-head, and the provision of the new attachments for doing certain classes of work more conveniently and expeditiously.

Fig. 1 shows the machine as a whole, its general arrangement being as just described. Fig. 2 shows the apron which is provided with two separate power cross-feeds, in addition to the original automatic reversing longitudinal feed. One of these cross-feeds, acting on the ratchet dial on the left, gives minute movements, and is used for cylindrical grinding; it is provided with an automatic stop for sizing the work. This dial is geared with the cross-feed screw to give the required sensitiveness of movement. The link motion operating the double ratchet and pawl movement on the cross-feed screw at the right, gives the coarser feed required for surface grinding. This feed operates at each end of the traverse, is reversible and may be effected at one or both ends of the stroke as required. The cylindrical cross-feed may be made as fine as 0.0002 inch per stroke, while that of surface grinding from 1/64 to 3/32 for each stroke of the table. The reversing mechanism is positive so that work may be ground close to a shoulder. The table slide is controlled by a single lever which reverses the feed in either direction, and starts or stops the traverse movement. By turning the handle at any point of the movement, the table will be stopped at the end of the stroke. The cylindrical grinding feed acts at each end of the table stroke, and the power for operating it is taken from the mechanism that reverses the table slide, through the compression swivel plunger shown below the large knurled knob in the center of Fig. 2.

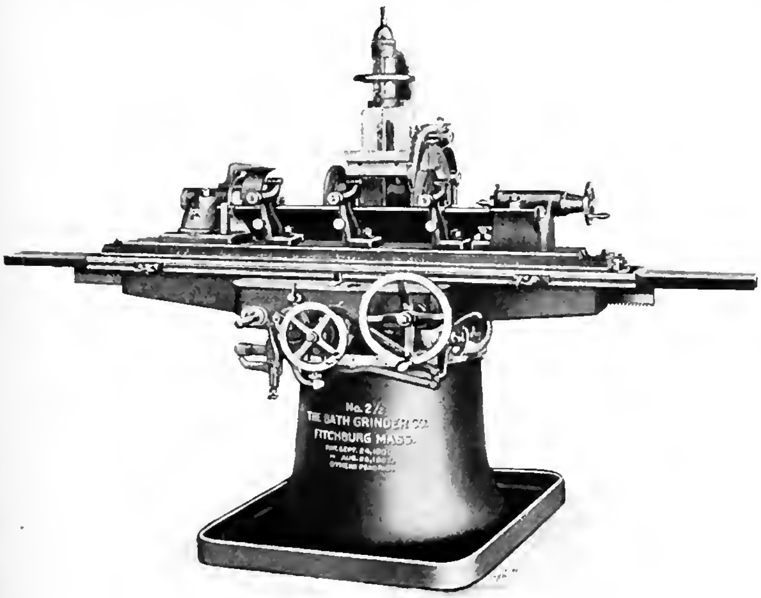


Fig. 1. The Improved No. 2 1-2 Bath Universal Grinder.

Fig. 4 shows the improved spindle-head, rigged up with the various attachments furnished for it. At *A* is seen the plain head. The finished bright surface at the end of the spindle bearing is for convenience in using a square or bevel protractor in setting work or attachments on the machine. Clearances in cutter and reamer grinding, and the setting of the wheel with relation to the work, are measured by the combined elevating screw and sliding graduated rod, together with the revolving dial on top of the machine. These give the micrometer readings. At *B* an extension arbor support for the wheel is shown attached to the head. This is used in surface grinding, sharpening form-cutters, finishing snap gages, and on similar work where a large overhanging of the wheel is desirable. At *D* is shown the method employed for clamping the various forms of tooth rests to the spindle head. The same screws are used as in clamping the overhanging arm in *B*. It should be noticed that the rests can be brought to the cup or disk wheel either from above or from below. At *E* is shown the head as arranged for plain cylindrical grinding, with a wheel hood and the makers' "Wizard" water spout. This water spout is of a peculiar design, which will furnish water a drop at a time or in full stream, without any spattering caused by the air blast from the wheel.

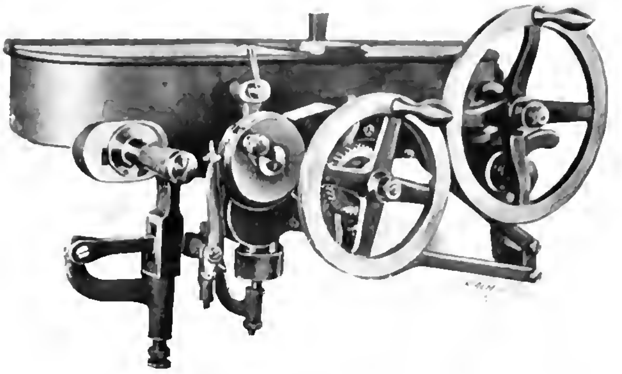


Fig. 2. Apron of the Grinder Provided with Two Cross Feeds, One for Cylindrical and the Other for Surface Grinding.

At *C* is shown a head as arranged for internal grinding. The arm which supports the internal spindle is mounted in a suitable seat at the base of the spindle column. The belt may be tightened while the machine is in motion by a vertical adjustment of the regular spindle head. In Fig. 3 are shown various internal grinding spindles, made with detachable flanged bearings. These spindles are made in different lengths and diameters to suit the character of the work being ground. That at the left is used for internal grinding of the heaviest character.

In Fig. 5 is seen another of the new attachments. This is a universal holder mounted in the tail-stock. It is shown grinding the side teeth of a side milling cutter, using an 8-inch cup wheel. The hinged plunger tooth rest should be noticed. In changing the angle, the cutter and tooth rest are adjusted at the same time, both being mounted on the same support. In sharpening this cutter, the tooth is reciprocated by the handle shown, it being un-

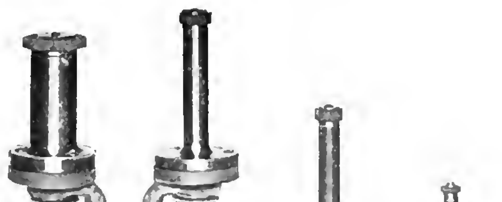


Fig. 3. Type of Internal Grinding Spindles used, carried in Detachable Flanged Bearings.

necessary to operate the table. In Fig. 6 is shown the same attachment engaged in grinding a large gear cutter. The machine is rigged for supplying water to the wheel during this operation. The use of the "Wizard" nozzle makes unnecessary the provision of water shields to keep the machine dry. The same tooth rest is being used as before. The other attachments for this machine, such as the universal holder, horizontal vise, flanged plate, etc., are the same as described in the article previously referred to.

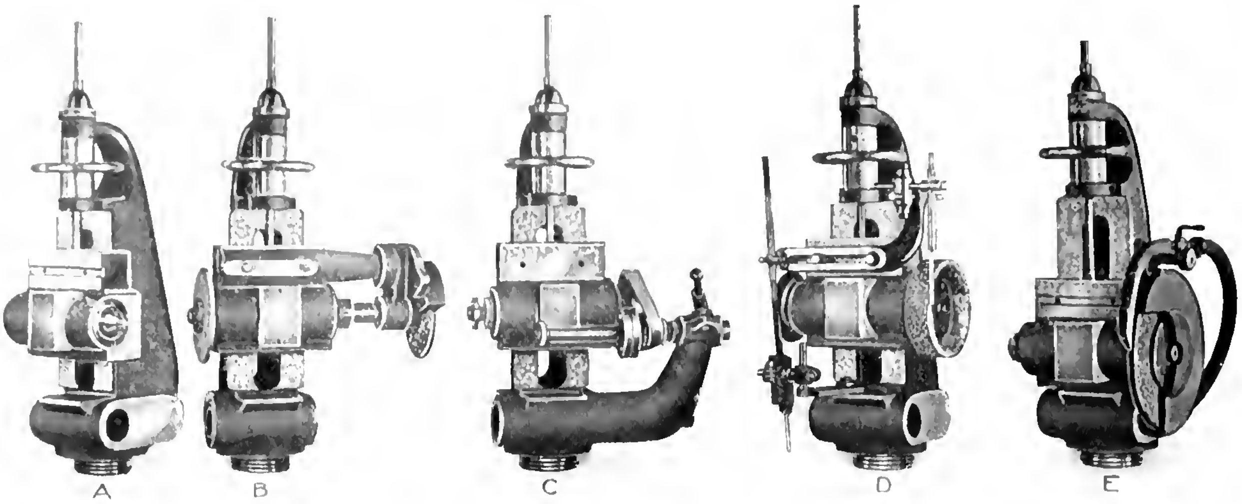


Fig. 4. Spindle Head of the Bath Grinder, Rigged for Various Operations, such as Cylindrical, Internal, Surface and Cutter Grinding, etc.

For external and internal cylindrical grinding, the machine is provided with a suitable head-stock and tail-stock, and with water guards, so as to make it an efficient tool for this work, free from the makeshift attachments often found on a universal tool-room machine. The head-stock swivel is graduated, and the swivel bearing is dust-proof. A dowel pin is provided for setting the swivel adjustment in a central position. The clamp nut and the swivel binding nut are both in the center of the head-stock and are independent of each other. The dead center pulley revolves on a conical bearing at the end of the quill, and is held in place by a detachable flange. The quill is so constructed that it can be used for either revolving or dead center grinding. The foot-stock has a spring center. It carries on the front end a flat projection for clamping a diamond holder for truing a wheel, or for clamping tooth rest stands for cutter grinding. Spring rests are used for absorbing vibration and supporting the work in shaft grinding. The supporting pressure on the shaft is relieved when the required diameter is attained. A hand tension screw is also furnished which keeps the supports up beneath the work and assures a rigid bearing. Suitable water shields for wet grinding are provided.

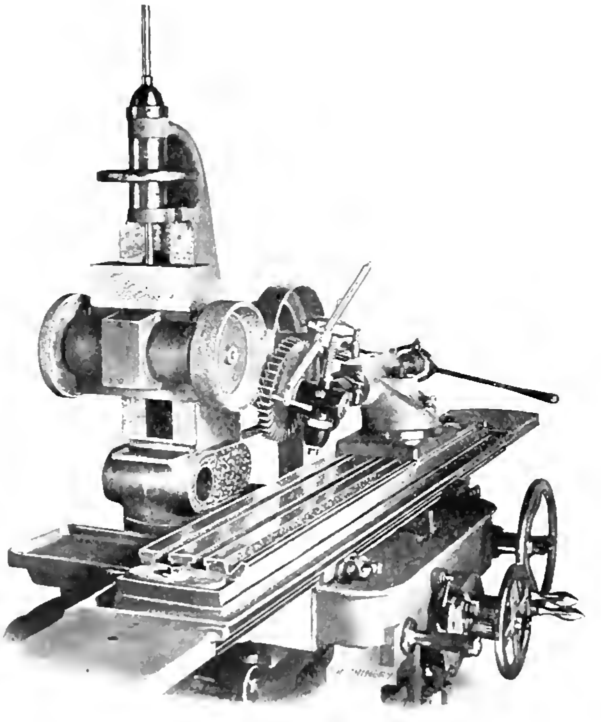


Fig. 5. Grinding Side Teeth of a Milling Cutter with a Universal Holder Mounted in the Tail-stock.

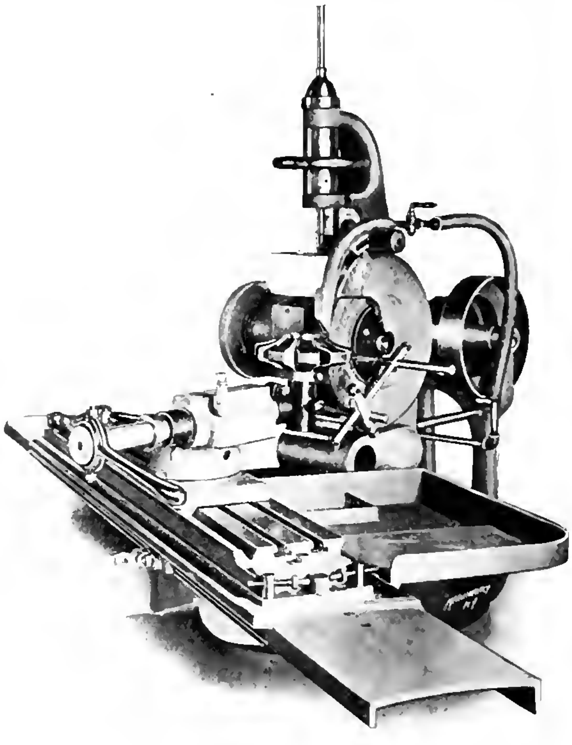


Fig. 6. Universal Holder Engaged in Grinding a Large Gear Cutter.

This grinder can be furnished by its maker, the Bath Grinder Co., Fitchburg, Mass., in any one of a number of styles for different classes of work, depending on the equipment sent with it. For instance, it may be furnished for plain, surface, internal, disk, and cutter grinding of all descriptions, or for any combination of these various purposes.

OESTERLEIN NO. 3 UNIVERSAL AND TOOL GRINDER.

This machine, like previous machines built by the same maker (the Oesterlein Mch. Co., 2850 Spring Grove Ave., Cincinnati, Ohio), is similar in its structural design to the column type of milling machine—that is to say, the work table is fed longitudinally on a saddle, which in turn has a cross adjustment on a knee; this knee is vertically adjustable on ways on the face of the column. This new design, however, bears little resemblance to its predecessors. While intended for the regular work of the cutter and reamer grinder, it is arranged as well to do cylindrical and surface grinding in a rapid and satisfactory manner, being provided with a full equipment of automatic feeds, work revolving connections, water guards, etc. The principal improvements so far as structural features are concerned relate principally to the provisions for wet grinding,

the elaborate safe-guarding of the sliding surfaces from emery dust, and the general strength and rigidity of the whole machine.

The spindle head is mounted on the top of the column, and may be swiveled in position about a vertical axis. This swiveling adjustment is read from graduations. This head is provided with a self-contained splasher and drip trough, as best seen in Fig. 1, which catches water thrown from the revolving work and leads it back into the channels provided for returning it to the reservoir. The spindle is driven by a two-step pulley, giving two speeds for the wheel.

The table bears on the saddle or cross slide for its entire length. The upper member of the table can be swiveled to any angle throughout the full circle, and clamped in any position when so swiveled. For grinding comparatively small tapers, a scale is provided reading in inches per foot. Fine adjustments for such tapers are obtained by a worm meshing with worm-wheel teeth cut in the right hand end of the table in Fig. 1. The slide has V and flat bearings on the saddle, and the saddle has similar bearings on the knee, thus insuring accurate alignment at all times, preserving the longitudinal and cross movement exactly at right angles to each other. The table comes down over its bearing on the saddle on all sides, thus protecting these parts. The bearing of the saddle on the knee is protected, as shown in the front view, by a guard which is supported in the rear, and passing entirely through an opening provided for it in the saddle, covering the ways under all conditions.

The head-stock is provided with swiveling adjustments to any angle in the vertical or horizontal plane. The tail-stock has a spring center, and is actuated by a lever when placing or releasing the work. The vise furnished for surface grinding may be mounted on the head-stock angle support, in which case it can be set to any angle in two planes. This vise may be used for holding round work, as a V-block is provided for its lower jaw. The upper jaw swivels to accomodate any taper; the vise has a back-stop as well, making it convenient for holding straight and taper shank mills for grinding, when they cannot be conveniently held on centers or in collets. The tooth rest provided is universal, and has a micrometer adjusting nut for accurate setting in any position. Back rest and splash guards are provided for cylindrical grinding. One of the latter is shown in place in Fig. 2.

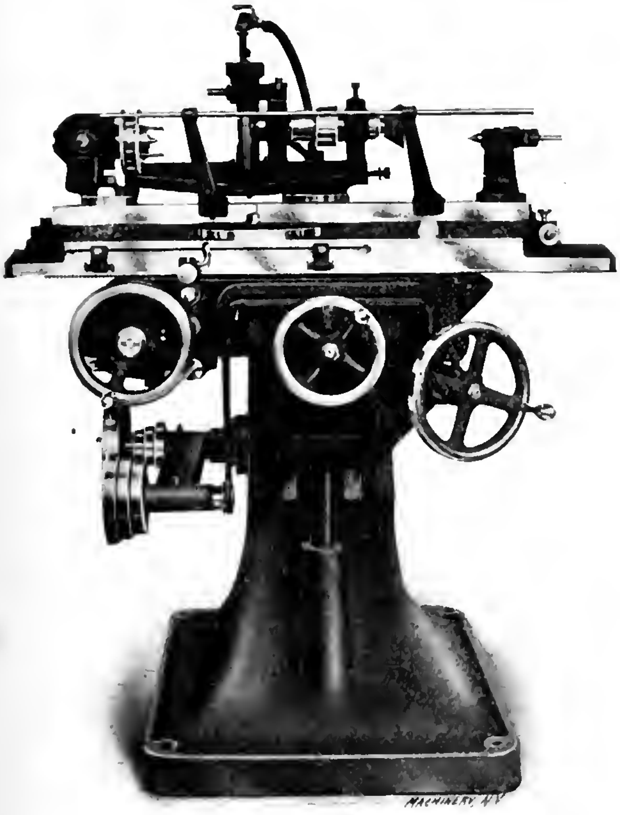


Fig. 1. Front View of the Oesterlein Universal Grinding Machine, showing Protection of Sliding Bearings from Emery Dust.

Besides main counter-shaft for driving the spindle, pump, and feed, there is a supplementary drum counter-shaft for revolving the work in cylindrical grinding. But one belt shifter is needed, as provision is made for starting and stopping the drum counter-shaft by tightening or loosening the belt which connects it with the main counter-shaft. This movement, as may be seen in Fig. 3, is effected by mounting the hangers on pivots and swiveling them by the worm shown, connected to a rod extending downward within reach of the operator. The loose pulley used on the main counter-shaft is shown in Fig. 4. It has a cored chamber, which, when filled with wicking, will retain sufficient oil for a long run. Mounting the pulley on a bushing protects the shaft from cutting or wearing.

Fig. 2. Side View of Oesterlein Grinder showing Provision for Wet Grinding.

The equipment of this machine includes a 4-inch chuck, a vise, head-and tail-stocks, tooth rest, centering gage, extension spindle, raising blocks, internal grinding attachment, seven steel bushed emery wheels of various shapes, the necessary wrenches, the main and drum counter-shafts, a set of dogs in a tray, and a steady rest. The automatic table feed is 16 inches in length, the transverse movement is 8 inches, and the vertical adjustment is 7½ inches. The swing between centers is 9 inches. When raising blocks are used, this is increased to 12 inches. The 6 rates of table feed provided range from eight to fifty revolutions per inch. The net weight of the complete machine is 1,400 pounds.

NEWTON DUPLEX FACE MILLING MACHINE.

A duplex milling machine designed for heavy face milling, or rotary planing of parallel perpendicular surfaces, is shown herewith. This machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. It is noticeable for its rugged design, and the very convenient arrangement of operating the handles and other controlling devices.

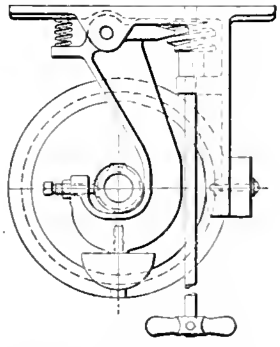


Fig. 3 Belt-tightening Hanger for Drum Counter-shaft, which avoids the use of a Belt Shifter.

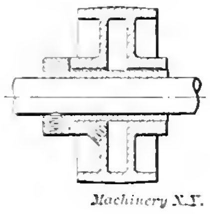
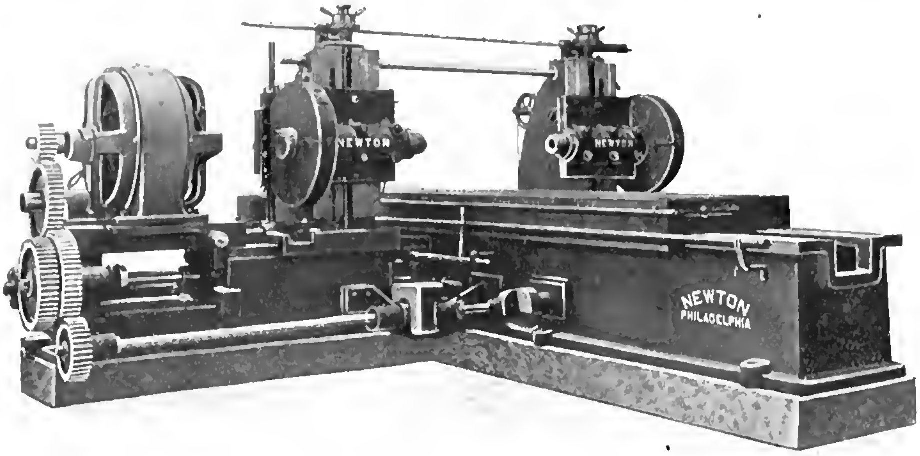


Fig. 4. Loose Pulley used on Main Countershaft; the Core is filled with Wicking.

The machine consists essentially of a long bed on which slides the work table, and is provided with two wings on which columns

are adjustably mounted, carrying vertical, adjustable spindle heads. These spindle heads may be adjusted either separately or together, the latter provision being useful if the machine is to be used for slab milling.

A 35 H. P. motor furnishes the driving power. From the armature shaft, the motion is transmitted through a train of gears, to the horizontal driving and feed shafts. On the latter is mounted a double train of miter gears, running loosely on the shaft, to which either may be connected by a double throw Carlyle-Johnson friction clutch. This is seen in the angle of bed in the illustration. This movement is further transmitted through miter gears to a feed box on the other side of the machine, where nine rates of feed are obtained. These feeds range from 0.789 to 8.15 inches per minute at the high speed of the motor, and from 0.394 to 4.08 inches per minute for the slow speed of the motor. Motion is taken from this feed box shaft of the machine, which is connected at the rear through worm gearing with the feed pinion of the table. This horizontal shaft may also be driven through quick acting spiral gears on the horizontal drive shaft by means of the positive clutch shown, which thus serves to connect either the slow feed or the fast traverse.



Double Horizontal Face Milling Machine for Heavy Work.

In the rear of the right hand ring a connection is made from the horizontal feed shaft for slow feed or quick adjustment for the spindle heads. Independent simultaneous movement for these is obtained by adjusting the friction clutches shown at the top of the up-rights. The shaft connecting these may be operated by hand for minute hand adjustment. The table may be clamped in position so as to use the verical feed in a face milling operation.

All the operations of this machine with the exception of the change in the rate of speed can be controlled from either side. This applies to the change from feed to fast traverse or vice versa, and to the reversing of the feed. The vertical and horizontal feed throw-outs are likewise provided with handles on either side.

The panels on which the uprights are mounted are of very solid construction, and are provided with key slots cut from the solid, which permits clamping the uprights securely in position with four bolts each. With this provision the adjusting gibs can always be kept loose for a free running fit. Additional spindle speed changes beyond those given by the two to one variation in the motor are provided for by change gears in the train connecting the armature shaft with the spindle driving gears.

The spindles of this machine are 6 inches in diameter, and are driven by steep lead bronze worm-wheels 33 inches in diameter and hardened steel worms running under continuous lubrication. The spindle heads are counter-weighted, and may be adjusted from 5 to 26½ inches above the table. The uprights have an in and out hand adjustment from a minimum of 30 inches to a maximum of 60 inches between the ends of the spindles. The heavy work table is 42 inches wide, and 15 feet 6 inches long, with a capacity to mill 14 feet in length. It is entirely surrounded by an oil pan fitted with a lubrication system, arranged to drain into a storage tank in the rear of the machine. The oil or water is returned to the cutters by a pump located at the back of the left hand wing. The table is driven by a steel rack and bronze spiral gear.

CINCINNATI PLANER ARRANGED FOR USING EXTENDED TOOLS.

The accompanying illustrations show a planer built by the Cincinnati Planer Co., Cincinnati, Ohio, provided with specially designed tool supports, which allow a great overhang of the tool without loss of stiffness or cutting power. While the planer was originally intended for the particular work of machining locomotive cylinders, the construction is one which can readily be adapted to any work in which a great overhang of the tools is required.

Fig. 1 shows the supports as arranged on the planer. Fig. 2 shows the detailed construction of the added parts. The machine itself, with the exception of the side heads, is the regular planer as arranged for parallel drive. The housings *A* have ways planed on them on the inside, each provided with a dove-tail front surface, and a square surface in the back. In these ways fit brackets *B*, which are counter-balanced with a weight and chain. The use of the chain allows them to be raised and lowered by a crank applied to the sprocket wheel. The brackets are secured to the housing by tightening the taper gib on the straight side. This forces the bracket against the dove-tail, and draws it in against the bearing.

The front end of *B* has a rectangular section, which is machined and scraped parallel with the front face of the housing. On this is fitted a shoe *C*, having a dove-tail on the opposite side, which fits the cross-slide of the special side heads *D*. After the slide is run onto this shoe, the latter is adjusted to the bracket by the two taper bearings, seen best in Fig. 1. When this has been done, the shoe is a part of the side head, and the two move up and down together, the shoe sliding on the bracket. When it is necessary to reach out 21 inches from the housing with the tool, the latter is supported by the bracket, which extends out about 18 inches, as rigidly as if it were mounted close to the housing.

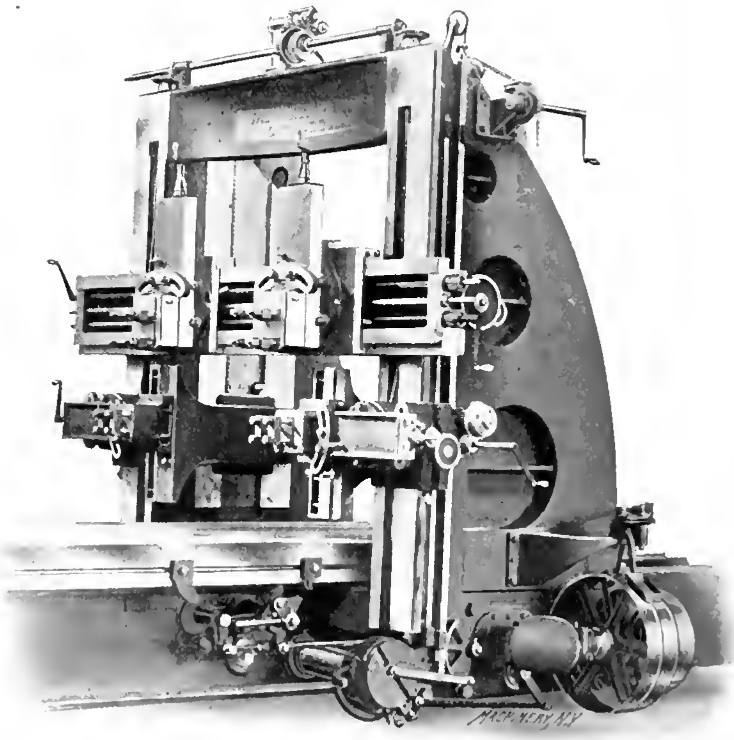


Fig. 1. Cincinnati Planer, with Bracket Supports for Extended Side Heads.

The bracket *B* is made of such a length as to clear the projections

on all sizes and makes of locomotive cylinders and yet have enough bearing so that shoe *C* would never extend over the bearing on the bracket. Fig. 2 shows, in dotted outline, one of the most difficult of the cylinders the planer is intended to handle. This diagram illustrates very plainly the advantage of supporting the tool, when it is necessary to reach out so far to get at the work as is required in piston valve cylinders of this design. When the planer is to be used for other purposes than this special work, the slide can be run back on the side head, as usual, and the brackets raised up out of the way. The machine then becomes an ordinary 72-inch x 72-inch x 18-foot planer, with its full capacity available.

BECHE PNEUMATIC POWER HAMMER.

The illustration shows a "pneumatic power hammer" as it is termed, which is well known in Europe, and is being made and sold in this country by the Nazel Engineering and Machine Works, Philadelphia, Pa. In this machine many of the advantages of the power and the steam hammers are combined. Briefly, the construction comprises two cylinders, one of which contains a piston worked by a crank and connecting rod, while the other carries the striking ram or plunger. The latter is reciprocated by the alternate compression and vacuum produced by the power operated piston.

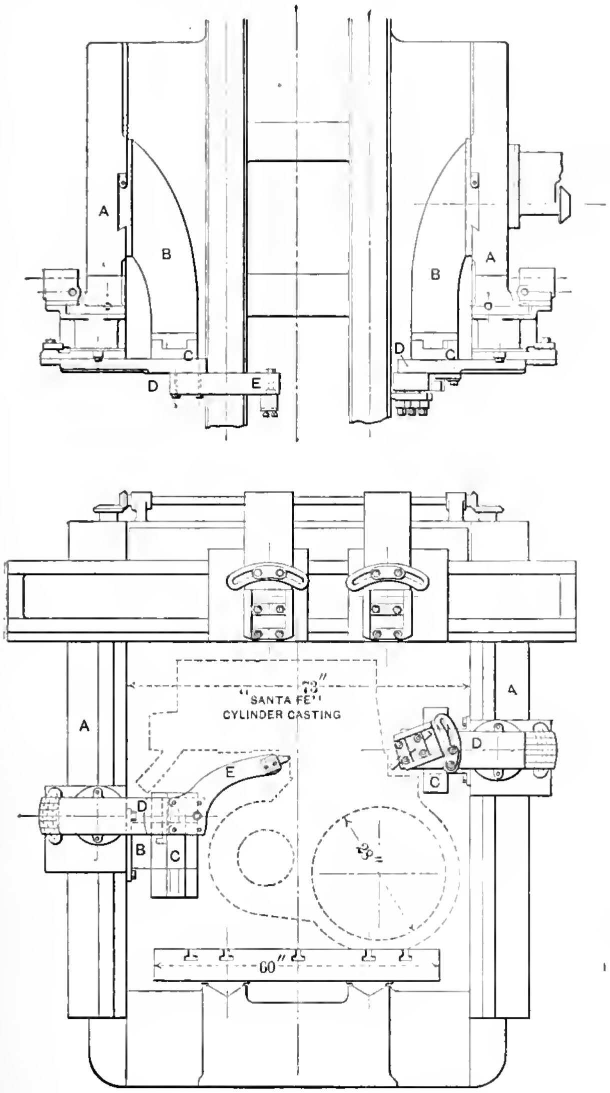
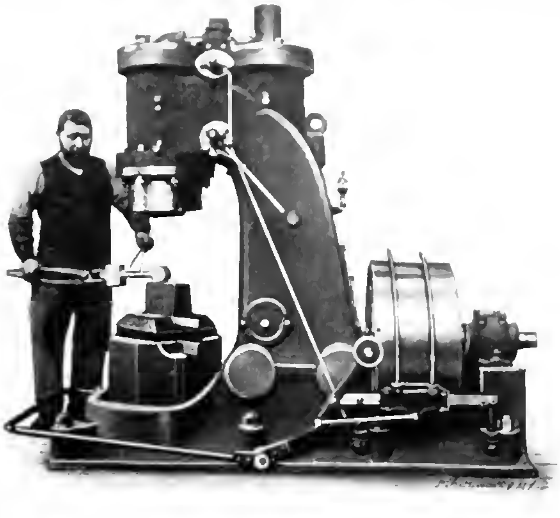


Fig. 2. Plan and Elevation of Special Planer Attachments, showing Use on a Difficult Job.

The construction of the hammer is very simple. The frame is made in a single piece, bolted to the bed-plate; the anvil block is separate. The power crank shaft has mounted on it, a heavy fly-wheel and it may be arranged to be driven either by belt power or by electric motor. The ram or hammer head in the other cylinder slides vertically on closely fitted guides. The whole mechanism is enclosed, so that no destructive forging dust or other foreign matter can reach the working parts. All the movable parts and both the cylinders are lubricated automatically. The hammer is easily operated, and by means of the air regulating valves it is possible to hold the ram suspended at any height, and to instantly change from a very light blow to a heavy one. On closing the valve, the ram remains immovable in its highest position. Suitable connections are made so that fresh air is admitted at every stroke, thus preventing the hammer from being overheated. The operating levers are so arranged that the workmen can control the machine and handle his work at the same time.

The uses of this hammer are numerous as it fills the requirements for general smithing and forge work. A large variety of work which is done on drop hammers can also be effected under the Beche hammer with great rapidity and accuracy. It is especially adapted to the welding and forging of axles, shafts, etc.

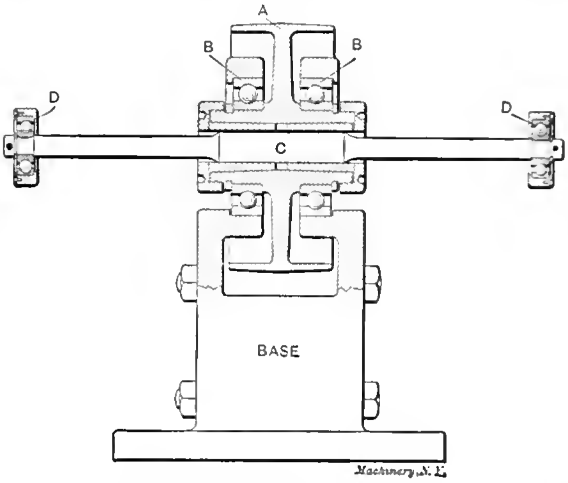


A Pneumatic Hammer, operated by a Direct-connected, Power-driven Air Cylinder.

The claims for this hammer are: Simple and rigid construction; easy adjustment; a quiet but forcible squeezing blow; lack of jar or vibration to the operator; long ram guides; enclosed construction; suitable speed; minimum power; long stroke; belt or motor drive; automatic oiling; and separate bed, with a rigid anvil block. It will be furnished in seven sizes, ranging from 66 to 660 pounds for the weight of the ram. Over a thousand of these machines are in constant use on the Continent.

WHITE-SOUTHER ENDURANCE TESTING MACHINE.

Tinius Olsen & Co., 500 North Twelfth Street, Philadelphia, Pa. have recently placed on the market the White-Souther endurance testing machine, whose construction is shown in the accompanying line engraving. This machine is intended to give dynamic tests of materials in a way which is at once convenient and effective. The deflection of the specimen is effected by a rotary, instead of by a reciprocating motion.



Machine which tests the Endurance of a Specimen by loading it at its Ends and Revolving it.

In the engraving, *A* is the driving pulley of the machine, mounted on ball bearings *B*. The hub of this pulley is provided with a split bushing arrangement for firmly clamping the test specimen *C*, which may be double ended, as here shown, or single ended only. The use of a double specimen has practically the effect of making

a check test, if a flaw exists in one end, the other end may be sound, so that a normal result is obtained. It should be noticed that it is possible to machine a standard tensile specimen from the central and unstrained portion of the sample after the dynamic test is completed.

The alternating strain is produced by rapidly rotating the specimen, which is weighted at its outer, or free ends. The loads are in the form of direct weights, supported on ball bearings *D*. A revolution counter is provided at each end to give the number of reversals of the strain in the test. The connection between the revolution counter and the end of the specimen is such that no damage results to the instrument from a sudden rupture of the specimen. 1300 revolutions per minute is the customary speed at which this machine is run in the laboratory of the inventors.

NEWTON CUTTER GRINDER ATTACHMENT FOR ROTARY PLANER AND FACE MILLING HEADS.

In the April, 1906 issue of MACHINERY, we illustrated and described a self-contained grinding attachment for automatically sharpening the blades in a rotary planer head. This attachment was designed by Mr. Riddell, and was used in the Schenectady shops of the General Electric Co. of which he is superintendent. In using it, the planer head was revolved slowly past the wheel, which ground each tooth as it passed by, and was swung in and out to give the proper clearance to the cutting edge. This machine is now being made in an improved form by the Newton Machine Tool Works, Inc., of Philadelphia, Pa., as shown in the accompanying half-tone and line engraving.

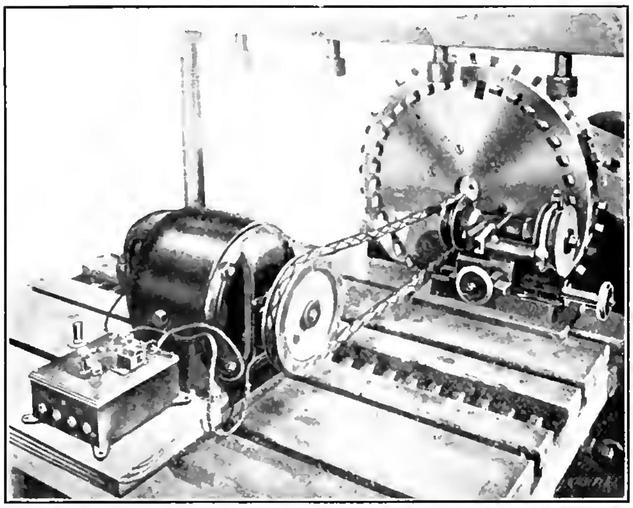


Fig. 1. The Riddell Portable Milling Head Grinder as built by the Newton Machine Tool Works.

The wheel *A* has its outline formed to give the desired shape of cutting edge to the inserted teeth. It is mounted on carefully protected ball bearings at either end of the spindle, in a swinging frame *B*, pivoted at *F*. The dog *C* extends over the wheel in line with the teeth, which strike it successively as they pass by. The swinging movement thus given the dog is transmitted through the rock shaft on which it is mounted to slotted link *E*, which engages an adjustable block in an arm cast solid to swinging frame *B*. By this means it will be seen that as the planer head revolves, each successive tooth operates the rock shaft in such a way as to force the wheel in to grind the clearance on each cutting edge, and bring it out again ready for the next tooth. The clearance is adjusted by shifting the position of the block along the solid arm on which it is mounted.

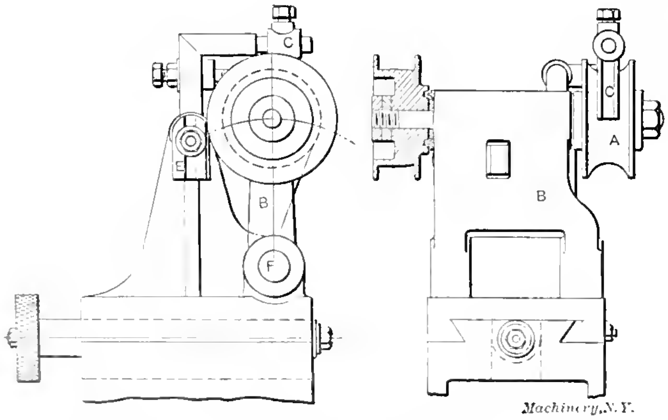


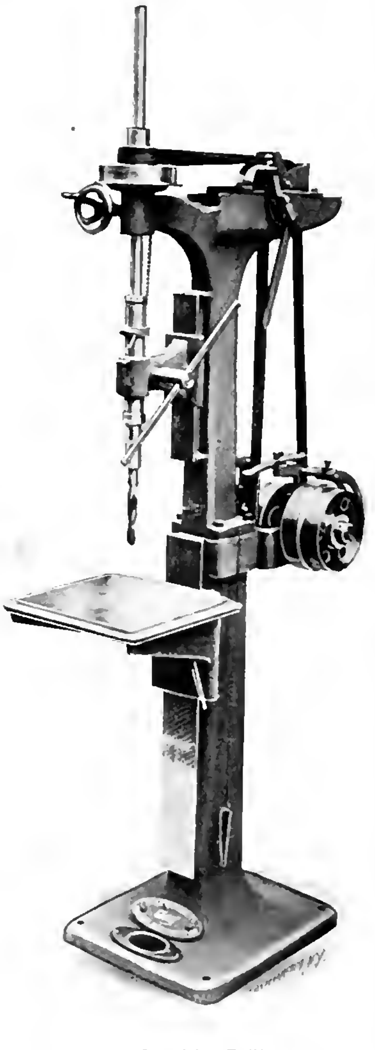
Fig. 2. Details of Grinder Similar in Construction to that shown in Fig. 1, but differently Mounted.

The slide carrying the spindle has an in-and-out adjustment of 3 inches, and a cross adjustment of 5½ inches. The motor shown is larger than necessary for the work, being a half horse-power direct current motor, running at 2,500 revolutions per minute. In using the device for grinding the teeth on a vertical spindle mill, (as illustrated in the description of the Newton four spindle milling machine, in the department of New Machinery and Tools of last month's issue of MACHINERY) finger *B* is adjusted to the opposite quarter. For grinding teeth that are too close together to permit withdrawing the wheel, a double pawl is provided, which permits skipping every other tooth.

The makers of this device have found it possible to double the feeds previously obtained, by grinding the blades in the cutter head in place. A smoother finish to the cut is also noticeable. A test on a vertical rotary planing machine recently made, after grinding the teeth with this attachment, gave a cut 14½ inches wide and ¼ inch deep, at a table feed of 8½ inches per minute, using a 10 H. P. motor.

AVEY SENSITIVE DRILL PRESS.

The sensitive drill press shown herewith is a new product of the Cincinnati Pulley Machinery Co., Cincinnati, Ohio. Aside from general good design and workmanship, some special features have been introduced in this machine; among them the driving arrangement will be particularly noted. Convenience, range, strength and speed are stated as factors sought for in the design.



The Avey Sensitive Drill Press.

The machine runs on ball bearings throughout. All the cones and balls are hardened and accurately ground, and have four point contacts. The spindles are of crucible steel, ground to size, and bored to fit the No. 2 Morse taper. The spindle sleeve is graduated, and is provided with a stop collet having a fixed clamp screw, requiring no wrench or screw-driver. This, in combination with the graduation, makes the use of a scale unnecessary in drilling to depth. The rack pinion and shaft for feeding are of one solid piece—an improvement over the usual separate construction. The upper and lower columns and the counter-shaft brackets are tongued and grooved, insuring proper alignment and interchangeability. If desired by the purchaser, the table will be fitted with a telescopic elevating screw, operated by bevel gearing, the construction being the same as that used in milling machines. This allows the maximum distance between the spindle and the table, and can be applied at any time subsequent to the purchase of the machine, though it is not furnished without extra cost.

The spindle has four changes of speed, which are instantaneously obtainable. A convenient handle shifts the belt on the two-step

cone pulley on the counter-shaft. Two more changes are obtained by shifting the quarter turn belt to one of two positions on the counter-shaft and spindle pulleys. To permit this shifting, the two quarter turn idlers perform different functions. The one at the left is adjusted longitudinally by the hand-wheel shown for tightening the belt to the proper tension. The idler at the right-hand side which leads the belt on to the spindle pulley, is raised or lowered to the proper position for either of the two speeds by means of the lever shown.

This machine has a spindle traverse of 13½ inches and a rack feed of 5⅝ inches. The maximum distance of the spindle to the table is 35½ inches. It is made as a single spindle machine, or with two, three or four spindles as required. The weight of the single spindle machine is 430 pounds, that of the four spindle machine is 1,220 pounds. The machine has a capacity for drilling up to 29/32 inch diameter.

VAN DORN ELECTRIC DRILL.

Fig. 1 shows the front view, and Fig. 2, a section of one of the new line of portable electric drills made by the Van Dorn Electric & Mfg. Co. of Cleveland, Ohio.

The motors for these drills are made in both open and closed designs depending on the conditions under which they are to work.

Fig. 1. The Van Dorn Electric Drill.

The example shown has ventilation holes in both heads, and in the sides of the machine. A current of air is forced through these holes by the peculiar design of the armature. The air is drawn in through the heads, and forced out at the sides, the current passing completely through the field opening at the air gap between the pole pieces and the armature. The upper and lower thrust, as shown, is taken on ball bearings. All the bearings that are not ball bearings are made of phosphor bronze. The gearing and all other wearing parts are made of steel, case hardened.

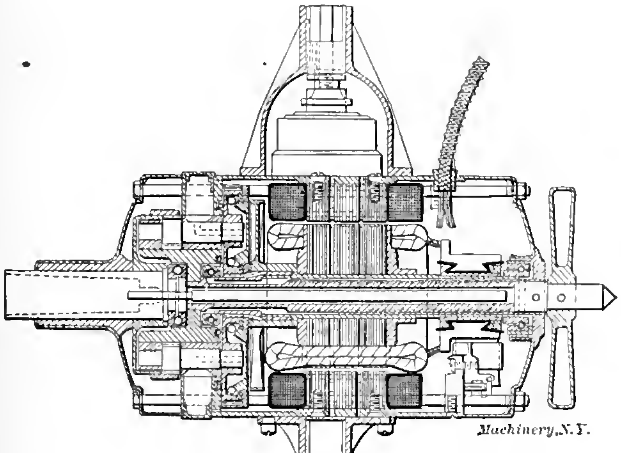


Fig. 2. Section through Drill, showing Use of Ball Bearings and the Provision for Cooling the Commutator, Armature and Field.

The tools are controlled through a switch handle operated by a knurled ring. A quarter turn of this ring will stop the machine, which is thus, at all times, under the instant control of the operator. Each machine is equipped with an armored cable. The armor of this cable is grounded in the machine, absolutely preventing the operator from getting a shock

These electric drills are built in five sizes; the smallest is equipped with a standard chuck having a capacity for any drill from the smallest up to a quarter inch in diameter. The other machines are fitted with Morse taper sockets, the largest size being bored for No. 4 taper and being capable of driving a 2 inch drill in steel. The design is the result of long experience, with a long and severe trying out in various establishments, all of which was done before the tools were placed on the market.

THE BEMIS HEXAGONAL MILLING MACHINE.

We show herewith an interesting automatic machine for milling hexagon flats on nuts, valve fittings, stuffing box glands, etc. It is a multiple spindle machine, with the work carried by an indexing spindle carrier, which leaves one station open to the operator for placing and removing the work. Except for this matter of placing and indexing the work, the machine is entirely automatic. It is built by Edgar W. Bemis, of Worcester, Mass.

The general arrangement of the machine is shown in Fig. 1, while Fig. 2 shows the details of the mechanism. The machine is driven by tight and loose pulleys on shaft *A*, which is connected by bevel gearing with the vertical shaft *B*, which extends up through the center of the machine. This shaft, in turn, is connected by bevel gearing in the cutter head *C* with the three cutter spindles *G*, which are placed at right angles with each other. These spindles are supported by outboard bearings in the overhanging arm *D*, which is clamped to cutter head *C*. This latter is raised and lowered to accommodate different lengths of work by means of a worm and worm gear *E*, operating a coarse screw *F*, threaded in the bottom of the head.

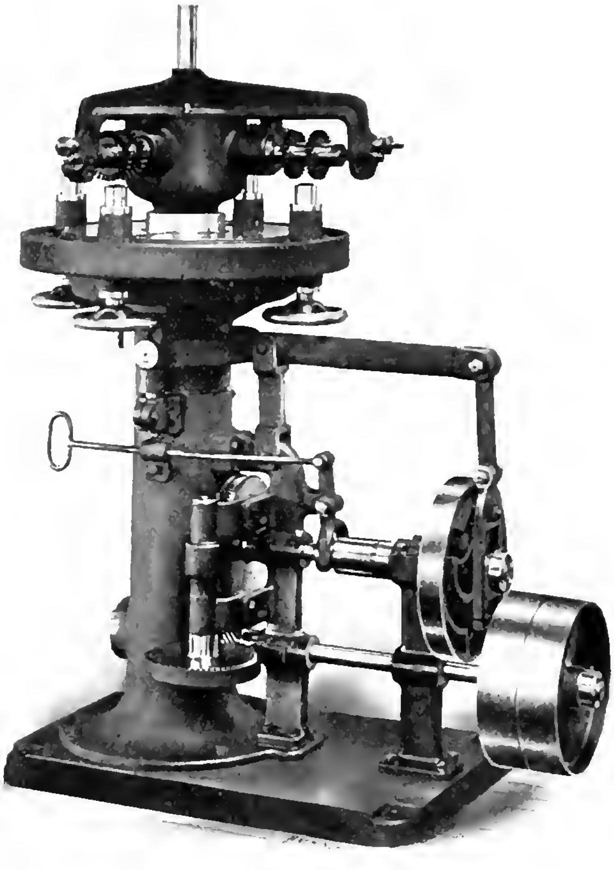


Fig. 1. A Machine for Milling Hexagon Surfaces on Valve Bodies, Nuts, etc.

The work-table *J* is supported on ball bearings on the lifting table *H*, which is moved up and down to feed the cutters into the work and withdraw them. The work spindles *M*, mounted in table *J*, have keyed to them gears *L*, meshing with the gear *K* fast to *H*. As the work-table is indexed to bring the work spindles into successive positions under the three cutter spindles, the work is indexed by gears *K* and *L* to the proper positions for cutting hexagonal sides, bringing a new pair of work faces to each set of cutters. The index ring *O* is locked by a bolt, controlled by a handle within con-

venient reach of the operator. The work spindle has an interior sliding spindle into which the work plug is secured. This interior spindle is threaded to a screw attached to hand-wheel A, and is raised and lowered by the turning of the latter. The hand-wheel thus serves to clamp the work, and its action brings it down against a solid shoulder, holding it securely in place during the operation.

Table *H*, and with it the work spindle and the work, is raised and lowered by a yoke *P*, the motion being guided by pins *Q*, which pass through lugs on the side of the column. The operation of the yoke is controlled by the cam and link movement, seen best in Fig. 1. The cam is operated by gearing from the drive shaft as shown. The feed may be thrown out at any time by a positive jaw clutch.

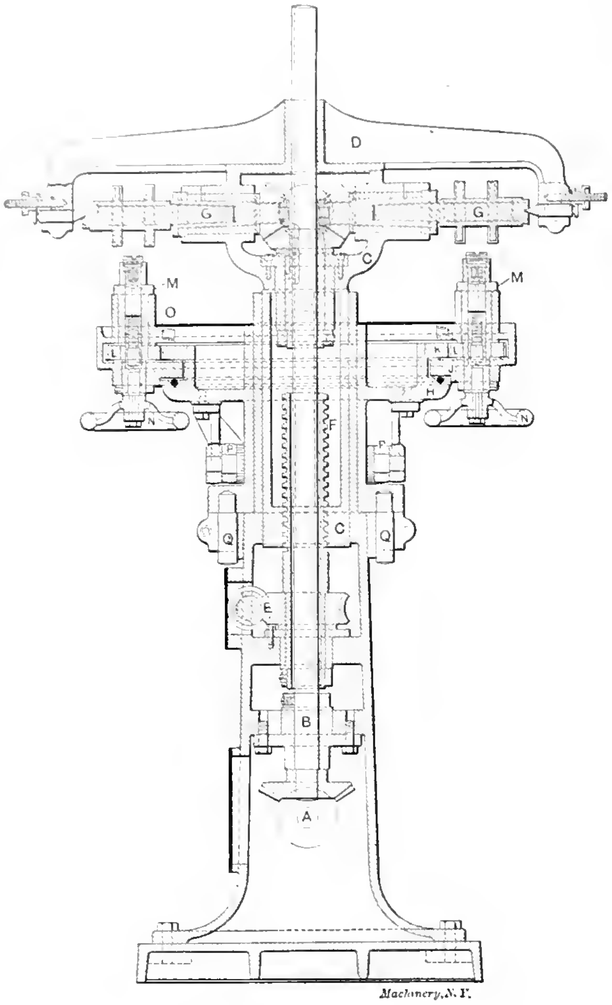


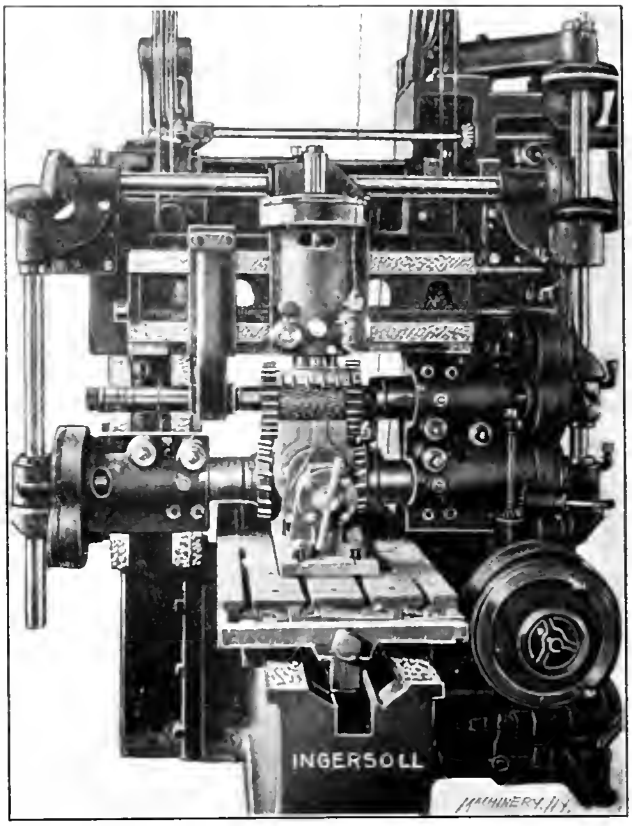
Fig. 2. Vertical Section, showing the Mechanism.

The weight of this machine is about 1,500 pounds. It is strong and substantial in construction, and has sufficient driving power for finishing nuts up to 3 inches across the flat. An output of 240 ¾-inch nuts per hour, or their equivalent in other sizes, represents the working capacity of the machine.

INGERSOLL SPECIAL FOUR-HEAD MILLING MACHINE.

The four-spindle milling machine shown herewith, illustrates the extent to which it is possible to specialize a machine of this kind by a slightly different arrangement of the spindles, without incapacitating it in any way for regular work. This machine, built by the Ingersoll Milling Machine Co., Rockford, Ill., carries two horizontal spindle heads on the right-hand upright, and one on the left-hand. There is a fourth head mounted on the cross rail; the cross rail also carries an outward support for an arbor, which may be driven by the upper of the two spindle heads on the right. When the machine is so used, this spindle head is fastened to the cross rail and is adjusted up and down with it, making the machine, to that extent, a slab miller.

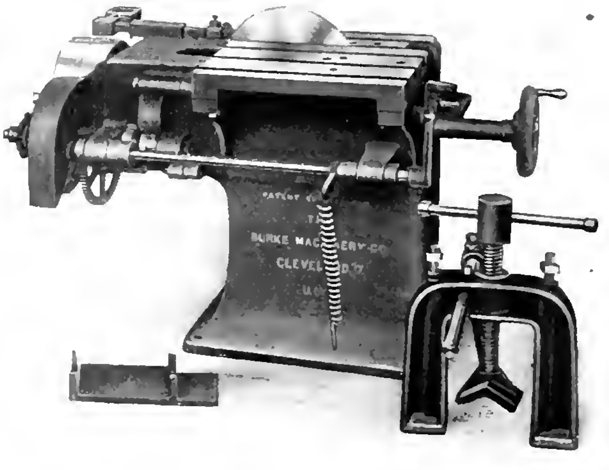
The engraving shows the tool operating on the work for which it is specially designed. The two lower horizontal heads each carry face mills. The upper horizontal head carries an arbor, which is clutched to the face of the spindle and drives a gang of cutters. The vertical head carries a face mill. This vertical head is far enough in advance of the horizontal arbor so that it is used for roughing out the cut, which is immediately finished by the cylindrical cutters on the arbor. It will be noticed that each spindle has a longitudinal adjustment.



Ingersoll Four-head Milling Machine in Operation.

IMPROVED BURKE COLD SAW.

The Burke Machinery Co., 1837 35th St., Cleveland, Ohio, has re-designed the cold-sawing machine, which we described in the June, 1908 issue of MACHINERY. Among the changes is the provision of a screw-feed, with ball-bearing thrust, in place of the rack and pinion feed previously used. This has meant an entire re-arrangement of the feed mechanism.



Improved Design of Burke Cold Saw.

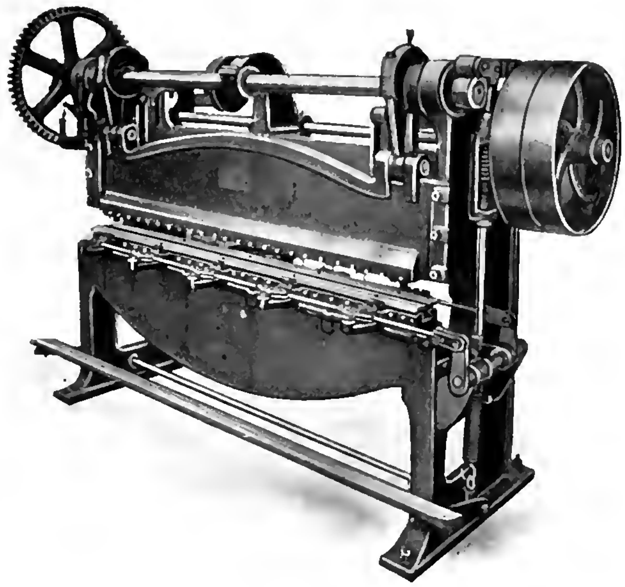
The saw blade rests upon and is bolted directly to a bronze worm-wheel. It is driven from it by three ½ inch cap screws and three ½ inch pins of hardened drill rod. These driving holes are well out from the center of the blade and give an unusually strong drive. This worm-wheel with the attached saw is mounted in a carriage sliding in suitable ways across the bed of the machine. At the front of the carriage is bolted a hardened steel casting, which acts at the same time as a guide to the saw and as a stripper

for carrying away the chips from the teeth. An automatic throwout is provided for the feed. In the train of feed gears is a loose gear, confined between two flanges lined with leather. A spring and adjusting collar tighten these flanges to the gear, and furnish the friction slip, which will give under abnormal pressure.

The machine shown is provided with tight and loose pulleys. A three-step cone with a suitable counter-shaft will be furnished in place of this, if desired. The clamps for holding round and irregular shaped stock are seen on the floor at the base of the machine. A stop for cutting to length is provided, as shown. This machine is made in two sizes, for 12 inch, and 20 inch saw blades. These have respectively a capacity for round stock up to 3 inches, and 5½ inches in diameter. The extreme capacity for rectangular stock is for each case, 3 x 5 inches, and 5½ x 12 inches. The capacity for ½ inch flat stock is 9 inches and 20 inches wide, respectively. The net weights are 500 and 800 pounds. The machines sell at the remarkably low prices of $80 for the 12-inch machine, and $160 for the 20-inch machine.

BERTSCH GANG PUNCH.

Bertsch & Co., of Cambridge City, Ind., make the multiple gang punch shown herewith. The ram and die bed are provided with a multiplicity of punches and dies, which may be set either by universal or independent adjustment to the center distances required to suit the work in hand. The machine illustrated has an automatic clamping mechanism for holding narrow bars or strips. Each machine is provided with a stripper properly designed for the particular work for which it is to be used. The machine may be furnished with the automatic clutch used on the makers' regular shears. This clutch is noiseless, positive and reliable in its action. The castings and steel parts for each machine are carefully calculated for the stresses imposed on them, particular care being given to have the bearings and gears of the right proportions. The machine is furnished by the maker in a variety of sizes for a wide range of work.



A Gang Punch with Adjuatable Dies.

NO. ½ VAN NORMAN DUPLEX MILLING MACHINE.

In Figs. 1 and 2 is shown a new design of the Van Norman duplex milling machine built by the Waltham Watch Tool Co., Springfield, Mass. The special feature of this machine, as in all of the Van Norman millers, is a movable cutter head mounted on a ram which can be adjusted in or out over the table, permitting the advantageous use of cutters for either vertical, horizontal or angular work. This particular machine meets the requirements for toolroom work, or general purpose light manufacturing.

The slides are operated by means of conveniently placed handwheels. That at the right of the knee in Fig. 2 is used as a quick return for the table. The table feed is operated by a revolving nut, the table screw being locked by a pawl which is thrown out of engagement when this feed is operated by hand. A table stop is provided, and means are furnished for clamping the table solidly when the longitudinal feed is not being used.

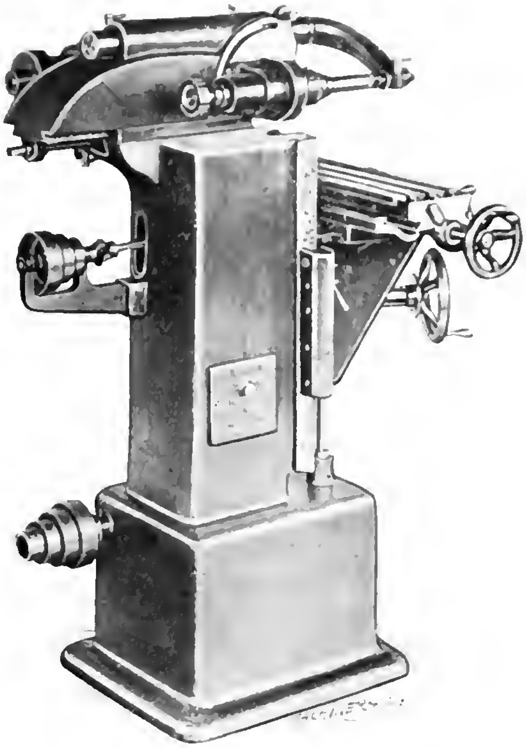


Fig. 1. Van Normen Miller, arreuged with Spindle Horizontel.

The cutter spindle holds a large split collet; large mills are mounted on a collet plug. The spindle is hardened and ground and runs in hard bronze boxes. The taper bearings are set up by an adjusting nut at the rear of the spindle. The driving cone is mounted on bearings at the side of the column. The splined driving shaft is connected to the cutter spindle by double bevel gearing. Fig. 1 shows the machine as arranged for horizontal milling, using the over head arm. Fig. 2 shows the ram adjusted forward, with the cutter spindle fixed at an angle. This machine weighs about 1,200 pounds. A semi-universal index head with draw-in collet is furnished if desired.

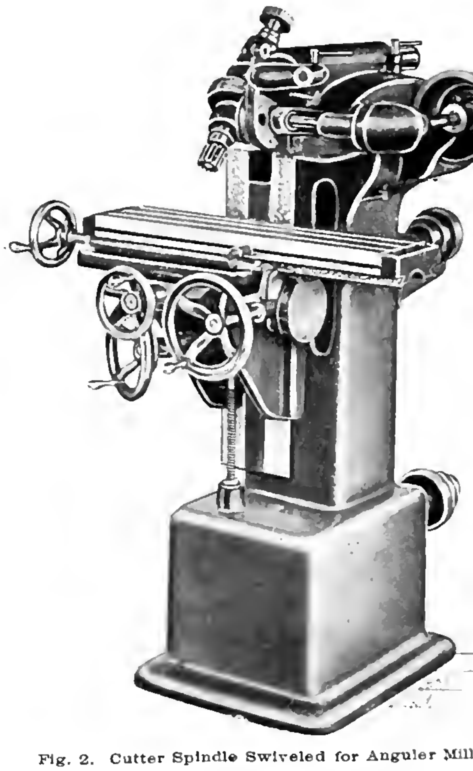


Fig. 2. Cutter Spindle Swiveled for Anguler Milling.

DALLETT AIR COMPRESSORS.

We [illegible] a new belt driven air compressor which is one of a line built by the Thomas H. Dallett Co., 23d and York Sts., Philadelphia, Pa. This line has been designed to meet the most exacting requirements for a machine of this kind. The general ruggedness of the design is plainly shown in the engraving. The following description will give some idea of the way in which the designs have been worked out.

The base is of the Tangye type; the main bearings have nearly three times the area called for by conservative calculations, and so may be depended on to run without heating and with a high overload as well, permitting the use of a larger capacity cylinder for the regular 100 pounds pressure, if desired. A flanged end is provided for bolting the cylinder to the frame; the convenience of this construction when tightening the nuts on the cylinder studs, will be appreciated by the engineer. The cylinders are of a special hard close-grained iron, cast with walls thick enough to allow for reboring when necessary.

A drain cock is provided at the lowest point on the cylinder heads, for use in cold weather. The clearance space is reduced to a minimum, and this, with the large water jacket cooling surface provided, results in a high efficiency. The lubricant is fed into the outlet passage, from which it is carried through the cylinder in the form of a fine spray. The connecting rod and crank shaft are of the marine type; both crank pin and cross head pin boxes are of high grade phosphor bronze. The crank shaft is forged from a solid billet of mild open-hearth steel.

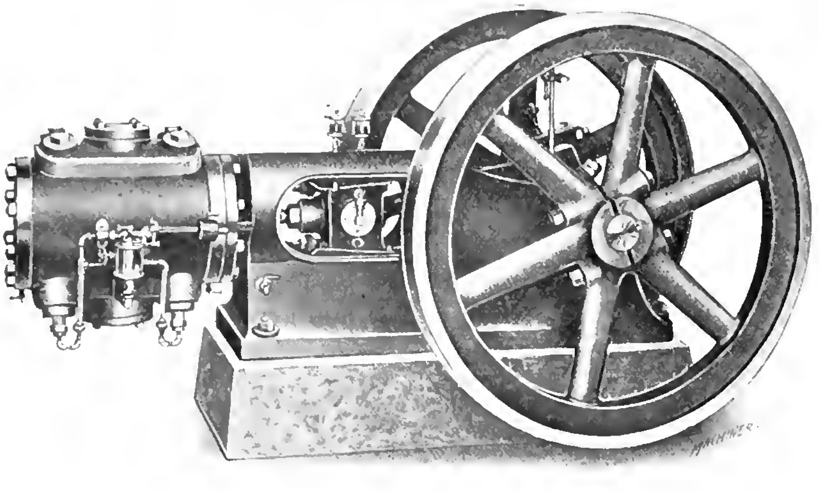


Fig. 1. A Belt-driven Example from a New Line of Dallett Air Compressors.

The air inlet and discharge valves are shown in Figs. 2 and 3 respectively. The outlet valve is a complete unit in itself, with no guides or stops to screw into the cylinder. The valve cap acts as a lock, holding the cage tight after it has been screwed down into its seat. Corrugated copper gaskets are used for forming the joints of the valve cage and cylinder, and under the valve cage cap. The valve is light, and of the proper area. The valve proper is of high-grade hardened steel with the seat and all wearing surfaces accurately ground. The tension of the phosphor bronze valve spring is carefully determined to give a light action, and yet shut the valve promptly on seating. The spring holder is of unique construction, consisting of a split taper ring set into a recess in the valve spring, and held by a solid taper ring which slides down over it. This entirely eliminates trouble from the shearing off of the spring holder, as sometimes occurs when held by a jamb nut or taper pin. The discharge valve, shown in Fig. 3, is of extremely simple design, being self-contained and having but four parts; viz: the malleable iron cage, the valve proper, the valve spring, and the cap. The latter acts as a positive stop when the valve has reached its full opening, thus obviating fluttering. Both valves are of large area and are practically noiseless in their operation. The time required to remove one from the cylinder is less than a minute.

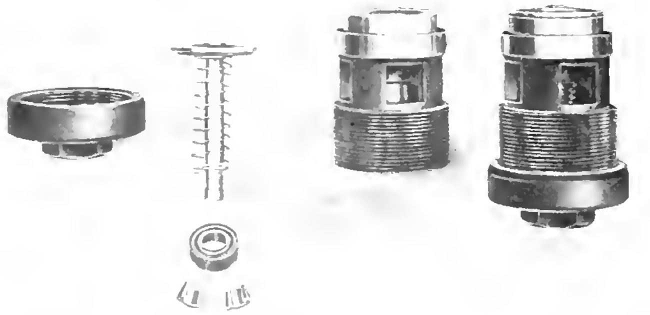


Fig. 2. The Self-contained Inlet Valve used on Dallett Air Compressors.

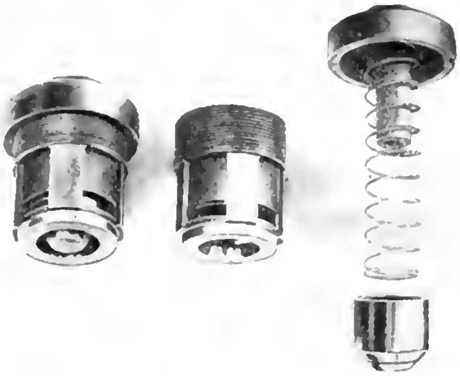


Fig. 3. Dallett Discharge Valve.

Pressure regulation is provided for in these belt driven machines, by an unloading device which automatically opens the air cylinder to atmospheric pressure when the receiver pressure has reached a certain pre-determined amount. This device holds open one or more outlet valves at both ends of the air cylinder, taking the load off the compressor, and allowing it to run light until the pressure drops in the receiver, when the valves are released and the air compression is resumed.

The makers also build a similar line of steam driven air compressors of the straight line type, either single, duplex or compound. In these a combined speed and pressure governor is used. The governor unloads the air cylinder exactly the same as on a belt-driven machine. At the same time, it controls the speed, allowing a single steam machine to just turn over when unloaded, and bringing a duplex or a compound machine to a dead stop. By this means a great saving in steam is effected, as well as a reduction in the wear and tear on working parts.

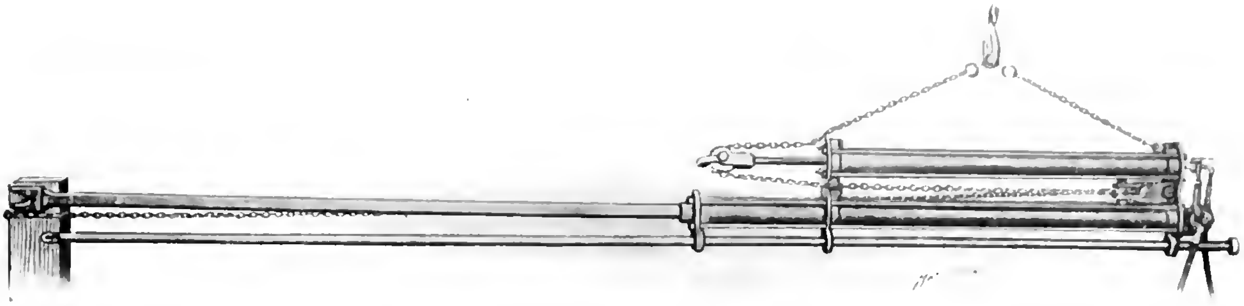
WILLIAMS, WHITE & CO.'S STAY-BOLT BREAKER.

Mr. Grover S. Lowe, a machinist in the Rock Island shops at Silvis, Ill., has invented a machine for breaking boiler staybolts, which works with rapidity and safety, so that jobs which formerly required five men's work for five days, are now done by two men in fourteen hours. It is not only useful in breaking staybolts when removing fireboxes from boilers, but can be used as well in wrecking steel buildings and bridges.

This machine, of which a general view is shown herewith, may be described as follows: It consist's primarily of two parallel cylinders securely fastened together. A valve is attached to the back end of each. The only purpose of the valve in the shorter cylinder is to act as a cut-off or a back pressure valve. The valve at the back of the longer cylinder is quadruple acting. The 100 pound striker or sledge is fitted in this cylinder. The front end is a cutting bar, with a boss welded around it at its rear end. Two lines of hose carrying compressed air are attached to the machine. One of them supplies pressure to the short cylinder, in which is fitted a piston which, by means of a chain and sheave, is made to hold the machine firmly against the cutting bar, pressing this in turn against the bolt to be cut. The machine thus moves forward automatically, taking up the slack as the bolts are broken.

The other hose is attached to the quadruple valve on the iron cylinder for operating the striker. Moving the handle of this valve in one direction admits compressed air behind the striker, sending it forward with great force, which is transmitted to the bolt to be broken. Twenty-eight 15/16-inch bolts have been broken by this means in three minutes. The machine is suspended from a crane or tripod, so as to be easily handled.

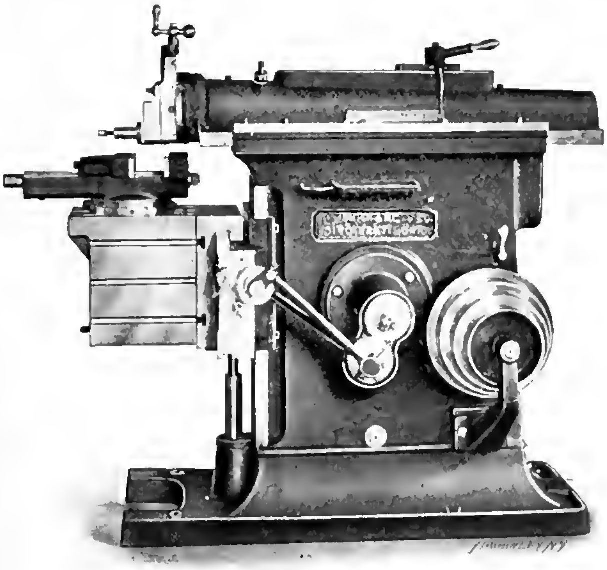
Three times the work with about ⅓ the men is the estimate as to the efficiency of the apparatus, and in the matter of safety there is no comparison. With the old methods the work of breaking staybolts is more dreaded than any other the boiler-maker is called upon to do. One of these machines is kept in constant service in the shop where it was designed, and it has displaced five other tools for the same purpose. The builders are Williams, White & Co., Moline, Ill.


A Pneumatic Staybolt Breaker Invented by a Machinist in a Railroad Shop.

SMITH & MILLS HIGH-SPEED BACK-GEARED CRANK SHAPER.

The crank shaper made by Smith & Mills, of Cincinnati, Ohio, has been redesigned to keep pace with the increasing demands of modern service. Entirely new and heavier patterns have been used throughout. The resulting machine is shown in the accompanying engraving.

The column is of generous proportions, strongly braced and ribbed on the inside, and with projections front and back for the ram guides. The base is provided with pads for attaching a table support if required. An outside bracket supports the end of the driving shaft. The box table furnished with the machine is arranged for clamping work on either side, or at the top; it can be removed if required, allowing work to be bolted to the slotted apron. The telescopic elevating screw for the cross-rail is fitted with ball bearings. It is unnecessary to make an opening in the floor for this screw.


Smith & Mills High-duty Shaper.

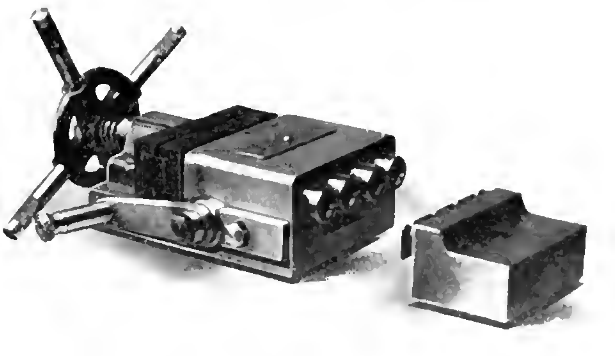
Among the new features of the machine, should be mentioned the fact that the changes of stroke, feed, speed and position of the ram are all made from the working side. The change in the length of stroke is made without stopping the machine. A locking device is provided which clamps the crank-pin rigidly, so that there is no possibility of a variation in the length of the stroke while the machine is in operation. The crank lever is adjustable to the wear of the sliding block, and is connected to the ram by a link. The automatic cross-feed of the table can be instantly changed while the machine is in operation. A new device on this machine is the automatic vertical feed for the cross-rail, which provides for raising the rail, table and work vertically, and feeding it against the tool. Micrometer dials are provided for the various movements, adapting the machine particularly to the cutting of racks, or, in conjunction with index centers, to the planing of gear teeth. A table of dimensions for rack cutting is furnished.

There are eight changes of speed on each machine. The back gears provide for this with the four-step cone. On a 16-inch machine these speeds range in geometrical progression between 6.21 and 157.15 strokes per minute. On the 20-inch machine the range is from 7 to 100.8, and on the 25-inch machine from 6.75 to 80 strokes per minute. The equipment of each machine includes a counter-shaft and the necessary wrenches, together with a swiveled jaw vise with a graduated base and steel-faced jaws. In ordinary work the 25-inch machine has removed a chip 1 inch deep, 3/16 inch thick and 18 inches stroke, at the rate of 15¼ cubic inches of steel per minute.

MILLER & CROWNINGSHIELD MULTIPLE SPINDLE INDEX CENTERS.

The multiple spindle index centers shown herewith are made by the Miller & Crowningshield Co., of Greenfield, Mass. The device is intended to be used in such work as fluting taps. The construction employed permits blanks of different lengths to be simultaneously and uniformly clamped in the four spindles by a single movement of the clamping wheel. An improved indexing device is also provided.

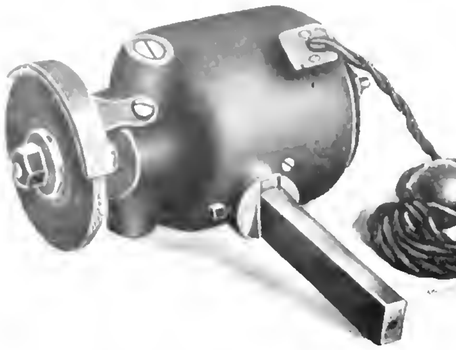
The tail-stock is practically a solid piece, as shown. The work is clamped by the end movement of the head-stock spindles. This end movement is effected by the screw and pilot wheel shown, which acts through a system of equalizing levers. The levers distribute the pressure over the four spindles, whether or not the four pieces of work are of equal length, within reasonable limits. It is possible with this arrangement to hold one or any number of pieces, up to four at a time, with equal firmness. The spindles are indexed by spur gears mounted on them, meshing with spiral gears on the index crank shaft, which passes through the head at a slight angle. This shaft is mounted in an eccentric bushing, which provides for adjustment in the case of wear. The ratio of the gearing is such that one complete turn of the index crank turns all the spindles in the same direction, into position for a new cut.


Multiple Centers for Fluting Taps, etc., provided with a Balanced Clamping Arrangement

WILLEY PORTABLE ELECTRIC GRINDER.

This grinder, made by the Willey Machine Co., Jeffersonville, Ind., is adapted to general grinding in the lathe. It can be used for plain cylindrical grinding in any lathe, or for taper grinding

in those provided with taper attachment or compound rest. The device is held by its shank in the tool post, the same as a lathe tool, and is operated by a lamp cord and socket connection with a shop lighting circuit. It is particularly useful for center grinding. On lathes having plain rests only, the centers may be ground by taking a succession of cuts the width of the wheel, finishing the centers to gage. The brushes and all the connections are enclosed and the bearings are adjustable for wear. The wheel is provided with a strong guard.



Electric Lathe Grinding Attachment.

"OMNI-PRESENT" LIGHT-HOLDER.

The Pennsylvania Specialty Mfg. Co., Cochranton, Pa., is making the "Omni-Present" light-holder, which is shown in detail in Fig. 1, and applied to a lathe in Fig. 2. This light-holder permits a lamp to be placed in any conceivable position, to which it may be instantly adjusted. It is especially useful in such work as internal threading and measuring. It may be used for the desk, drafting-room, table, machine, vise, etc.

This holder consists of a standard to which is attached a double flexible arm, connected by universal joints. An insulated swivel joint is provided for holding the lamp to the outer end of the arm. Two forms of base are provided. One of them seen just under the standard in Fig. 1 may be screwed to a table or machine. The other form, shown at the left, is used for mounting the holder in the T-slots of the milling machine, lathe, or other tool. The base of the holder may easily be changed from one end of the table to the other, or from one machine to another. These holders will be furnished with longer arms than shown at a slight additional cost. The finish of the parts is in oxidized copper, the base is japanned, giving the appliance an attractive appearance.

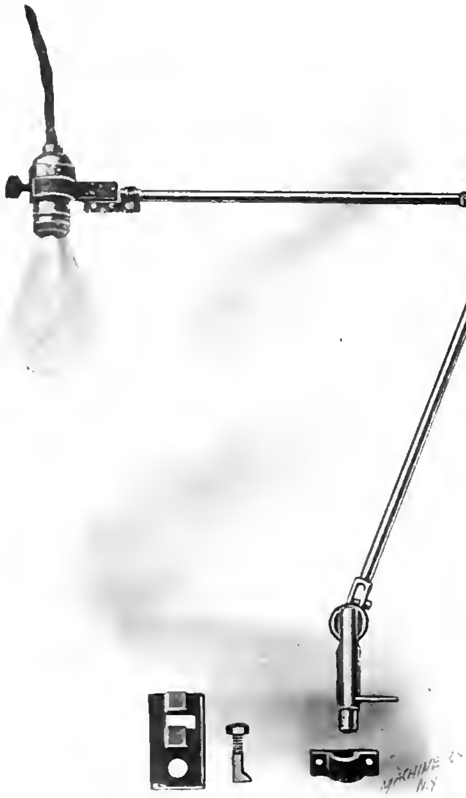


Fig. 1. "Omni-Present" Light-Holder made by the Pennsylvania Specialty Mfg. Co.

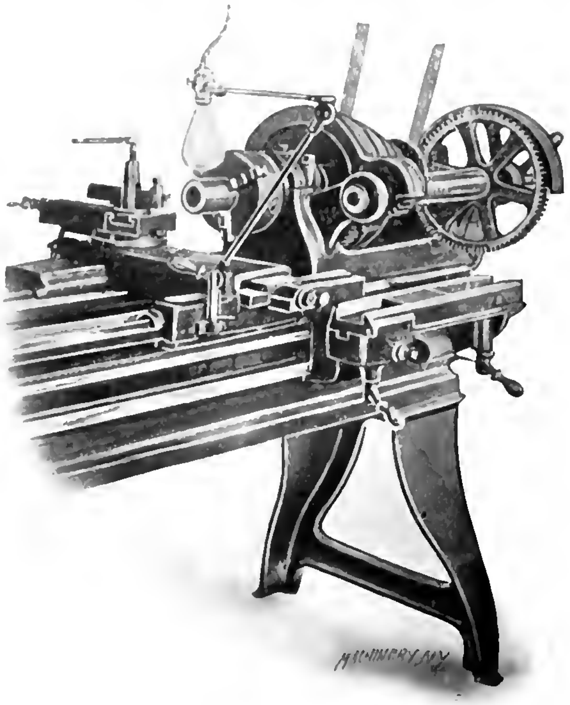
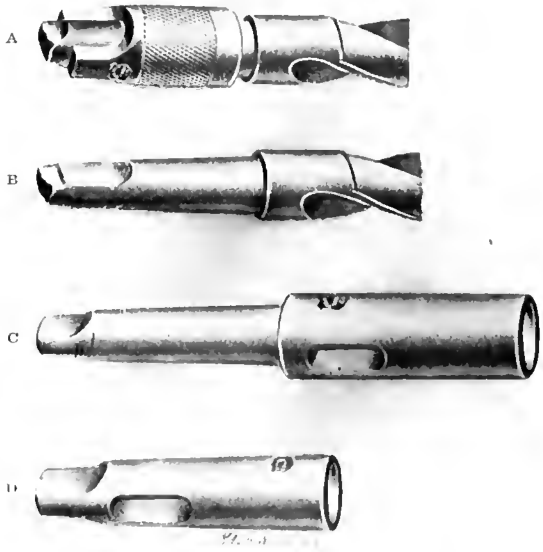


Fig. 2. Application of the Light-Holder.

STANDARD TOOL CO.'S "ECONOMY" DRILL SOCKETS AND SLEEVES.

The Standard Tool Co., of Cleveland, Ohio, has recently placed on the market a shortened design of the regular taper socket and sleeve. This design is used for extending the life of twist drills which have failed, from the twisting or breaking of their driving tangs. Such a drill is shown at *B* in the engraving. This drill has had a new tang formed on it, it will be noticed, by milling flats further up on the taper. By the use of the gage shown at *A*, lines may be scribed, to which the flats are formed on the broken shanks; this may be done by grinding, filing or milling, as most convenient. When the broken tang is thus treated, it may be used in the socket as at *C*, or the sleeve as at *D*. The new tang is heavier and stronger than the old one, and insures an accurate and powerful drive. The shanks of the "Economy" sockets and sleeves are made of regular dimensions, and will fit the regulation Morse taper



Short Sockets and Sleeves, for using up Drills with Broken Shanks.

hole in the drill press spindle. The use of this appliance should save many otherwise useful drills from being consigned to the scrap pile.

WALKER TOOL-ROOM GRINDER.

The tool-room grinder made by the Walker Grinder Co., Worcester, Mass., is now made in a new design, which is herewith illustrated and described. This new design includes, among other improvements, a new table feed mechanism, and an improved construction of the spindle head, which allows a greater range of adjustment to the spindle without interfering with the free running of the belts.

The characteristic feature of the Walker grinder is the provision made for swiveling the cutter spindle in two planes, about a vertical and a horizontal axis. This provision allows the utmost flexibility in setting up work of a difficult character, and renders unnecessary the use of complicated and insecure holding devices for such work as grinding face mills, spiral reamers, etc. The arrangement of this well-known drive is shown diagrammatically in Fig. 2. The belt on the counter-shaft pulley A, passes down to an idler B at the head of the spindle column. From here it passes over the spindle pulley C, back to a second idler D in the column, and down through to the lower idler E in the base of the machine. The adjustment for height is effected by raising or lowering the spindle column F. The adjustment of the spindle is about axis xx in one plane and yy in the other. The adjustment about axis xx carries idler E with it, twisting the belt without materially altering its length. Similarly, the swiveling about axis yy is permitted without material change in belt length The two movements may be made simultaneously, or together, with perfect freedom.

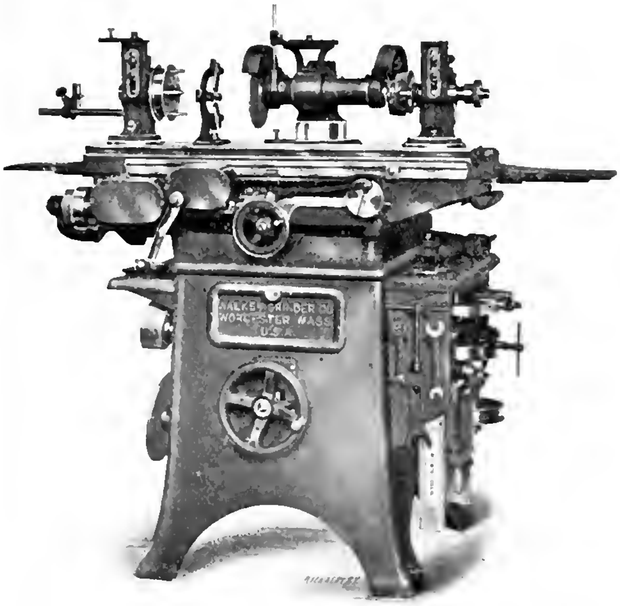


Fig. 1. The Walker No. 2 1-2 Tool-room Grinder.

The improvement at this point in the new design consists in mounting idler B (which is flanged, and of about the width of the belt) on pivot G, so that it swings in a vertical axis zz as shown; and in lengthening idler D to permit the belt to travel from one side to the other as required. This permits extreme adjustment without harmful straining of the belts, or rubbing against flanges of the pulleys.

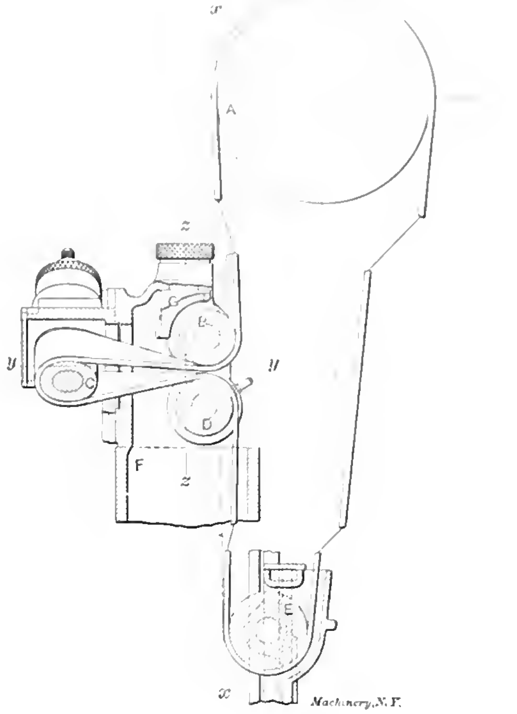


Fig. 2. The Improved Belt Drive of the Walker Grinder.

The new cross and longitudinal feed mechanism is shown in the line engraving, Fig. 3. It is driven from the main counter-shaft through a jack-shaft mounted at the side of the machine, which carries a two-step cone pulley connected with that shown at H. This, through the bevel gear and the clutch reversing mechanism J, drives the drum K. This drum, in turn, through the gearing indicated, operates the rack pinion shaft L, by means of which the table is reciprocated. A disengaging clutch is provided for throwing out the feed independent of the reversing mechanism by the longitudinal movement of pin M. The reversing is controlled by dogs N and N', adjustable in the T-slot at the front of the table. These shift slide O to the right and left alternately. Projection P and P' on slide O alternately compress springs Q and Q', which press against boss R, attached to the reversing clutch rod. As dog N pushes slide O to the left, for instance, spring Q is compressed;

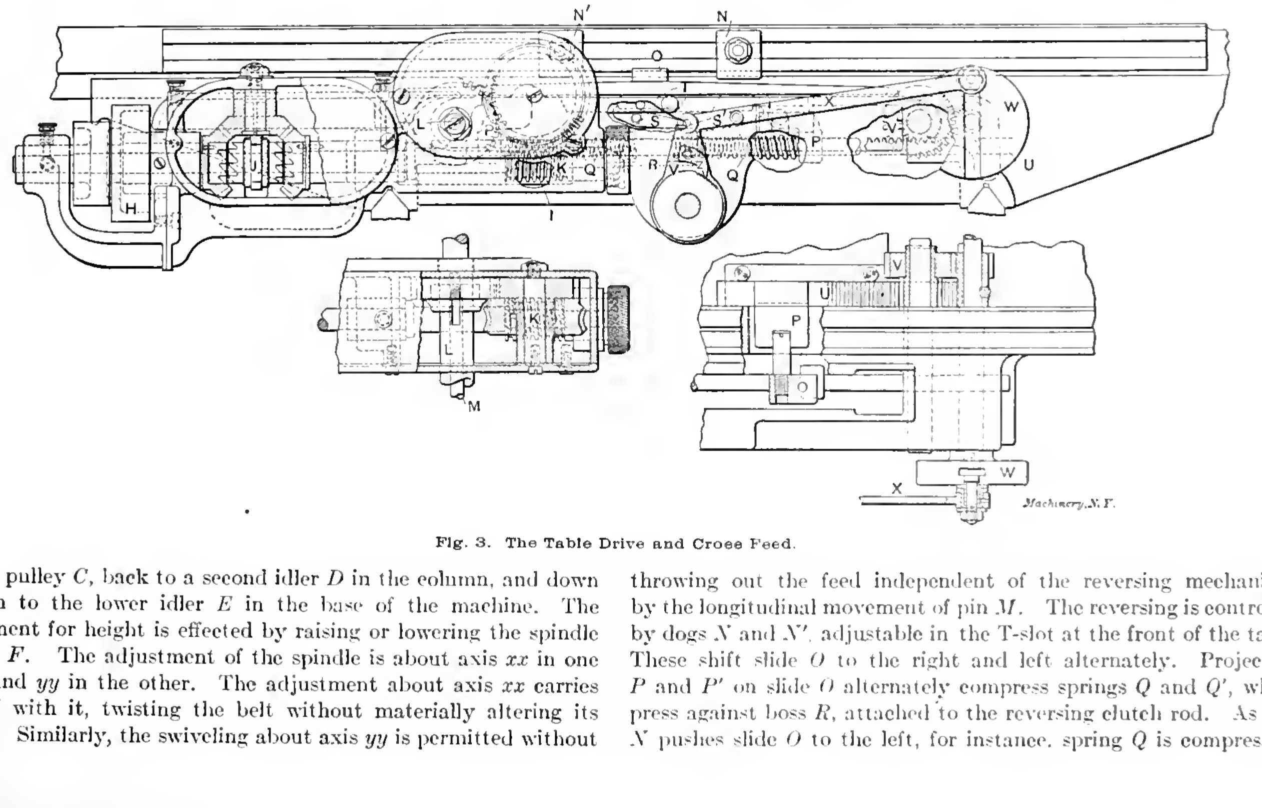


Fig. 3. The Table Drive and Cross Feed.

but R is prevented from operating the clutch rod under the pressure of the spring, by latch S. This latch is finally released by a cam T on slide O, which allows the spring to suddenly reverse the clutch. For reversing at the right of the stroke, dog N' moves slide O to the right, causing projection P' to compress spring Q'. When it has been compressed sufficiently, T raises latch S' allowing the clutch rod to be thrown over in the other direction, again reversing the mechanism. This arrangement, which is similar to others used for the same purpose, avoids the possibility of stopping on the center.

The automatic cross feed is operated by slide U, which is connected so as to reciprocate with slide O under the influence of dogs N and N'. U has rack teeth cut on its upper surface, engaging with the compound idler gear V. This, in turn, imparts at each reversal a half revolution to slotted crank disk W. The crank-pin adjustably mounted on this disk operates connecting rod X, which thus gives a back and forth angular movement to a bell crank which, in turn, by means of pawl Z, gives a ratchet feed to the cross-feed screw at each reversal of the stroke. The amount of the feed is regulated by the position of the crank-pin in the slot on the face of crank W. For reversing the feed, a similar ratchet to the one shown is mounted behind the bell-crank; it, however, has teeth pointed in the opposite direction. When one pawl is thrown in, the other is out, and *vice versa*.

In this new design, the best features of the previous machines have been retained. The overhead works is of the multiple speed type, with no step-down of the revolutions per minute, and providing for a wide range of adjustments between the maximum and minimum. The machine is furnished, as shown, completely equipped for cutter grinding, or for cylindrical and surface grinding, thus making it especially useful for tool-room work.

DIRECT BELTED GRINDER WITH SELF-OILING LOOSE PULLEY.

The Artisans Guild, Benton Harbor, Mich., is building the direct drive grinder shown herewith. The spindle of this grinder is provided with tight and loose pulleys, so as to make a countershaft unnecessary. As may be seen, the column is of rigid construction with long bearings and a heavy spindle, adapting the machine to the severe service that is likely to be required of it.

The principal novelty in the construction of this machine is the loose pulley. This pulley is self-oiling, and has a reservoir for lubrication, which requires refilling not oftener than five or six times a year. Its construction will be understood from Fig. 2, which shows a sectional view through the hub and oil reservoir. This journal, it will be seen, is ring-oiled, but on a different principle from the usual form, since the bushing is the revolving part, while the shaft remains stationary. The ring is of such diameter as to ride on the bottom of the revolving oil chamber, and almost touch the top of the stationary shaft. As the pulley revolves, it thus rotates the ring, which carries the oil up to the top of the shaft, from which it finds its way into the bearings on either side. After working its way through the bearings to the outer ends of the hubs of the pulleys, it is collected in an annular groove, and returned by centrifugal force through the ducts shown back to the central reservoir again.

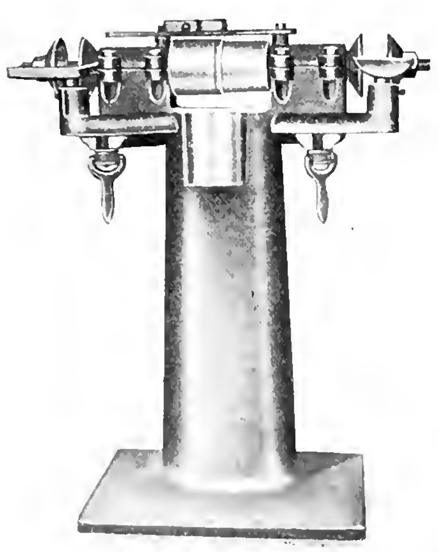


Fig 1 Grinding Stand made by the Artisans Guild.

This oiling arrangement may also be furnished in the form of a self-oiling bushing, to be applied to loose pulleys already in use.

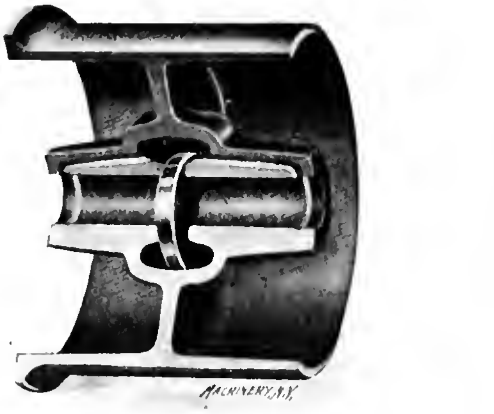


Fig. 2. Ring-oiling Loose Pulley used on the Spindle of the Grinder.

In either form, one of its chief merits is its inexpensiveness as compared with other devices designed for the same purpose. The parts are few and easily made, and the device is automatic in its action, only requiring filling the oil-well at intervals of two months or thereabouts.

CUTLER-HAMMER HAND LIFTING MAGNET.

A novel electrical appliance has just been placed on the market by the Cutler-Hammer Clutch Co., of Milwaukee, Wis., whose large lifting magnets are widely used in the iron and steel industries for handling pig iron, scrap, etc. The new device is a hand magnet weighing only about 7 pounds, but capable of lifting castings of from ten to fifteen times its own weight. The magnet is designed for operation on 110 volt, direct current circuits, and is furnished with a drop cord and attachment plug, so that it may be readily connected to any ordinary lamp socket. The push-button, mounted on top of the magnet and operated by the thumb, closes the circuit to the coils and makes the magnet operative. On releasing the button the poles become demagnetized and the load is released.

Fig. 1. A Hand Lifting Magnet.

Fig. 2. Handling Long Nails.

The first of these little magnets was built for use in the manufacturer's own shop, where it proved so useful and attracted so much attention from visitors that it was decided to manufacture it in quantities for the market. It seems to be capable of many useful applications. In machine shops it is used for clearing chips and borings out of the machinery, or removing them from parts of the work not easily accessible—as for instance from the bottom of a deep cylindrical casting. Dropped tools, bolts, boring bars, etc., are easily recovered with the aid of the magnet from places from which it would be difficult to fish them by ordinary means.

In shops where large quantities of brass and iron filings accumulate, which it is desirable to separate before selling as waste

material, the magnet is especially useful, since brass is not attracted by the magnet, like iron, thus enabling the two metals to be separated by merely passing the magnet through the mixed metals. In the same manner tacks or nails can be separated instantly from brass screws with which they may have become accidentally mixed. In foundries this magnet may be used to pick up hot or awkwardly shaped castings; smooth plates, which are sometimes difficult to secure a hold on when laying on a flat surface; or for cleansing the molding sand of minute particles of metal.

Suspended with its two poles immersed in the liquid, the magnet will attract to itself any particles of iron or steel which it may be desired to remove from the tubs in which paints, glazes, chemicals, etc., are mixed. One purchaser, who uses several automobile trucks in his business, has put this magnet to a novel use. He is paving an alley in the rear of his store with ashes, and finding that many nails from packing boxes, burned under the boilers, were mixed with the ashes, he is now guarding against punctured tires by employing a magnet to remove the nails from the ashes before strewing them in the alley. In the shipping departments of large establishments many hundreds of nails are recovered daily by hand from the sweeping. For work of this sort, or for handling nails, nuts, screws, etc., in hardware stores, this little magnet should prove useful.

HIGH-DUTY SIX-FOOT SURFACING GRINDER.

In the manufacture of its regular product, the O. K. Tool Holder Co., of Shelton, Conn., has to do a quantity of surfacing on metal parts of various kinds, much of the work being hardened steel. Various methods of doing this surfacing were tried, among others, finishing the parts on the commercial disk grinder. This was not altogether satisfactory in this particular instance, as the emery disks were quickly rubbed smooth, and much time and expense was involved in keeping the wheels supplied with new surfaces. The final solution of the problem of doing this work is shown in concrete form in Figs. 1 to 3, which illustrate a large steel wheel with narrow segmental faces of abrasive. This wheel has proved so efficient from the standpoints of output and cost of upkeep, that its maker has decided to place it on the market.

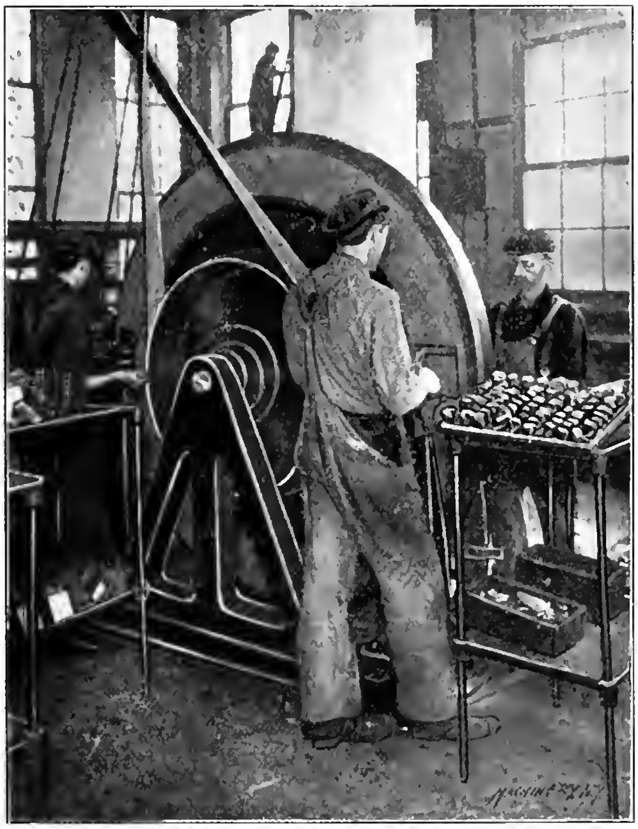


Fig. 1. A Face Grinding Wheel of Unusual Size.

The disk is of solid steel, and runs on Timken roller bearings, which are carefully protected from grit, and can be renewed at a slight expense. The driving pulley is 36 inches in diameter for a 6-inch belt; it should drive the wheel at about 250 revolutions per minute. The spindle is mounted on rigid frames and base. Four swinging work tables, similar to those used on the regular disk grinder are provided, so that four men can work simultaneously, as in Figs. 1 and 3. These work tables are pivoted at the base of the machine.

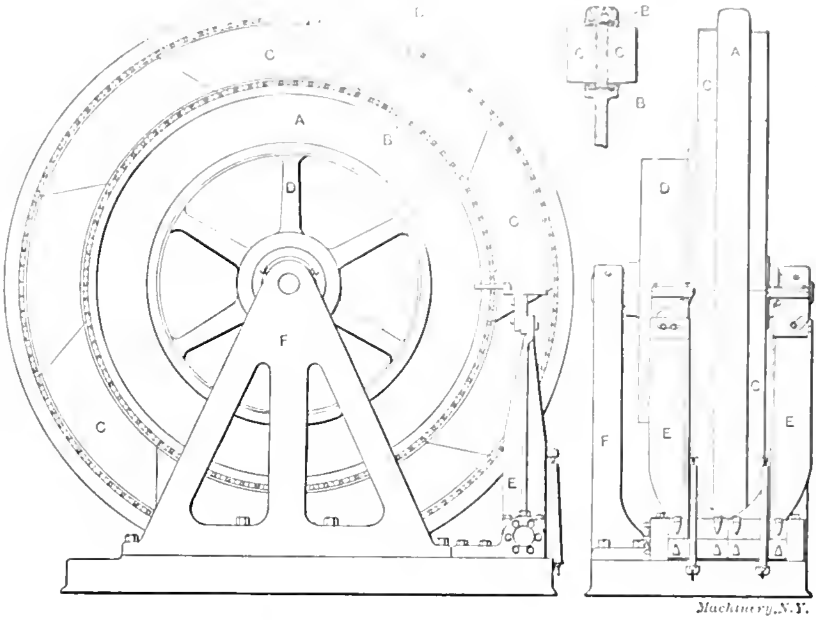


Fig. 2. Construction of the Grinder.

On each face of the rim of the disk is machined a wide, shallow groove, in which segments of abrasive material are set. There are nine segments on each face, each 8 inches wide and 4 inches thick. Before mounting in place, the backs of the segments are carefully surfaced, so that there is no danger of cracking them when they are being clamped into place. They are held by a series of small wedges, which grip the beveled edges of the abrasive, and draw it down firmly into place. To prevent the crumbling of the brittle material when clamping, thin strips of sheet lead are laid between

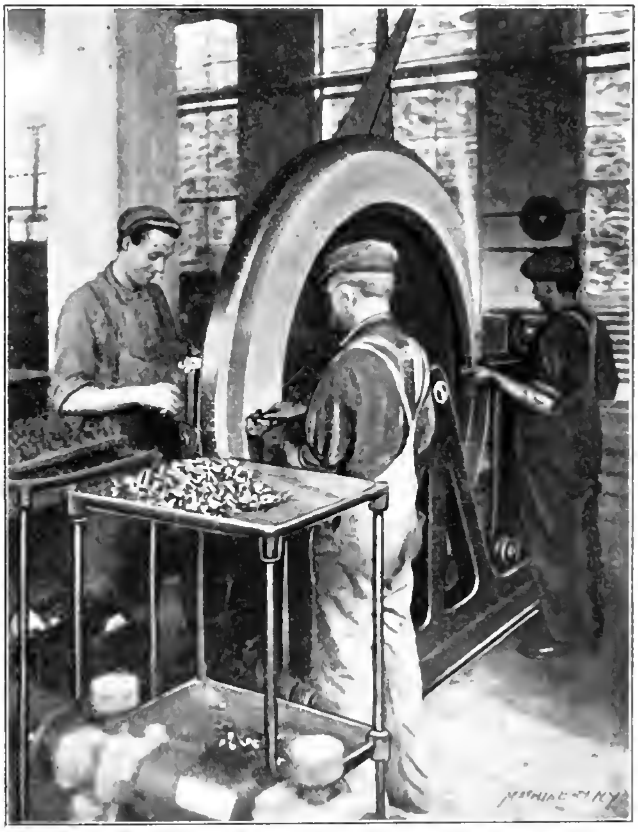


Fig. 3. Four Men at Work—the Usual Complement of Operators.

the wedges and the segments. To obviate the remote possibility of the work's catching in the joints between the segments, these joints are not made radial, but at a considerable angle, as shown. The method of fastening will be seen to be absolutely safe, as the only possibility of failure is by shearing, and that is highly improbable at any speed which is safe for the solid steel disk.

When the blocks become worn, from 4 inches thick down to $1\frac{1}{2}$ inch, they are packed out by placing wooden strips behind them, after which they may be used down to $\frac{1}{2}$ inch thick, thus wasting but $12\frac{1}{2}$ per cent of the material.

The builders make the interesting statement that they are able to grind on this machine three times as fast as on a wheel of the same grain and grade, running at the same peripheral velocity, but of one third the diameter. Two reasons are advanced for this increase of output. For one thing, the velocity of the abrasive is practically constant throughout the whole width of the 8-inch face, while on the face of the smaller wheel, the speed of the effective face varies from the maximum down to one half or one third of that amount, as the center is approached. This limits the efficiency.

Another point in favor of this 6-foot wheel is its enormous power storage capacity. Momentary pressure, which would slow up a smaller wheel, has not noticeable effect on the speed of this one. All four operators may force their work on the wheel simultaneously, but the stored-up energy carries the wheel around with no perceptible decrease in velocity; in other words the percentage of speed variation is very low.

THREAD MILLING ATTACHMENT FOR "CATARACT" BENCH LATHE.

In Figs. 1 and 2 a thread or worm milling attachment is shown applied to the "Cataract" precision bench lathe, manufactured by Hardinge Bros., 1031-1040 Lincoln Ave., Chicago, Ill. The special mechanism comprises a worm drive for the main spindle and a milling cutter spindle and bracket mounted on the tool-slide. The regular threading attachment is employed. Fig. 1 shows the front side of the machine thus equipped, and Fig. 2 the rear.

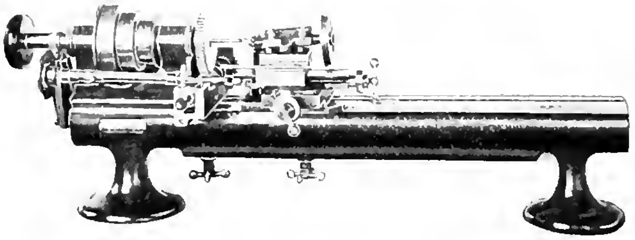


Fig. 1. Thread Milling Attachment used on Precision Lathe built by Hardinge Bros.

To the T-slot in the back of the bed is bolted a support for a supplementary driving-shaft with a cone mounted on it, identical with the regular spindle cone on the machine. This is driven from the same counter-shaft pulley used for driving the main spindle. The driving shaft is connected by bevel gears with a worm, which in turn drives a worm-wheel mounted in place of the face-plate on the nose of the spindle. This wheel is connected with the spindle by an arrangement which makes it possible to drive it in either direction without unscrewing from the nose. On the tool-slide is mounted a bracket carrying a cutter spindle. This spindle is held by the block at the required threading angle for the particular job in hand, and is driven from a separate pulley on the front shaft. The regular threading attachment, as mentioned, is used for connecting the main spindle with the tool-rest to give the desired pitch of thread. This attachment is applied to the upper screw of the compound rest, which is set parallel with the axis of the lathe for this purpose. When the required length of thread has been milled, an adjustable stop on the rest strikes a trip which allows the worm to drop out of mesh with the worm-gear on the spindle, thus stopping the machine.

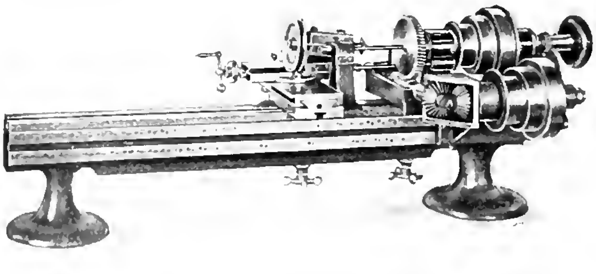


Fig. 2. Spindle Drive for Thread Milling Attachment.

Fig 1. The Stromberg Chronograph or Electrically-controlled Time Stamp.

This attachment has been found of great service in manufacturing work on such parts as are required for electric meters, anemometers, small taps, etc. The cutter spindle may be used interchangeably with brackets of various angles for threads of various pitches and diameters.

STROMBERG ELECTRIC CHRONOGRAPH.

The use of time stamps in shop accounting and other systems, is not a new idea. So far as we know, however, the Stromberg Electric Mfg. Co., 23 South Jefferson St., Chicago, Ill., is the first one to apply the time stamp to such work without using a clock in the instrument itself. In this new electric "chronograph," as its makers call it, the dies which stamp the time are controlled from a master clock which may be located anywhere in the establishment, and may be used to control synchronously any number of stamps. This insures uniformity of records throughout the establishment; reliability of operation is assured, since there is only one clock to look out for, and that may be of the highest grade; there also results a simplicity in construction of the stamps themselves. It is not necessary to buy a special clock as the proper connections may be applied to any existing time-piece.

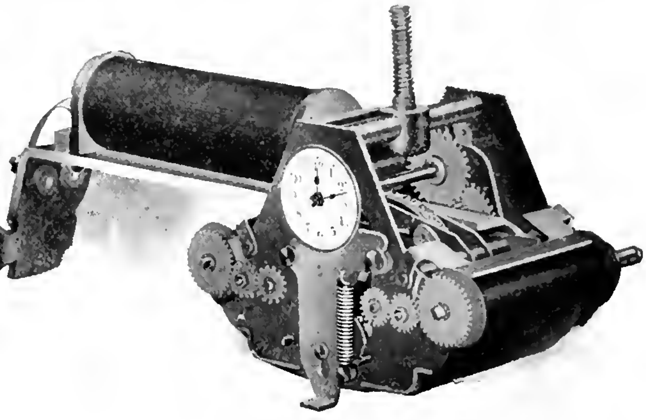


Fig. 2. Interior Mechanism of the Chronograph.

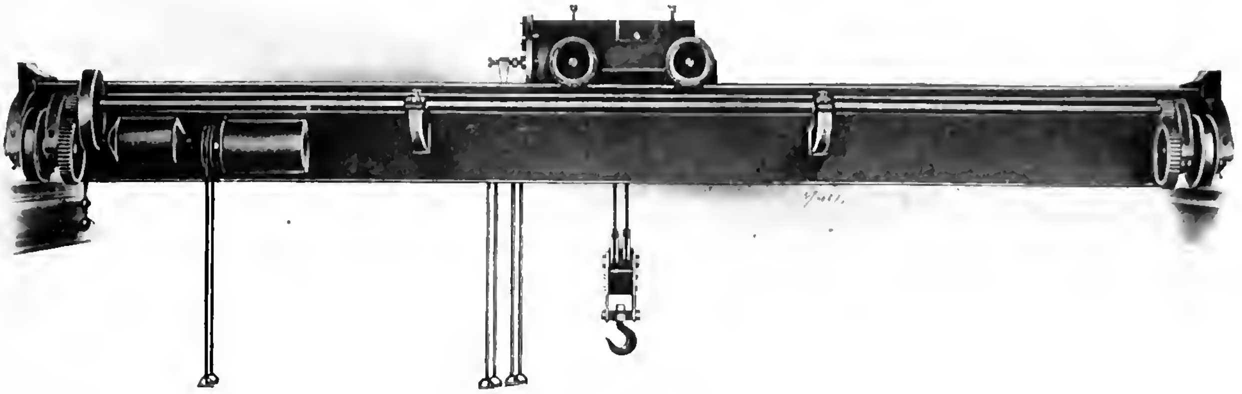
This chronograph is furnished as a plain time stamp for general use, or with such gaging and locating devices or special stamping dies as may be required for special uses. For time card stamping, for instance, gages are provided for locating the records in proper columns and on the proper lines for weekly or monthly records of employes' time. The only change in the device necessary is that of setting the gage from day to day.

This instrument prints right side up. It is provided with an automatic reversing ribbon feed which will give 150,000 impressions without a change of ribbon. The printing wheels and the hands at the side of the dial are moved by a simple magnetic action controlled by an automatic make and break device attached to

the clock. This stamp can stand hard usage without affecting its accuracy, which would not be possible if a delicate clock movement were contained within it. The chronograph mechanism contains no pawls, springs or dogs. It has a positive action and locked printing wheels, which can not be moved except by the interior magnetic mechanism, making it impossible for employes to tamper with it. The instrument requires only a monthly setting.

NORTHERN FLOOR-CONTROLLED ELECTRIC TRAVELING CRANE.

We illustrate herewith a small floor-controlled electric traveling crane built by the Northern Engineering Works, Detroit, Mich. This crane, which can be furnished in either the 1-, 2-, or 3-motor design, is adapted to loads of from 1 to 5 tons, and spans ranging from 12 to 40 feet. As regularly made, it consists of a double-girder bridge upon which rests a trolley, supporting an electric hoist of a type furnished by the makers. Any standard motor will be furnished, however, for either direct or alternating current.


Northern Floor-controlled Electric Traveling Crane.

The trolley is so arranged that it may be operated in either high, medium or low positions, thus adapting it to any height ceiling or any established distance from rail to truss cord. The hoist is equipped with both mechanical and electric brakes, and has an automatic limit stop for the block to prevent overwinding. The mechanical brake not only assists in holding the load but effectually controls the lowering operation as well. The automatic limit stop is operated by positive contact and does not depend on the hoisting ropes for its operation. The hoisting gearing is of the spur geared type, no bevel worm or planetary gearing being included in the crane. It is entirely enclosed in an oil-tight case.

The controllers have ample resistance for giving a wide range of speed, thus making the crane well suited to delicate handling such as is necessary over foundry floors, and in riveting work, etc. While it is regularly furnished to be controlled from the floor by ropes or levers, it can be arranged, if desired, to be controlled either from a cab attached to the bridge, or from a fixed operating stand on the floor.

TEMPERED, POLISHED AND BLUED STRIP STEEL.

The illustration shows a roll of interesting product, for which Edgar T. Ward & Sons, 23-25 Purchase St., Boston, Mass., are the American agents. It is a roll of 2-inch by 0.002-inch tempered, polished and blued strip steel, true to gage, and suitable for making fine springs and other parts of machinery for which a tempered stock is required. Many other uses for thin metal of this order will be found in the manufacture of small machinery. The company carries in stock 180 sizes ranging in thickness from 0.0015 inch to 1/16 inch, and in widths from 1/8 to 6 inches.

The company also sells approximately the same assortment of cold rolled steel not tempered, but of a carbon content capable of taking a high temper. This metal is suitable for formed springs, machine parts, circular cutters, saws, etc. Another grade of thin metal of lower carbon is supplied in rolls which will not harden.


Tempered, Polished and Blued Strip Steel.

SCREW CUTTING ATTACHMENT FOR ELGIN PRECISION LATHE.

The device shown in the accompanying engravings, built by the Elgin Tool Works of Elgin, Ill., for cutting threads with its precision lathe, is of the design which gives the greatest simplicity and directness of construction. It consists of a set of change gears mounted on a sector at the rear end of the bed, and connected with the feed-screw of the compound rest by universal joints and a telescopic shaft. No special lead-screw is required.

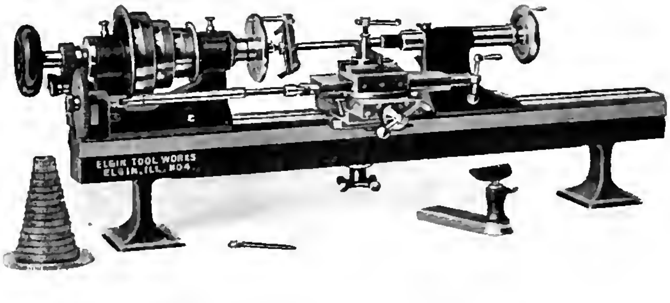


Fig. 1. Screw Cutting Attachment operating on the Feed-screw of the Compound Rest.

The sector is clamped to the lathe bed by a T-bolt. It carries the necessary studs for the change gears, which mesh with a driving pinion mounted directly on the spindle. The change gears provided cut English or metric threads as required. The range of English threads is from 10 to 150 per inch. The upper slide of the compound rest is made of extra length, permitting the cutting of long threads. So long as this lead-screw is set parallel with the ways of the lathe, which it has to be to cut a straight thread,

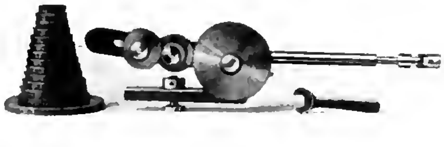


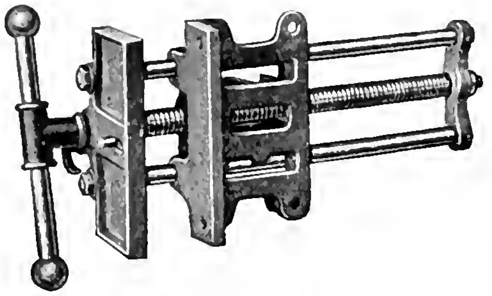
Fig. 2 Elgin Screw cutting Attachment Dismantled, showing its Simplicity.

the simple universal joint connection provided will give it a rotation uniform with the spindle.

Fig. 2 shows the parts of this attachment disassembled, and illustrates the extreme simplicity of its construction.

YOST QUICK-ACTING MANUAL TRAINING VISE.

The G. M. Yost Mfg. Co., Meadville, Pa., has recently devised the quick acting vise shown in the accompanying illustration. It is particularly adapted to the needs of manual training schools or other wood working plants, where a quick acting vise at a reasonable cost is required. This vise is of the combination type, since it can be used either as a regular screw vise or with the quick acting feature. It is unnecessary to reverse the handle in releasing the quick acting movement. It is very simple in construction, having only eight parts in all. The vise is made with either wood or leather face jaws as required. It can be furnished also with a taper attachment to the front jaw, permitting tapered or irregular work to be clamped securely. The rods are of cold drawn steel, and the screw is of high grade tool steel; the jaws are gray iron castings. It is made in eight different sizes, with jaws up to 10 inches long and 4 inches deep.



A Simple and Inexpensive Quick-acting Vise for Wood-working.

* * *

NEW MACHINERY AND TOOLS NOTES.

Screw-Driver: Elmore Tool Mfg. Co., Hartford, Conn. This screw-driver is drop-forged in one piece with the handle, which has wooden grips rivetted to it, jack-knife fashion. The shank is square so that a wrench may be used with it if required.

"Gravity" Level for Machine Shop and Tool-Room Use: Risdon Tool Works, Inc., Waterbury, Conn. This level is of the type in which a pointer, moving over a graduated dial, is connected with a hanging weight in such a way that a slight movement of the latter gives a multiplied movement to the pointer.

Light, Rapid Action Punch: Rock River Machine Co., Janesville, Wis. This tool is intended for light steel punching, in plate up to ⅜-inch in diameter. It may be also fitted for shearing arrangements for bar or round iron and for angles. It will shear angles up to 2 x 2 x ⅛ inch. The frame and the floor standard are cast in one piece.

Universal Cam Cutting Machine: Kearney & Trecker Co., Milwaukee, Wis. This is an adaptation of the builders' standard milling machine; it is provided with a special table and work feeding and controlling apparatus, which fits it for the cutting of either face or pheriphery cams. Like all machines of its kind, a form or master cam is employed for giving the desired shape to the work.

Power Press With Automatic Feeding Mechanism: V. & O. Press Co., Glendale, L. I. This firm has recently brought out a line of inclinable power presses for automatic production of parts in sheet metal, fiber, etc. A recent equipment includes all the machinery necessary for making an improved four-part, metal bottle cap.

Cold Bend Testing Machine: Messrs. Tinius Olsen & Co., Philadelphia, Pa. This machine is used for the "cold bend" testing of specimens of iron and steel. The machine is provided with an electric motor of such power that specimens up to 1 inch square or its equivalent may be bent cold in about three minutes to an angle of 180 degrees. Bending dies for stock of any size up to 2 inches may be used; the smaller dies are reinforced to withstand the bending pressure.

"Rochester" Helve Hammer: West Tire Setter Co., Rochester, N. Y. This Helve hammer is of the type which employs a wooden beam with the pivot at one end, and the upper die or hammer head at the other. It is reciprocated by a crank and connecting-rod, attached to the beam by a flexible spring connection. A handle within convenient reach of the operator makes provision for altering the length of stroke.

The Woggle Punching Table: Standard Bridge Tool Co., Pittsburg, Pa. The punching table combines a swinging support for holding the work and presenting any portion of it to the punch, with a combined indicator and stripper, which serves to locate the work with reference to a paper or sheet metal templet.

Set of Tool Makers Scrapers: J. E. Poorman, 1722 St. Paul St., Philadelphia, Pa. This set of three scrapers for tool makers use is provided with handles of knurled steel tubing, and has blades of high grade steel, tempered, ground and polished. Three shapes are provided. One is triangular, hollow ground on all sides; one is rounded and curved, and the third one flat, for plain surface scraping.

Rapid Action Automatic Vise: Quick Automatic Vise Co., 236 Mill St., Rochester, N. Y. In this quick acting vise the jaws are adjusted in the usual way to suit the work. The first piece being clamped in this way, the vise may then be opened and closed for succeeding pieces of the same size by the action of the operator's foot on a pedal. On lifting the foot from the pedal the jaws close as firmly as before. It should prove an efficient tool in manufacturing bench work.

Improved Friction Clutch: Messrs. A. L. Schultz & Son, Chicago, Ill. This clutch is made in sizes from 6 inches up to 72 inches in diameter, transmitting from 3 to 500 H. P. at 100 revolutions per minute. It may be used as a clutch coupling to connect two shafts of the same or different diameters, or it may be attached to pulleys, gears, etc. It operates by the clamping of an internal flange on the driving member between two radial wood-faced surfaces on the driven member. The pressure is applied by a toggle mechanism.

Bench Legs: Frederick Pearce Co., New York City. These bench legs are designed for machine shop or laboratory use. They are particularly rigid when used as center benches, away from the walls. The frame is designed to hold two shelves, the upper one for files or tools, the lower one for boxes of stock, work, etc. The leg is 2 feet 10 inches high, and 24 inches across the top. It weighs 52 pounds. The makers are prepared to furnish these bench legs in either cast iron or in a non-magnetic alloy for laboratory use, where iron would be objectionable.

Motor Driven Speed Lathe: J. G. Blount Co., Everett, Mass. This tool is intended particularly for manual training schools. The motor, which is of the constant speed type, is mounted under the leg at the head stock end of the machine, and carries a cone pulley on the armature spindle, which is belted to the spindle cone above; the spindle is carried by a head stock of a shape which permits this arrangement of belting. The spindle runs in ring oiling bearings.

High Speed Steel Cutting-Off Machine: Colton Combination Tool Co., Easthampton, Mass. This machine employs a thin abrasive wheel of carborundum, running at 2,500 revolutions per minute. This is employed for cutting steel into sections for use in tool holders. It has the special advantage of doing this with a minimum of waste, and without starting the minute fractures which are caused from nicking and breaking the bars, and which result in the cracking of the cutting edges in use.

Self-Adjusting, Friction Sensitive Drill: Barry & Zecher Co., Lancaster, Pa. This drill press provides a friction disk drive mechanism in which the pressure is constantly maintained at the proper point. The feed change and the starting and stopping of the machine are both controlled by foot levers, so that the operators hands are free. The machine is started and stopped by lowering and raising the friction disk so that no counter-shaft is necessary. The machine will be furnished with either standard or right angle drive.

Light Riveting Machine: H. B. Townsend Mfg. Co., 32 Union Pl., Hartford. Conn. In this riveting machine the rivet is struck a large number of rapid blows per minute. The head of the spindle lies in a path of a series of rolls, loosely carried on pins in the face of a rapidly rotating disk. These rolls act as hammers, in striking the riveting die on the work, as the latter is raised into contact with it by pressing a treadle on the base of the machine.

BORING JIGS USED BY THE QUEEN CITY MACHINE TOOL CO.

In the present issue of MACHINERY, Mr. Einar Morin shows several interesting designs of boring jigs in his article entitled, Jigs and Fixtures. The two accompanying illustrations, Figs. 1 and 2, are of special interest in this connection, showing as they do, two boring jigs in operation, and illustrating the very features which have been brought out in the articles on the principles of jigs and fixtures. These two boring jigs are employed in the manufacture of shapers in the shops of the Queen City Machine Tool Co. (Station V), Cincinnati, Ohio. The illustration, Fig. 1, shows a boring jig for shaper columns. By means of this jig it is possible to get all the holes through the column in perfect alignment, and to provide for interchangeability. The jig is of the full box pattern, both ends of the boring bars being supported in the jig. The boring bars are connected with the driving spindle of the machine by universal or knuckle joints; two cuts are taken, the roughing cut leaving but a thin film of metal to be removed by the finishing cut.

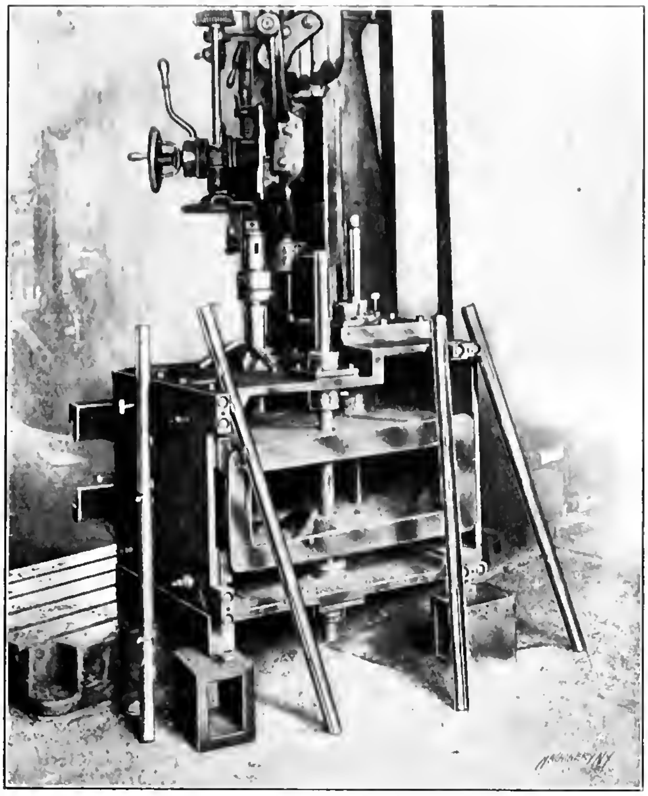


Fig. 1. Boring Jig for Shaper Columns.

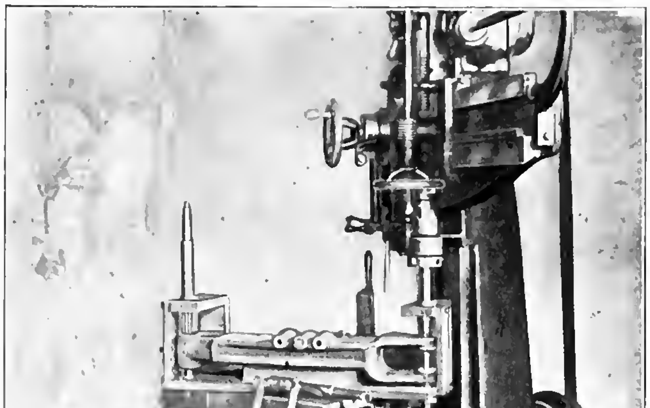


Fig. 2. Boring Jig for Boring and Reaming Holes in Rocker Arm.

In Fig. 2 is shown a boring fixture for boring and reaming the top and bottom holes in a rocker arm. These must be carefully bored at right angles to the sliding block bearing. It will be seen from the illustration that the rocker when finish planed is located on a projection of the jig, which is carefully planed at right angles to the guide holes for the boring bars. By this means it is possible to obtain bearings in the arm which are in proper relation to the sliding surface.

It is of great importance in the manufacture of these parts of the shaper, that the tools and fixtures employed fill the requirements for high-grade work, as otherwise twisting strains will be produced in the finished shaper, which are liable not only to injure the machine itself, but to cause inaccuracies in the work being performed on the machine. The influence of rigidity on the efficiency of a machine was ably demonstrated by the interesting experiments on the milling machine, undertaken by Mr. A. L. De Leeuw, and described in a paper read before the last annual meeting of the American Society of Mechanical Engineers, which paper was abstracted in the December issue of MACHINERY (engineering edition). These experiments were undertaken on a milling machine, but the necessity for rigidity, is, if anything, even greater on a shaper. There are so many joints, so much over-hang, so many parts subjected to twisting stresses that it is absolutely necessary in the machining of shapers, to use jigs and fixtures which will insure accurate work and perfect alignment, if the best results are to be obtained.

* * *

PERSONAL.

William Lonsdale, formerly assistant superintendent of the Knox Auto Co., assumed the superintendency of the same concern on January 1.

Frank S. Waters, president of the Lyon Metallic Mfg. Co., Aurora, Ill., maker of steel racks and factory equipment, has been spending a few weeks in Texas and Cuba, recuperating.

George H. Baush, sales manager of Hill, Clarke & Co., Inc., Philadelphia, Pa., has resigned his position, to take effect February 1, and will go with the Fay Machine Tool Co. of Philadelphia as general sales manager.

Augustus Brown, for the past six years superintendent of the Monarch Emery & Corundum Wheel Co., Camden, N. J., is now assistant superintendent of the American Emery Wheel Works, Providence, R. I.

Harry H. Mason, recently promoted from machine foreman to apprentice instructor in the A. T. & S. F. Ry. shops, has again been promoted to the position of bonus demonstrator, on the Middle and Oklahoma Divisions, with headquarters at Newton, Kansas.

* * *

OBITUARY.

George W. Shotwell, president of the Diehl Electrical Mfg. Co., Elizabethport, N. J., died at his home in Bayonne, N. J., January 22.

Prof. Benjamin Franklin Clarke, Professor Emeritus of mechanical engineering at Brown University, died December 29 of pneumonia at his home in Providence, R. I. Prof. Clarke was born in Newport, Me., in 1831, and since his graduation from Brown University in 1863 had been connected with the faculty. He was twice acting president of the university.

Henry Wallace Caldwell, president of H. W. Caldwell & Son Company, Chicago, Ill., died December 22 at Redlands, Cal. He was born in Kentucky in 1843. After creditable service in the civil war, he engaged in business in Indianapolis and later in St. Louis, becoming particularly interested in grain elevator management. This led to the invention of the Caldwell conveyor and the business of designing and erecting elevators. He later moved to Chicago, where he devoted his entire attention to the making of screw conveyors and other machinery for the conveying and elevating of materials and the transmission of power.

CHARLES H. BESLY.

Charles Howard Besly, head of the firm of C. H. Besly & Co. of Chicago, died at the Henrotin Memorial Hospital in that city December 31 from the effects of an operation. Mr. Besly was born in Milwaukee in 1852, educated in the Chicago public schools, and began his business experience with Marshall Field & Co. Afterwards he went with S. D. Kimbark & Co., and later with the predecessors of Crerar, Adams & Co. In 1873 he became manager of the Bergen Tool Co., Batavia, Ill., and in 1875 started in for himself as a broker in machinists' supplies. The firm of C. H. Besly & Co. was established in 1881, and comprised Mr. C. H. Besly and Mr. David J. Kennedy, being located at 175 Lake St. In 1886 Mr. Kennedy retired from the business and since that time Mr. Besly has been the sole owner. In 1891 he removed to 10-12 North Canal St., continuing there until he built the present building in 1903, at 15–21 South Clinton St.

In 1886 the Beloit factory was established in a small way for the manufacture of die-stocks, and was gradually increased for the production of various specialties, including the Besly disk grinders, "Helmet" temper taps, etc. This branch of the business grew as rapidly as the merchandise end and necessitated the erection of new and extensive buildings in 1905. Mr. Besly also owned the business of Brown & Besly, established in 1884, for the manufacture of letter files, filing cabinets, etc. This business has increased in like proportions with the others and now occupies a building of its own at 139 Besly Court, Chicago.

Mr. Besly was a graduate in chemistry of the Rush Medical College of Chicago, and also spent a year in a mechanical school in London. He was a member of many societies and clubs, including the American Geographical Society of New York, and the Engineers and Machinery Clubs of the same city; the National Machine Tool Builders' Association, and the Union League and Athletic Clubs of Chicago.

Mr. Besly was first married in 1884 to Minnie Zilpha Welles, who died in 1893, leaving one daughter. In 1894 he married Kathleen M. Healy, daughter of G. P. A. Healy, the celebrated portrait painter. Mrs. Besly, with the eldest daughter and three younger daughters survive him

Mr. Besly was widely known among Chicago business men and to the machinery trade all over the country. While he was a shrewd and successful business man, he gave liberally and unostentatiously where his sympathies were enlisted, and when he thought his help would be of practical benefit. He was an unusually well-read man, and his keen observation enabled him to present his knowledge in an attractive way which is not often found with men who so closely apply themselves to business. These traits and his jovial disposition made him many warm friends to whom his death was a heavy loss.

Mr. Besly's large interests were left in a strong financial and physical condition, and will be continued as heretofore under the general management of Mr. Edward P. Welles, his nephew, who has been connected with the firm of C. H. Besly & Co. for the past twenty-two years, and as general manager since 1896.

* * *

Next to gold, silver is the most malleable and ductile metal. It may be hammered into foil 0.0001 inch in thickness, and a single grain can be drawn into wire over 400 feet long.—*Brass World.*

HILL, CLARKE & CO.'S "FAMILY PARTY."

The "family party" given annually by Hill, Clarke & Co. of Chicago to the manufacturers they represent and to their organization in the West, took place on January 11th at De Jonghe's restaurant in Chicago. There was everything one could think of to eat and drink, speechifying and music—and no casualties. Those present were: Mr. Bosch of the Western Tool Works, Holland, Mich.; Mr. J. N. LaPointe of the LaPointe Machine Tool Co., Hudson, Mass.; Mr. Ralph LaPointe of the Universal Boring Machine Co., Hudson, Mass.; Mr. Wood of the Wood Turret Machine Co., Terre Haute, Ind.; Messrs. Adt and Case of the Geometric Tool Co., New Haven, Conn.; Mr. H. E. Flather of Flather & Co. and Mr. E. J. Flather of the E. J. Flather Mfg. Co., Nashua, N. H.; Messrs. Kearney and Trecker of the Kearney & Trecker Co., Milwaukee, Wis.; Mr. August Marx of the Gray Planer Co., Cincinnati, Ohio; Messrs. Sibley and Workinger of the Sibley Machine Tool Co., South Bend, Ind.; Mr. Thwing of the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.; Mr. Van Hyning of the Pignall & Keeler Mfg. Co., Edwardsville, Ill.; Mr. Carlton of the Consolidated Press & Tool Co., Hastings, Mich.; Mr. O'Brien of the South Bend Machine Tool Co., South Bend, Ind.; Messrs. Clarke, Wigglesworth, Mons, Ditfurth, Hale, Wendland, Kimball and Brandes of Hill, Clarke & Co., of Chicago, and Mr. Luchars of MACHINERY.

* * *

COMING EVENTS.

February 1-6—Second Annual Hartford Industrial Show of machinery, tools, accessories, supplies, etc., will be held in Foot Guard Hall, Hartford, Conn. R. B. Jacobs, general manager, Hartford Conn.

February 9.—First regular meeting of the National Gas and Gasoline Machine Trades Association at the Auditorium Hotel, Chicago, Ill.

March 27-April 3.—Mechanical and Electrical Exhibition, under the auspices of the Worcester County Mechanics Association, in Mechanics Hall, Worcester Mass. The exhibition will include machinery in operation manufacturing goods, and is under the direction of Mr. H. F Campbell, superintendent, room 6, Mechanics Hall, Worcester.

May 18-20. American Foundrymens' Association convention. Cincinnati, Ohio, Hotel Sinton, headquarters. Richard Moldenke, sec'y, Watchung. N. J.

June 16-18.—Annual convention of Railway Master Mechanics Association on Young's Million Dollar Pier, Atlantic City N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 16-23.—An exhibition of machinery, tools and supplies for the railway supply trade will be held under the auspices of the Railway Supply Manufacturers Association. Membership dues in the association are $25.00 per year and carry one badge only. Additional badges may be obtained by members for $5.00 per badge. Contracts have been let for the erection of exhibition structures covering 59,000 square feet, exclusive of aisles. The charge to exhibitors will be 40 cents per square foot, to cover the cost of erection, etc. The association has prohibited the distribution of souvenirs. Application for space should be made immediately to Mr. Earl G. F. Smith, secretary, 345 Old Colony Building, Chicago, Ill.

June 21-23.—Annual convention of the Master Car Builders Association on Young's Million Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

NEW BOOKS AND PAMPHLETS.

COMPARATIVE TESTS OF RUN-OF-MINE AND BRIQUETTED COAL ON LOCOMOTIVES. By W. F. M. Goss. 57 pages, 6 x 9 inches. Published by the Department of Interior, United States Geological Survey, Washington, D. C., as Bulletin No. 363.

The report includes torpedo boat tests and some foreign specifications for briquetted fuel. The locomotive testing plant of the Pennsylvania R.R. at Altoona, Pa., was the scene of the locomotive tests made by Professor Goss; and the pamphlet is illustrated with halftone and line drawings showing the characteristic features of the plant. The results of the test will be studied with much interest by those interested in the fuel problem.

HANDBOOK OF SMALL TOOLS. By Erik Oberg. 526 pages, 5½ x 8 inches, 282 illustrations. Published by John Wiley & Sons, New York. Price $3.00.

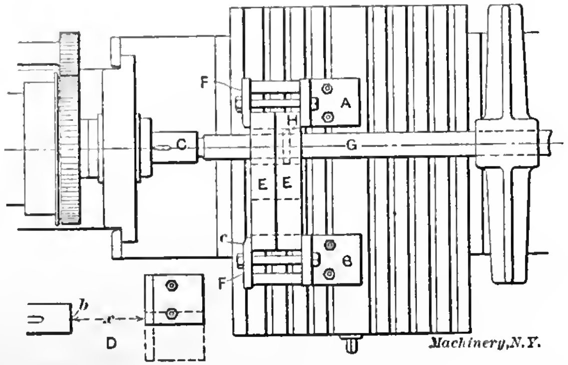
The advent of this work on threading tools, taps, dies, cutters, drills, reamers, counterbores, hollow mills and other accessories of the machine shop and metal-working trades emphasizes the specialization which marks American mechanical development, and the genius for classification that has made that development possible. The old-school mechanical engineer considered the details of small tools a matter scarcely worthy of his distinguished consideration, being something that could safely be left to the whims, vagaries, ideas—good, bad and indifferent—of the machinist, toolmaker and other mechanics using them. But the same human faculty that enables the scientist to classify all animal life, from bugs to elephants, placing each representative of type in its respective class, can be profitably employed to organize and classify every detail of manufacture. Nothing is too small or insignificant to be overlooked. The surprising fact is learned in such work, that the small things are the real factors that make for success or failure. The importance of small tools in the mechanical trades is expressed by a word—indispensable; the efficiency of production depends as much on them as on the machines and men. The author has treated his subject principally from the manufacturing point of view, giving the details of standard manufacturing practice in the matter of pitch lead, diameter, angles, rake, clearance, numbers of teeth, shape of flutes, sizes of squares, dimensions of shanks, taper per foot, and the thousand-and-one other details that are important in the manufacture of small tools. The book contains 134 tables of valuable data, most of which are for the first time published herein, or were originally published by the author in MACHINERY. The formulas for obtaining the dimensions of tools are largely of the author's own derivation. The following table of contents will give an idea of the scope and value of the work to manufacturers, tool-makers and others concerned with the making and maintenance of small tool equipment: Screw-thread systems; methods and principles of thread-cutting; measuring threads; threading tools; definitions of taps; hand taps; tapper taps and machine taps; screw machine taps; hobs and die taps; taper taps; miscellaneous taps; threading dies; plain and side milling cutters; miscellaneous milling cutters; reamers; drills; counterbores; hollow mills; lathe arbors. The work is not a treatise on tool-making practice, but rather a collection of data, elaborated and fully explained. It tells *what to do* rather than *how to do it.*

Supplement to MACHINERY, March, 1909.

Operations for the Article in this number entitled "Machine Shop Practice—Machining a Three-throw Built-up Crank-shaft."

SHOP OPERATION SHEET NO. 91.

W. Burns. MACHINERY, March, 1909.



Machining a Three-throw Built-up Crank-shaft—Boring the Webs.

NOTE.—As the crank-shaft is of the built-up type, the crank-pins and parts of the shaft proper are fitted into the webs after the latter are bored; therefore this operation, which will be performed on a horizontal boring mill, will be considered first.

1. First plane the webs on their sides to the finished width, and then lay them out as illustrated in Shop Operation Sheet No. 92. As the webs are to be machined in pairs, it will only be necessary to lay out three, or half the whole number.

2. Bolt angle-plates *A* and *B* to the table, spacing them far enough apart to clear the finished holes in the web, as shown. Move the table until one side of the plate *A* is opposite the spindle *C* as shown at *D*. Then caliper the distance *x* from a point *b*, say on the lower side of the spindle, to the plate. Move the table until the angle-plate is in the position indicated by the dotted lines, and, without moving the calipers, again measure the distance *x* from the same point *b* on the spindle. Adjust the angle-plate until the calipers just touch it on either side.

3. When angle-plate *A* is set, move the table across the bed until the plate *B* occupies the position shown at *D*; then, with the calipers set to the distance *x* last used when setting plate *A*, set plate *B*.

4. Place two webs *E* against the angle-plates, with the laid-out side of one next to the clamps *F*.

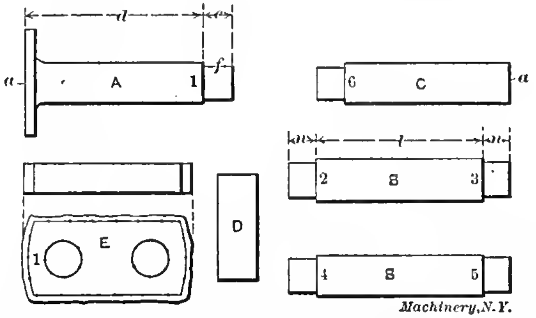
5. Set the circles representing the holes to be bored, the same height above the machine table, using the surface gage.

6. Start the holes, if the webs are solid, with a small drill, say ½ inch; then enlarge with a larger drill, say 2 inches. A short cutter bar with a cutter in the end may then be used to remove enough material to let the boring bar *G* pass through.

7. Set one of the scribed circles on the web concentric with the spindle *C*, using hermaphrodite calipers, and finish the hole with double-ended cutters *H*. Draw a line *c* across one side of the table to some point on the saddle. Move the table until the distance between the line on it and the line on the saddle, equals the center distance of the two holes to be bored. Then finish the second hole.

SHOP OPERATION SHEET NO. 92.

W. Burns. MACHINERY, March, 1909.



Machining a Three-throw Built-up Crank-shaft—Rough Turning the Parts.

NOTE.—The crank-shaft, as before stated, is of the built-up type, which means that instead of being a solid forging, it is made by machining the several parts and shrinking them together in proper relation with one another.

1. The parts *A*, *B*, and *C*, of the shaft proper, and the three pins *D*, are first centered, preferably in a centering machine. The end parts *A* and *C* should be provided with large centers at *a*, as the entire shaft will be supported upon these during the finish turning operation.

NOTE.—In order that the location, in the assembled shaft, of the parts shown in the illustration above may be understood, the reference letters, for a given part, in this and the succeeding illustration are the same.

2. Rough turn the parts *A*, *B*, and *C* to within about 3/16 inch of the finish diameter, and face the ends, leaving the forgings full length. These parts should be rough finished to the same size, as uniform diameters will aid in assembling the shaft.

3. Number the shaft holes of the webs from 1 to 6, using preferably small steel stamps; then number each piece *A*, *B*, *C*, as shown, on the rough bearing.

4. Finish the end (1) of the flanged part *A* as indicated by the finish mark *f*, making it a shrink fit in web number 1. When cutting the shoulder, set the tool a distance *d*, from the rough-turned face of the flange, equal to the dimension given on the drawing, plus one-half the difference between the thickness of the rough and finished flange. Face the end of the shaft until the distance *e* equals the thickness of crank web number 1.

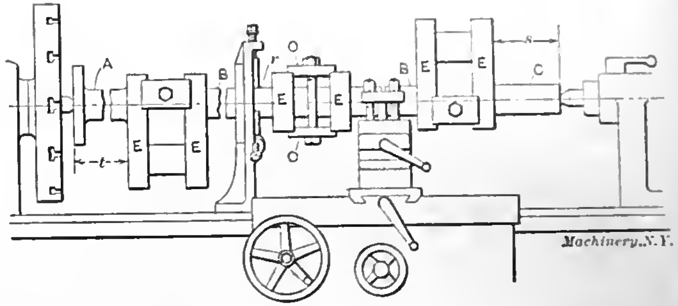
5. Turn the ends 2 and 3 of part *B* to a shrink fit in webs 2 and 3, respectively, making the bearing length *l* to correspond with the dimension on the drawing. Face the ends until the distance *n* equals the thickness of the respective webs. In a similar manner finish the second part *B* and the end piece *C*.

NOTE.—The numbers on the webs and the corresponding numbers on the shaft parts, enable the one who finally assembles the crank-shaft to place each end in the hole to which it was fitted.

6. Turn and fit the crank-pins *D* to shrink fits in the webs, numbering them as described for the main parts of the shaft.

SHOP OPERATION SHEET NO. 93

W. Burns. MACHINERY, March, 1909.



Machining a Three-throw Built-up Crank-shaft—Turning the Journals.

NOTE.—It is assumed that the edges of the webs have been machined (a simple slotting operation) and the parts shrunk together, with the shaft and pins properly keyed in position. As it would be impracticable to attempt to get the parts *A*, *B*, and *C* in perfect alignment when shrinking the shaft together, these pieces are rough turned and then finished after the shaft is assembled, as described in the following:

1. Fit packing pieces *O* between each pair of webs, as shown. These pieces are held in position by a bolt which passes through them, and their purpose is to prevent the springing of the shaft, which would occur were it placed between the lathe centers with no supports between the webs.

NOTE.—The distance between each pair of webs should be measured with an inside micrometer gage, or calipers, before and after the packing pieces *O* are fitted in place, to make sure that the webs have not been sprung apart, as a very small amount would throw the shaft out of true.

2. Place the shaft between the lathe centers after greasing or oiling them, and fix to the head-stock end a suitable dog for driving.

3. Start the lathe and test the journals *A*, *B*, and *C* to see if they run fairly true. The two center pieces *B* are often slightly out, but if they will finish to the required size, this will not matter.

NOTE.—It will not be necessary to bolt weights on the face-plate for the purpose of counterbalancing this shaft, as the cranks, being equally spaced, balance each other.

4. Turn a small spot about 2 inches long at *r*, leaving it about 1/32 inch over the finish size, and place a steady rest at this point. Light cuts should be taken when turning this spot, to obtain a true surface and also to prevent the tool from gouging into the unsupported shaft.

5. Finish one of the journals *B* and the journal *C*, and polish with emery cloth. Face the end of the part *C* to the dimension *s* given on the drawing.

6. Reverse the position of the shaft between the centers and support it by setting the steady rest against the finished bearing *B*. Take a finishing cut over the parts *A* and *B*, and finish the coupling flange to the dimension *t*, and to the required diameter.

Supplement to MA

Tables for the Article in

I.—STEAM PIPE SIZES FOR HEATING SYSTEMS.

Table I– Flow of Steam in Pounds per Minute through Pipes 100 feet in Length.

Diameter of Pipe	Drop in Pressure (Pounds) in 100 feet Length of Pipe.								
	1/4	1/2	3/4	1	1 1/2	2	3	4	5
1	0.44	0.63	0.78	0.91	1.1	1.3	1.7	2.0	2.3
1 1/4	0.81	1.2	1.4	1.7	2.1	2.4	3.0	3.6	4.1
1 1/2	1.6	1.9	2.3	2.7	3.4	3.9	4.9	5.9	6.8
2	2.9	4.2	5.2	5.9	7.4	8.6	10.9	13.0	14.9
2 1/2	5.3	7.5	9.3	10.8	13.4	15.6	19.7	23.4	26.9
3	8.6	12.3	15.2	17.6	21.8	25.4	32.0	31.8	43.7
3 1/2	12.9	18.3	22.6	26.3	32.5	37.9	47.8	56.9	65.3
4	18.1	25.7	31.8	36.9	45.8	53.3	67.2	80.1	91.9
5	32.2	45.7	56.6	65.7	81.3	94.7	120.0	142.0	163.0
6	51.7	73.3	90.9	106	131	152	192	229	262
7	76.7	109	135	157	194	226	285	339	390
8	108	154	190	222	274	319	402	478	549
9	147	209	258	299	371	432	545	649	745
10	192	273	339	393	487	567	715	852	977
12	305	434	537	623	771	899	1130	1350	1550
15	535	761	942	1090	1350	1580	1990	2370	2720

Contributed by Chas. L. Hubbard.

II.—STEAM-PIPE SIZES FOR HEATING SYSTEMS.

Table II– Factors with which to multiply the figures obtained in Table I, for initial pressures over 10 pounds, to obtain the flow of steam in pounds per minute through pipes 100 ft. in length.

Drop in Pressure, (Pounds)	Initial Pressure (Pounds).					
	10	20	30	40	60	80
1/4	1.27	1.49	1.68	1.84	2.13	2.38
1/2	1.26	1.48	1.66	1.83	2.11	2.36
1	1.24	1.46	1.64	1.80	2.08	2.32
2	1.21	1.41	1.59	1.75	2.02	2.26
3	1.17	1.37	1.55	1.70	1.97	2.20
4	1.14	1.34	1.51	1.66	1.92	2.14
5	1.12	1.31	1.47	1.62	1.87	2.09

Table III– Factors with which to multiply the figures obtained in Table I, for length of pipe smaller or greater than 100 feet, to obtain the flow of steam in pounds per minute.

Feet	Factor	Feet	Factor	Feet	Factor	Feet	Factor
10	3.16	120	0.91	275	0.60	600	0.40
20	2.24	130	0.87	300	0.57	650	0.39
30	1.82	140	0.84	325	0.55	700	0.37
40	1.58	150	0.81	350	0.53	750	0.36
50	1.41	160	0.79	375	0.51	800	0.35
60	1.29	170	0.76	400	0.50	850	0.34
70	1.20	180	0.74	425	0.48	900	0.33
80	1.12	190	0.72	450	0.47	950	0.32
90	1.05	200	0.70	475	0.46	1000	0.31
100	1.00	225	0.66	500	0.45		
110	0.95	250	0.63	550	0.42		

Contributed by Chas. L. Hubbard.

III.—STEAM PIPE SIZES FOR HEATING SYSTEMS.

D'Arcy's formulas for flow of steam in pipes, used for calculating Table I.

$$Q = c\sqrt{\frac{(P-P_1)\,d^5}{wL}}, \qquad W = c\sqrt{\frac{w(P-P_1)\,d^5}{L}},$$

$$d = \sqrt[5]{\frac{W^2 L}{c^2 w (P-P_1)}}, \qquad P-P_1 = \frac{Q^2 wL}{c^2 d^5},$$

Q = Cubic feet of steam per minute,

W = Pounds of steam per minute,

w = Weight per cubic foot of steam at pressure P_1

P = Initial pressure,

P_1 = Terminal pressure,

$P-P_1$ = Drop in pressure,

d = Diameter of pipe in inches,

L = Length of pipe, in feet,

c = Constant.

Table IV.

Diameter of Pipe, Inches.	Value of Constant C.	5th. Power of d.
1	45.3	1
1½	48.5	6
2	52.7	32
2½	54.3	97
3	56.1	243
3½	57.1	523
4	57.8	1024
5	58.4	3125
6	59.5	7776
7	60.1	16807
8	60.7	32768
9	61.2	59049
10	61.8	100000

Contributed by Chas. L. Hubbard.

IV.—STEAM PIPE SIZES FOR HEATING SYSTEMS.

Table V.

Diameter of Pipe in Inches	Direct Radiation. Based on an efficiency of 300 heat units per square foot of radiating surface per hour, and a drop in pressure of ¼ pound in 100 ft. length of pipe. Square feet of direct radiation.	Indirect Radiation. Based on an efficiency of 600 heat units per square foot of radiation per hour and a drop in pressure of ¼ pound in 100 ft. length of pipe. Square feet of indirect radiation.
1	60	40
1¼	100	72
1½	135	95
2	370	260
2½	670	475
3	1080	775
3½	1625	1160
4	2280	1620
5	4060	2900
6	6520	4660
7	9660	6900
8	13600	9720

Table VI.

Single Pipe Risers. Based on velocities of 10 and 15 feet per second.

Diam. of Riser	Square feet of direct radiation 10 feet per sec., velocity	Square feet of direct radiation 15 feet per sec., velocity
1	30	50
1¼	60	90
1½	80	120
2	130	200
2½	190	290
3	290	340
3½	390	590

Table VII.

Return Pipes.

Steam Pipe	Dry Return	Sealed Return
1	1	¾
1¼	1	1
1½	1¼	1
2	1½	1¼
2½	2	1½
3	2½	2
3½	2½	2
4	3	2½
5	3	2½
6	3½	3
7	3½	3
8	4	3½
9	5	3½
10	5	4

Contributed by Chas. L. Hubbard.

MACHINERY

March, 1909.

ORGANIZATION AND EQUIPMENT OF AN AUTOMOBILE FACTORY.

CONSTRUCTION AND DESIGN OF THE PRODUCT.

C. B OWEN *

THE Leland, Faulconer & Norton Co., of Detroit, Mich., was formed in 1890 for the purpose of building machine tools and special machinery. The incorporators were H. M. Leland and C. H. Norton of Worcester, Mass. (both of whom had been with Brown & Sharpe for many years), and R. C. Faulconer and C. A. Strelinger of Detroit. Special milling machines, a lathe center grinder, a well-known wet tool grinder, and some special machinery were built. Later the manufacture of wood trimmers for pattern shop use was undertaken; and next, during the development period of the bicycle industry, a line of machinery for making hardened and ground bicycle gears was developed. As the bicycle business declined, the company began building gas engines for motorboats, which were then rapidly rising in popularity. Mr. Norton severed his connection with the company in 1894, and returned to Worcester, where he later became interested in the Norton Grinding Co. A large foundry was completed in 1895, which has run steadily ever since, doing a large outside business.

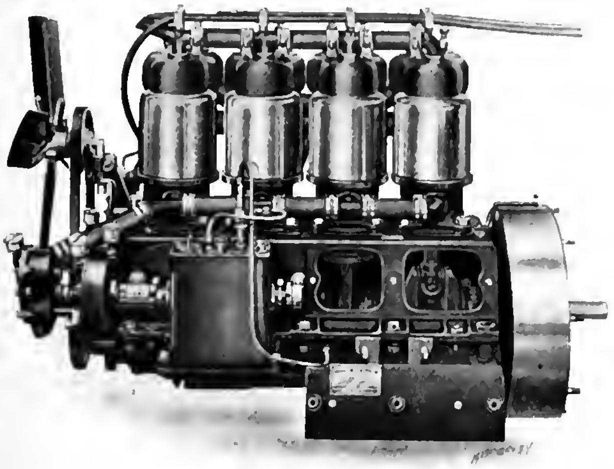


Fig. 1. Left Side of Cadillac 30-horse-power Engine.

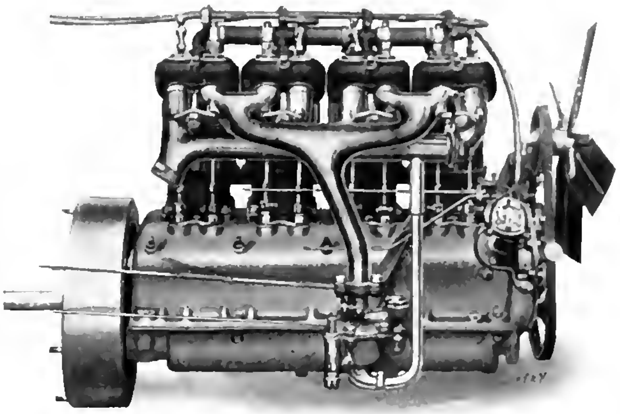


Fig. 2. Right Side of the Engine, showing Carburetor, Commutator, etc.

The natural step from the marine to the automobile type of gas engine was made in 1901 to 1902, when the motor now used in the Cadillac car was produced. The firm's previous experience enabled it to build an engine which was thoroughly standardized and accessible for adjustment or repairs and for the replacing of worn parts. A stock company formed by Detroit business men about this time for the manufacture of automobiles, made arrangements with the Leland & Faulconer Co. to build the engines. The car made its first public appearance in September, 1902, at the time the city was celebrating its bicentennial, and the car was called the "Cadillac" in honor of La Mothe Cadillac, who founded the city in 1702. In 1904, Mr. Leland was made general manager of the Cadillac Co., and in the next year the stock of the Leland & Faulconer Co. was absorbed and both plants united to form the present Cadillac Motor Car Co. From 1902 until the present time about 21,000 cars have been turned out, 17,000 of which were single cylinder 10 H. P. machines, and the rest four cylinder cars, rated at 30 H. P.

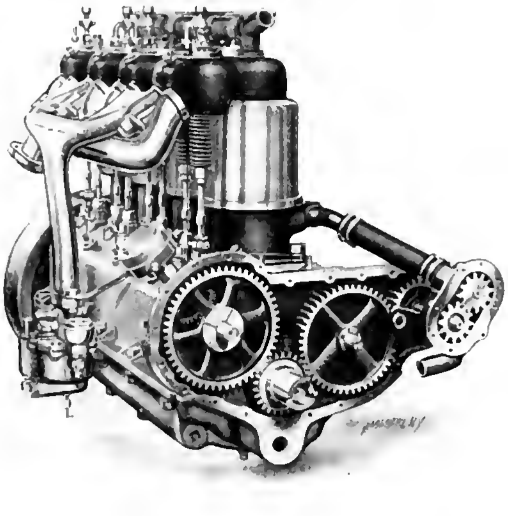


Fig. 3. Front View of the Four-cylinder Engine.

The first automobile, made in 1902, was a runabout containing a 10 H. P., single cylinder, four cycle, horizontal engine, of 5-inch bore by 5-inch stroke. This engine was found to be so satisfactory that it has been retained practically unchanged up to the present time, and its general features have been adopted, so far as possible, for the vertical four cylinder engines of the 30 H. P. machine. A number of original features were employed on this engine which have proved their value in actual practice. One of the most interesting of these is the cylinder construction, best seen in Fig. 9. This cylinder, which is a fine-grained gray iron casting, has a flange near the forward end, which enters and fits a bored and faced seat in the frame. The copper water jacket slips over the cylinder, and is flanged to match its outer face. Both it and the cylinder are held in place by a ring which passes around the outside of the copper jacket, and is tightened down by the studs shown screwed into the frame. In this way the copper jacket forms its own gasket. The cylinder head or valve chamber is held in place by a hollow steel nut (or nipple, rather) which is threaded externally right- and left-hand, and screws into both the cylinder and the valve chamber. The upper end of the copper jacket is clamped between the two, and thus serves for a gasket at this joint also, forming the only packing needed. Parts are kept in alignment by a dowel, and suitable openings connect the jacket space of the cylinder and the head. Among the advantages of this construction over the usual cored jacket are lighter weight, greater water space, more uniform thickness of cylinder walls, facility in cleaning the jacket space, elimination of trouble from freezing the cooling water, and low repair cost for broken parts.

The exhaust valve is placed in the cylinder head with its axis vertical, and it is operated from the cam shaft by a push-rod and bell-crank. The inlet valve is of the inverted

* Address: 857 Lincoln Ave., Detroit, Mich.

type, located directly above the exhaust valve. It is operated by a lever with a roller on its outer end which, in turn, is actuated by a push rod riding on a roller mounted on one arm of a short lever. The push-rod is connected with an eccentric on the cam shaft. The lever on which it rides is under the control of the driver, so that the timing of the valve and the amount of lift may be varied according to the work required. The throttling is thus effected by the inlet valve gear. The carburetor (shown in Fig. 10) is formed in one piece with the inlet valve mechanism. As may be seen, the inrush of air lifts valve *M* and allows the escape of the oil, which falls into the wire mesh basket *K*, where it is vaporized. The lift of the valve may be regulated to give the desired richness of mixture.

The motor frame is made in three parts—the frame proper, and the top and bottom plates. The main shaft, which is offset, is a nickel steel, center-crank forging, finished all over by grinding. It is carried in babbitt lined bronze bearings, fitted in bored and reamed seats in the motor frame. These are held in place by cap plates, which can be adjusted without opening the motor. The cam shaft is carried in bronze bushings inserted in the bottom plate. This plate and the cam shaft may be removed at any time without disturbing the crank shaft.

The transmission of the 10 H. P. machine is of the planetary type, providing for two speeds forward and a slow reverse. As shown in Fig. 11, the gearing is all enclosed in an oil-tight casing. On the high-speed forward gear the whole transmission revolves as a unit. The driving pinion is of 40 point carbon steel and is case-hardened, as are also the idler pinions, which have bronze bushings pressed into them after hardening, and run on hardened and ground pins pressed into the gear case. Power is transmitted to the rear axle sprocket by a Whitney roller chain. An assembled view of the engine is shown in Fig. 8.

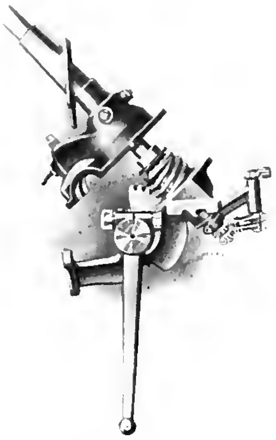


Fig. 4. The Cadillac Steering Gear.

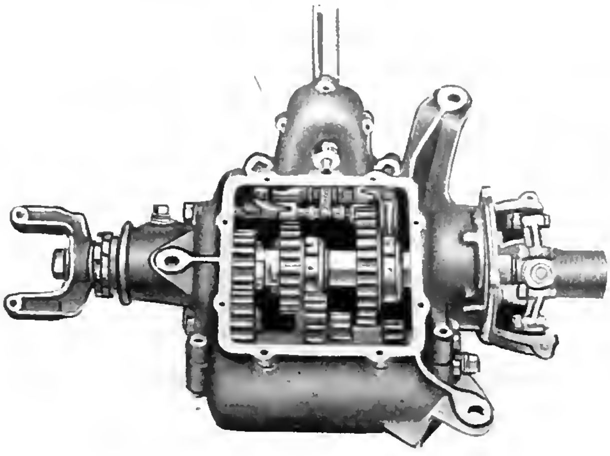


Fig. 5. Selective Type Sliding Gear Transmission

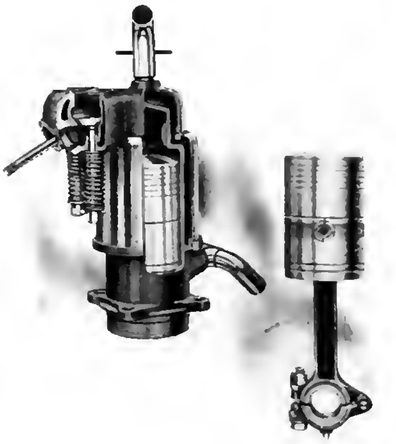


Fig. 6. The Cylinder and Piston.

The later vertical four cylinder engine for the 30 H. P. machine is shown in Figs. 1 to 7 inclusive. This engine has been built, as far as practicable, on the lines of the horizontal machine. As may be seen in Fig. 6, the same arrangement is used for clamping together the cylinder, the copper jacket and the cylinder head, although a somewhat different joint is used at the lower end of the jacket. In this engine also the crank-shaft is offset; the construction of the crank case and base is different, of course, as shown in Fig. 7. A leather-faced cone clutch in the fly wheel transmits power to the sliding gear transmission (see Fig. 5) which gives three speeds forward and one reverse. The gears and shafts are of oil-treated chrome-nickel steel, and are carried on ball bearings. The gear case is oil-tight, as is also the universal joint housing and the rear axle casing. The rear axle carries an oil-treated chrome-nickel steel bevel gear and pinion, and the gear mounts are adjustable for wear of the teeth. The steering gear (see Fig. 4) is of the worm and sector type, treated in the same ways as the transmission and differential gearing.

The Plant and its Organization.

The main or Cadillac plant is located on both sides of Cass Ave., and has a double siding connected with the Belt Line Railroad, thus giving ample shipping facilities. The factory buildings are of brick and reinforced concrete construction, lighted by large windows. Heat is supplied by a live steam system. The boiler-room contains three water tube boilers, with room for another if it is needed. Light and power are furnished by electric current supplied by the Detroit Edison Co. Electric driving is used throughout the plant, with motors connected with each line shaft, and occasional installations with direct connected tools. A large compressor furnishes air at 125 pounds pressure for the penumatic hammers in the frame department, and for use in the various assembling departments, for cleaning parts, running air drills, etc. Five large elevators in fire-proofed brick shafts convey materials and parts between the various floors. An automatic sprinkler system is installed, supplied by four tanks on the roof. These tanks are filled by a large fire pump which operates whenever the level of water in the tanks is reduced. This same system supplies water for lavatory and wash-room use. There are two large wash-rooms, each having 600 bowls and 1,000 lockers. Soap is furnished by the factory.

The old Leland & Faulconer plant comprises a foundry building of brick, steel and glass, supplied with cupolas and a hydraulic jib crane; a pattern shop and pattern storage building; a brass foundry building; a brick building for the case-hardening department; and a large three-story brick building for the power plant and the sheet metal and brass working departments. The building is lighted by both gas and electricity, has a hot air heating system, and is provided with large wash-rooms on each floor.

The organization of the plant is divided into the following departments: First, the general manager; second, the secretary; third, the sales department; fourth, the advertising department; fifth, the purchasing department; sixth, the time-keeping and cost-keeping department; seventh, the superintendent and his assistants; eighth, the engineering and designing departments, who produce the new models, tools and fixtures, and in conjunction with the experimental department, test the new cars before placing them on the market; ninth, the foremen and their assistants in the forty-four manufacturing departments; and six other special departments, some of which will be mentioned later. While the reader will be most interested in the departments devoted strictly to manufacturing, the work of the engineering and purchasing departments is worthy of some notice.

The designing-room is separate from the general drawing-room and is used by the chief engineer and two designers. Suggestions for new designs and improvements in old ones may be made by any one on suitable blanks. They are all considered and passed upon by a mechanical committee, consisting of the general manager, the chief engineer, and the two designers. When approved, such changes are made immediately on the tracings, and new blue-prints are made and sent to the departments concerned in producing those parts. This keeps the blue-prints up-to-date, and avoids loss in the carrying through of parts of obsolete design. A well-organized experimental department is provided, having the necessary apparatus for testing new designs. The work

of the general drawing-room includes the detailing of new designs, and the drafting work on the necessary tools, gages, jigs and fixtures needed to produce new parts or models. Filing cabinets are provided for current drawings, as well as for those which are obsolete, of which a full record is kept.

The Purchasing Department, the Stock-rooms and the Gasoline Storage.

The purchasing agent has final authority on all matters concerning the actual buying of material used in the cars, and the care of this material until it goes to the machine or assembling departments. Purchasing orders are made out in quadruplicate. One copy goes to the seller, one to the receiving office, one to the bookkeeping department, and one to the file in the purchasing office. Small commercial parts, such as nuts, rivets, etc., are stored in bins in the general stock-room, which also receives the finished and inspected parts turned out by the manufacturing departments. The stock-room record is kept on a card index system, and material is delivered by the stock keeper only on presentation of a requisition from the foreman of the department where it is to be used. Bulky parts and materials are kept in a large warehouse, which is also under the care of the purchasing department. A separate stock-room is required for repair parts. These are kept in stock for all models, clear back for the first one placed on the market, and they are replaced as fast as sold out.

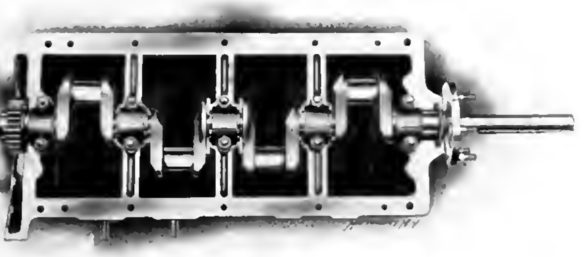


Fig. 7. Top View of Motor Case and Crank-shaft.

The gasoline used in testing the cars is also considered as stock, and a very carefully planned storage system is provided for it. Four cylindrical tanks of 15,000 gallons capacity each are buried in concrete near the siding, with the tops of the tanks about five feet below the street level. They are connected at top and bottom by separate cross piping. The system of storage is such that these tanks are always full of water or gasoline, or both, so that air is always excluded, making explosion impossible. The upper cross pipe permits the free passage of gasoline between the tanks, while the lower pipe performs the same function for the water. A suitable arrangement of automatic valves lets in water as fast as gasoline is removed, or permits the escape of water as gasoline is introduced.

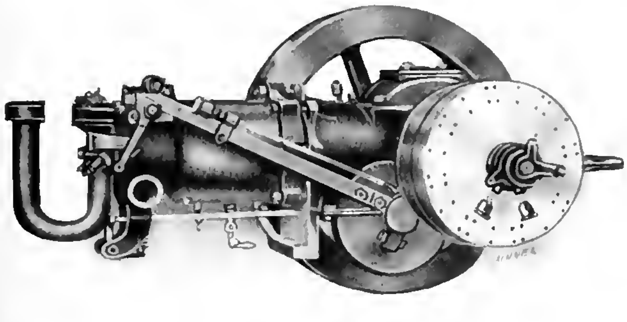


Fig. 8. The 10 H.P. Engine of the Single-cylinder Car.

A notable safety provision in the outlet piping for the water, positively prevents the escape of gasoline into the sewer. The outlet pipe is formed into a long U-bend, which extends vertically to a depth of 70 feet, inside of an 18-inch casing. From this it returns and discharges through a trap into the sewer. The depth of this bend is such that the column of water on the outlet side will balance a column of gasoline having a height corresponding to the head obtainable from a tank car on a grade 5 feet higher than the present siding. The water thus furnishes a permanent seal against the discharge of gasoline.

The distribution of the gasoline is also carefully safeguarded. It is supplied to the various testing rooms and to the factory garage through piping from the storage system. It is retailed by Bowser registering pumps which are kept locked when not in use. As a further safeguard, all the piping is enclosed in concrete, and the whole system is so arranged that it may be flooded with water to a depth of five feet in case of fire in any building which might later be built over it.

Tool and Tool Supply Departments.

The tool department is located on the top floor and at the north side of the building, where the best light is obtainable. It is devoted to the manufacture of the jigs and fixtures and many of the gages employed in the factory. The equipment consists largely of Reed and Hendey & Norton lathes, Hendey shapers, Brown & Sharpe milling machines, and Brown & Sharpe universal and surface grinders. The high degree of interchangeability required in the product demands a high standard of workmanship in this department. At the time Fig. 12 was taken, some manufacturing was being done here. A wire enclosure at the right contains the tool inspecting department. The tool steel stock and tool grinding rooms are at the further end of the picture.

The tool supply department is closely allied with the toolroom. Its work is principally that of caring for, sharpening and recording the various jigs, fixtures and cutting tools. All these tools are looked out for by a card index system, which shows where they are used, and what repairs if any have been necessary. This department orders all the small commercial tools, and keeps a debit account with each branch tool-room for the supplies furnished it, giving credit for all tools worn out in legitimate use or broken in unavoidable accidents. A perpetual inventory is thus kept of all the special and commercial tools kept on hand. A card index inventory of the machine tools is kept in the purchasing department.

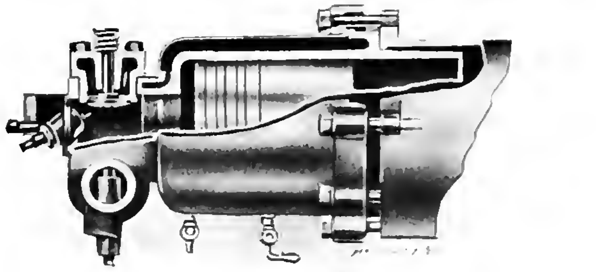


Fig. 9. Section through Cylinder showing the Water Jacket Construction.

Forge, Foundry and Sheet Metal Departments.

It will not be possible to more than briefly mention that part of the equipment of the forty-four manufacturing departments, which is concerned with the actual work on the parts. The blacksmith shop is small, owing to the extensive use of drop forgings, but it is finely fitted up with Buffalo down-draft forges, a tool forge with a coke magazine, gas furnaces, water jacketed dipping tanks, and an electric welding machine. The bulk of the work consists of tool dressing, and the making of forgings for jigs and fixtures and for special car equipment. The case-hardening department has ten large Frankfort gas furnaces equipped with pyrometers, connected by a switch-board with a galvanometer reading to degrees Fahrenheit. Oil and water dipping tanks with steam and cooling water jackets are provided. These are piped to a steam pump to give positive circulation. Square and oblong pots are used for small machine parts, while round pots with central holes, to insure uniform heat, are used for the large rear axle bevel gear.

The iron foundry is provided with a large and a small cupola. The latter is used largely for heats of a special

nature. The most approved methods for testing and chemical analysis are employed to keep track of the output. This is necessitated from the fact that the foundry furnishes castings for other motor car builders besides the Cadillac Co. The brass foundry furnishes the necessary castings for the bronze bushings, carburetor and lubricator parts, small valves and fittings, etc. These are finished in the brass machine shop, which is equipped with forty Warner & Swasey screw machines, besides several Fox lathes, drill presses, milling machines and several special lathes. All the lubricators, gasoline valves, carburetors and bearings used are produced here.

In the sheet metal department are made the vertical tubular radiators, gasoline tanks, dashes, fenders, etc., as well as small punchings, such as washers, clips, etc. The pressroom has a complete equipment, ranging from foot presses up to 20 ton power presses, capable of cutting and forming parts up to 36 by 48 inches. Gas furnaces are used for heating the soldering irons and work when assembling the radiators. The radiators and tanks are tested by compressed air while submerged in water. The frame department is equipped with gas furnaces and pneumatic hammers for riveting and heading.

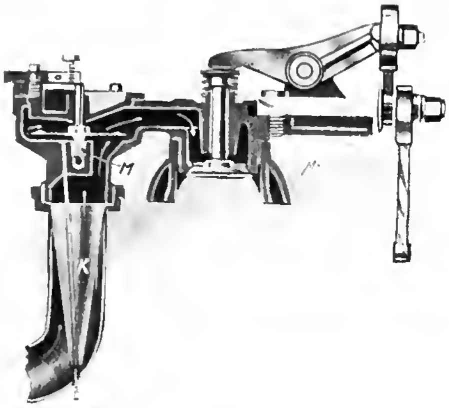


Fig. 10. The Cadillac Carburetor.

Equipment of the Machine Departments.

For convenience in handling the work, all the engine parts are drilled and milled in two separate departments in one large room, while the similar operations on the chassis parts are performed in another room, which is shown in part in Fig. 13. The equipment of this department includes a large number of Cincinnati drill presses, Cincinnati and Brown & Sharpe milling machines, and a Beaman & Smith cylinder boring machine, arranged for handling transmission cases and axle housings. The engraving shows the large use of multiple spindle drills, quick change drill sockets and jigs.

The equipment of the motor drilling department is somewhat similar, ranging from a sensitive bench drill to a 24 spindle motor-driven Baush machine. This is used in drilling the 24 holes for studs, cap screws, etc., in the lower half of the motor frame. These holes are all drilled at one time, and have to accurately match similar holes in the upper half. This, it will be seen, requires a high grade of workmanship. The milling department for motor parts employs several Whitney hand millers, Brown & Sharpe horizontal millers of various sizes, several vertical machines of the same make, and six heavy motor-driven Cincinnati machines. There are also to be found here two milling machines built by Leland & Faulconer, which are unusual in that the table has longitudinal and cross feeds only, the vertical adjustment being applied to the spindle. High-speed steel inserted tooth cutters are in general use.

The screw machine department is one of the largest in the factory, occupying a floor space of 80 by 200 feet, and containing 62 machines, exclusive of the tool grinders. Brown & Sharpe, National, Acme, Davenport and Cleveland machines are used for making cap screws, nuts, studs and other parts up to one inch in diameter. Gridley machines are employed for larger work. Jones & Lamson flat turret lathes are used for shafts, spindles and some gear blanks. The Potter & Johnston automatic machine is employed for much of the chucking work in combination with the Gisholt and Steinle machines, which are used mostly for machining clutch and gear mounts. A group of Bardons & Oliver machines are used on certain engine parts, which have to be held in face-plate fixtures and finished largely by hand labor. The larger Acme machines are direct connected.

While most of the round parts are finished complete on the screw machine, a lathe department is necessary for some work which has to be turned on arbors. Fly-wheels and some long axle shafts are also finished here. The equipment includes Reed lathes, a Bullard boring machine for finishing fly-wheels, and two Beaman & Smith double-spindle horizontal boring machines for roughing out the cylinders. The latter are similar in design to that described in the department of New Machinery and Tools of the October, 1908, issue of MACHINERY, being provided with turntable fixtures, so that two cylinders may be set up while two others are being bored. After the cylinders are roughed out, they are tested under hydraulic pressure and sent to the grinding department.

The grinding department finishes practically every round part on the car except the crank-shaft, which comes finished from a firm making a specialty of that work. Heavy Norton and Brown & Sharpe grinders are used for finishing long parts. Medium sized Landis and Brown & Sharpe grinders take care of work up to 3 inches in diameter and 8 inches long. Special Brown & Sharpe and Heald grinders are used for finishing the cylinders, which are held exactly as they will be on the assembled engine, so that clamping strains are duplicated. The pistons are finished in one of the heavy Norton machines. The group of Heald machines is used exclusively on internal work, and an equipment of face grinders finishes the washers and flat disks used in the cars. The square shafts which carry the sliding members of the transmission are ground to size on a group of Brown & Sharpe surface machines, fitted with suitable index fixtures. In contrast to the heavy Norton grinders with their 24-inch wheels, is a bench grinder purchased from the Waltham Watch Tool Co., for finishing internal ball races. This little machine uses a wheel about the size of a five-cent piece, and may be set to grind to a radius of ⅛ inch. Careful attention is given to providing suitable racks for ground work to avoid injury in handling.

In Fig. 14 is seen a partial view of the gear-cutting department. A Gleason bevel gear generating machine is here shown at work cutting a rear axle gear. The complete equipment includes thirty standard machines, and four others of special design, besides four testing machines. The list includes fifteen Brown & Sharpe automatic gear cutters, one large Gould & Eberhardt machine, two Fellows gear shapers for internal gears, one Bilgram and three Gleason bevel gear planers, two imported French machines for special pinion work, and a Pratt & Whitney worm milling machine. One of the testing machines, that for bevel gears, is seen at the extreme right of Fig. 14. The testing machine for spur gears is provided with a vernier scale for reading center distances to thousandths of an inch.

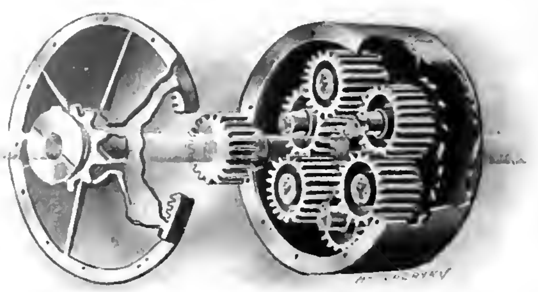


Fig. 11. Planetary Transmission used on the Single-cylinder Engine.

Inspection and Assembling Departments.

The inspection department consists of a chief inspector and his foremen, and the men under them, who together form a corps of over one hundred men. These men inspect commercial parts as they go through the receiving department, the output of each manufacturing department as it goes to the

assembling, the final assembling of the parts in the chassis, and the finish of the completed machine on both the mechanism and the body. The inspectors are furnished with all necessary appliances for doing this work accurately. Drop forgings are examined for visible flaws, and sounded for invisible ones. Springs are tested on machines especially built for the purpose. Every machine department has its inspection bench, provided with the necessary plug and snap gages for the entire range of its output. Micrometer calipers up to the 6-inch size are in general use. Thread micrometers are used in place of ring thread gages wherever possible. For testing turned and bored parts for concentricity, Brown & Sharpe testing centers and indicators are used. Suitable surface plates, V-blocks and height gages are provided. The inspectors in the grinding department are furnished with strong reading glasses for use on certain work. These inspectors are outside the jurisdiction of the other department-heads, and have full authority to throw out all parts and materials not up to the standard.

Fig. 12. A Partial View of the Tool-making Department.

Fig. 13. The Chassis Drilling and Milling Departments.

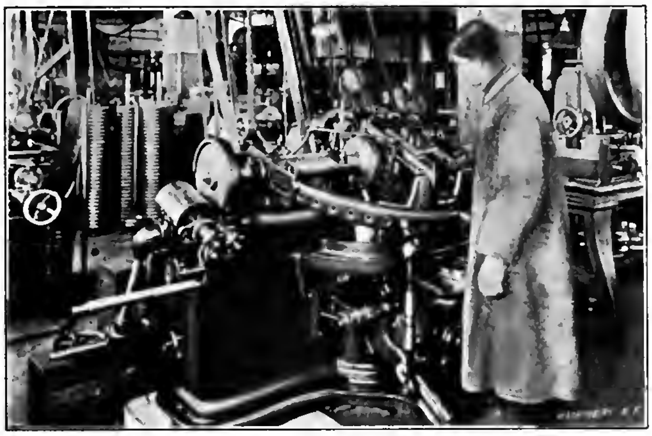


Fig. 14. A Corner of the Gear-cutting Room.

Fig. 15. The Four-cylinder Engine Assembling Department

The work of assembling is divided between several gangs, each of which does its own particular work. One group of assemblers scrapes the crank-shaft bearings to fit, and "runs them in" by a belt on the fly-wheel. Another assembles the cam-shaft members. Still another assembles the piston, its rings, pins, connecting rod and bearings, while the "cylinder gang" assembles the cylinder and cylinder head and copper water jacket. The final assembling is then done on stands as shown in Fig. 15. This consists merely in bolting the various parts together, setting the cam gears (which are marked in a jig), timing the valves, adjusting the bearings, and testing the water connections. The points of valve opening and closing are marked on the rim of the fly-wheel, and a fixed pointer shows the central position.

The Testing Department and its Equipment.

From the assembling room the engines are taken to the testing department, where they are placed on iron stands and connected with the gasoline and water supplies, and to the electrical connections for the ignition, which are shown plainly in Fig. 16. The engines are run at moderate speed until they get down to work, when the speed is gradually brought up to the maximum. A brake horse-power test of each chassis is made, and those which fail to come up to the requirements are returned to the assembling department for reconstruction. As a check on this test, stock engines are sent to the experimental department at regular intervals, and tested there by connection with a dynamo fitted with suitable electrical measuring instruments. After the testing the engines go into stock, or to the chassis assembling department.

All the parts necessary for the completed chassis are brought to this assembling department. The order of assembling is as follows: The frames are first laid on horses and the mechanism dust shield is put on. The springs and axles are next attached, and then the engine and transmission gearing are set and lined up. The engine is supported at three points, and is connected by a universal sliding joint with the transmission gearing, thus permitting weaving of the frame without danger of disalignment. The universal joint between the transmission and the differential gearing is practically straight when the car is loaded, and runs at a very slight angle when the car is light. The exhaust pipe and muffler are next connected, and then the controlling and brake levers and the pedals. The radiator and water connections come next, followed by the steering gear. The placing of the mahogany dash in position permits the mounting of the electrical apparatus; and the bolting on of the gasoline tank and its connections completes the chassis, except for the wheels and tires. An old set of these are put on the car in the assembling department, to be used for the road test. The method of assembling is practically the same for the single cylinder car.

Two separate testing departments are provided—one for the single cylinder cars, and the other for the four-cylinder cars. The former were given road tests for the first two years of their manufacture, until all the weak points in the construction had been eliminated. The testing-room shown in Fig. 17 was then built, and the cars have since been tested here. Fifteen stands are provided. The rear wheels rest on a pair of 48-inch pulleys, mounted on a shaft which carries a fan about 72 inches in diameter by 36 inches wide, projecting through the floor in the sheet iron casing shown. In addition to the resistance thus offered by the fan, a brake is mounted on the shaft between the pulleys, controlled by the hand-wheel

of the stand shown projecting through the floor at the rear of each machine. By this means it is possible to work the engine against any desired resistance, even to the extent of stalling it. The chassis are held by padded hocks, fastened by ropes or chains to the brake wheel stands. The blast of air produced by each fan is led through a sheet metal conduit and directed against the radiator of the engine, thus giving the same cooling effect that would be experienced at corresponding speeds on the road on a still day. The speed in miles per hour is read from Schaffer & Budenburg tachometers.

The four-cylinder testing stands are similar in principle, though somewhat differently arranged, as the fans are placed beneath the front of the machine, being connected with the driving shafts by sprockets and chains. After being run here a sufficient time to make sure of their adjustment and running condition, temporary bodies are placed on the chassis and each car given a thorough test by reliable men on the country roads outside the city. After this has been done to the satisfaction of the foreman of the department, the testing body is removed and the chassis is washed successively in water and gasoline, and dried by an air jet.

Finishing.

The painting and finishing of the chassis, bodies and wheels is done in separate departments. The bodies receive one coat of rough filler, and fifteen more coats of filler color and varnish, before completion. A view of the trimming departments for the bodies is shown in Fig. 18. Fenders, hoods, brackets, etc., are enameled and baked. Fig. 19 shows some of the pipe frame trucks used to hold these sheet metal parts during the baking.

The chassis, bodies, hoods, fenders, etc., finally go to the large finishing-room on the ground floor, where the final assembling and testing of the complete car is done. Each complete car is driven out by a final inspector to make sure that all adjustments are correct. Before shipping, a detailed record is made of each car, beginning with the motor number, and giving the dates of motor assembling, motor testing, all the various painting, finishing and shipping dates, together with any information of a special kind, such as size and color of body, etc. This record has been found of the greatest assistance to the repair order department in filling poorly written orders.

Interchangeability.

In connection with this subject of repair orders, mention should be made of the high degree of interchangeability attained by the Cadillac Co. This was illustrated by a test made last March by a committee of the Royal Auto Club of England, who selected by lot three Cadillac cars of the same 10-horsepower model, disassembled them under the eyes of an inspector of their own appointment, placed the disassembled parts (721 from each car) in a pile, and mixed them up indiscriminately, 81 parts were then taken out and replaced by 81 repair parts from stock. The cars were thereupon reassembled from this mixed pile by the use of wrenches, screw-drivers, etc., but without the use of scrapers, files or even emery cloth. Only one part, a cotter pin, was injured in reassembling. These three heterogeneously reassembled cars were each given a 500 mile reliability run on the Brooklands track, at an average speed of 33 to 34 miles per hour, without developing the slightest defect. This test speaks well for the organization of the factory.

The whole Cadillac plant is now devoted to the production of the four-cylinder, 30-horse-power car, the "Model 30" as it is called. The machine departments are run twenty-two hours a day, employing a total of 3,000 men in all departments. Thirty-six complete cars a day are produced.


Fig 16. Testing the Four Cylinder Engines.


Fig. 17. The Single Cylinder Chassis Testing Stand, arranged for Fan and Brake Resistance.


Fig 18. The Body Trimming Department.

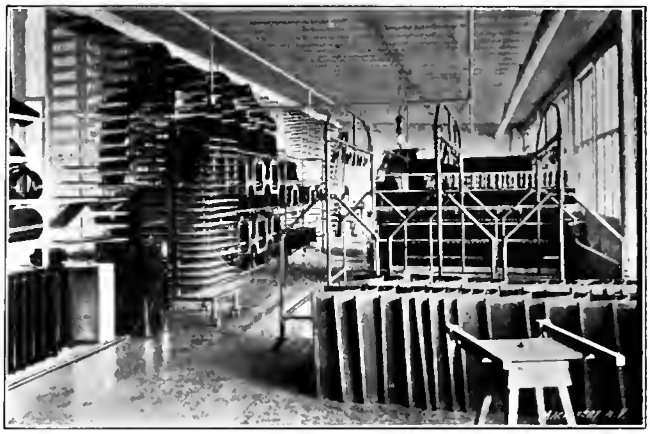


Fig 19. Storage of Enamelled Parts, showing Wheeled Stands used in the Baking Ovens.

* * *

So-called black oil finish on steel may be produced in several ways, but the *Brass World* states that the following method is one of the best. The article to be finished is heated in a furnace to a cherry red heat, and is then plunged into lard oil. It is immediately removed, and the oil is burned off in the furnace. When this has been done, the object is immersed in water. After the immersion in water, the surface of the steel will be black and will not rust. In order to bring out the best surface, a light film of linseed oil may be applied to the article after it has been removed from the water.

GEOMETRICAL PROGRESSION FOR SPINDLE SPEEDS.

FRANCIS W. SHAW *

The utility of the data sheet table of geometrical progressions for spindle speeds, published in the November, 1908, number of the engineering edition, is unquestionable, but in the writer's opinion, it is not confined to the use suggested by the author. I have now had several years' experience in the use of a similar table, and have designed many gear systems, but I have never yet been able to make use of its labor saving properties in getting out a series of speeds in geometrical progression, except as will be described herewith. The required speeds have never happened to correspond in their percentage of decrease with any of those given in the table.

The chief use I have made of the table is to find roughly the percentage of decrease, which is done as follows: A pair of dividers is set so that the points span a distance from 1 in the "Number of Speed Changes Required" column to the number corresponding to the number of speed changes required—say, for example, 16. Having decided upon the maximum and minimum speeds, the dividers as previously set are used to find in the percentage column, by trial, two speeds 16 spaces apart, which most nearly correspond with those required. The tables, from my point of view, would have been much more useful had the differences between the adjacent columns been smaller, say ½ per cent.

In designing a speed-varying mechanism for a machine tool drive, it is usual to consider first what limit speeds are necessary to meet the requirements of the work, then the number of speeds. As a matter of fact, however, the latter point is usually governed by some set design already applied, it may be, to other sizes of the same class of machine. Oftentimes, the productions of our competitors cause us to draw the lines a little wider, as we must have as many talking points as possible.

Having decided the points enumerated and chosen the limit speeds, there appears to the writer no good reason why they should not be adhered to; why be content with an approximation when to secure the ideal is so simple? The difficulty of applying the table has been admirably obscured by the author in the example quoted, by taking 250, an aliquot part of 1,000, as one of the limit speeds. Had he chosen, say 346, as the highest speed, he would have been under the necessity of multiplying each number by 0.346. To do this operation for, say 16 speeds, would involve practically as much labor as to arrive at the result by the logarithmic process. A method by which any reasonably simple geometrical progression can be found in less than half an hour, is shown in the following working of a suppositious example. The requirement is 16 speeds varying from 6.5 to 270 R. P. M.. To find the common ratio, *i. e.*, the number by which 6.5 must be multiplied to produce the second speed, and by which the second or any other speed must be multiplied to produce the next higher speed, it is necessary to use the well-known formula, modified a little to suit the method of working, *viz.:*

$$r = \sqrt[n-l]{\frac{l}{a}}$$

in which

r = common ratio,

l = last term,

a = first term,

n = number of terms (not means).

For the benefit of the beginner, the following graphical proof may be followed with profit. Examine the following series in geometrical progression: 2, 4, 8, 16, 32. In this progression the common ratio obviously is $4 \div 2 = 2$, 32 is the fifth term (l), and 2 the first term (a). If these terms only are known, the common ratio is found by extracting the fourth root of $32 \div 2$ which equals 2. The root, it will be noted, (4) is the number of terms $n - l$. In our suppositious case

$$l = 270$$
$$a = 6.5$$
$$n - l = 15$$

$$r \text{ therefore is } \sqrt[15]{\frac{270}{6.5}}$$

the value of which expression may be found logarithmically thus:

$$\log \sqrt[15]{\frac{270}{6.5}} = \frac{\log 270 - \log 6.5}{15} = \frac{2.4314 - 0.8129}{15} = 0.1079$$

$= \log r$. Continued addition of $\log r$ (or 0.1079) to log 6.5 (or 0.8129) gives the log of subsequent terms in the speed progression.

Speed.	Log	Number.	Speed.	Log	Number.
1	.8129	6.5		1.5682	
	.1079			.1079	
2	.9208	8.333	9	1.6761	47.43
	.1079			.1079	
3	1.0287	10.69	10	1.7840	60.81
	.1079			.1079	
4	1.1366	13.70	11	1.8919	77.96
	.1079			.1079	
5	1.2445	17.56	12	1.9998	99.98
	.1079			.1079	
6	1.3524	22.51	13	2.1077	121.1
	.1079			.1079	
7	1.4603	28.86	14	2.2156	164.3
	.1079			.1079	
8	1.5682	37.00	15	2.3235	210.6
				.1079	
			16	2.4314	270.1

It will be noted that although four figure logarithms have been used, the error after 15 successive additions is practically negligible. The original number, obtained at the fifteenth step, is a certain check upon the accuracy of the calculation.

When the numbers have been obtained, they are set out in tabular form (useless decimal places being omitted) to suit the particular gear system. For example:

SPINDLE SPEEDS.

Levers at	Hand Wheel at A	B	C	D
1 and 3.............	6.5	8.3	10.7	13.7
1 and 4.............	17.6	22.5	29	37
2 and 3.............	47	61	78	100
2 and 4.............	128	164	211	270

These figures will no doubt require some modification after calculation of the gearing to the nearest tooth, but care in arrangement of center distances of gears always gives an approximation within about 2 per cent.

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MALLEABLE VS. STEEL HAMMERS.

In the discussion of the paper by Mr. Raffe Emerson, presented before the New York Railroad Club last fall, the assertion was made that it is nonsensical to supply enginemen with good cast steel hammers. It appears that the New York Central experimented some years ago in this direction to save expenses. First, a hammer made of a steel casting was used with satisfaction, and finally one was made still cheaper by using ordinary malleable iron.

We do not know what the feelings of the average engineman are when required to use a malleable hammer, but we think that if he has had the mechanical training proper for the position that he would regard it as an insult. In the first place a malleable hammer is likely to be a dangerous tool; chips are liable to fly from the face when struck against a steel surface, which may injure the sight, and in the second place the cheapness and crudity of such a tool would tend to destroy the pride an engineman should have in keeping up his tool equipment. The importance of this depends largely on the personal equation, but the point is that there are wasteful economies, and we believe that the malleable hammer is a horrible example. The amount that a railroad corporation can save in one year by using such hammers in place of good steel hammers is so inconsequential that it can hardly afford to offend the sensibilities of its employes by such substitution.

SIZES OF WORKING DRAWINGS.*

WILLIAM L. BREATH †

William L. Breath ‡

Manufacturers do not have any universal standard of sizes for working drawings. From time to time there have been recommendations made by various societies regarding standard sizes, but these recommendations have had little effect in bringing about any generally accepted standard in drafting-room practice. Many firms use large and unwieldy drawings, which are as difficult for the draftsmen to work on, as they are cumberscme to handle by those who are to use them. Of course, most drafting-rooms have their own standard sizes for the sheets. There is usually a small sheet for sketches and details and then larger sizes which are multiples of the detail size. These larger sizes are used for the assembly drawings and for detailing large pieces. It is, however, difficult to take care of all these various sizes of drawings, a difficulty which can be avoided by having only one size sheet of a convenient size for both the draftsmen and the shop.

The size of the sheet to be adopted should be chosen first of all with regard to economy in cutting the sheets from commercial sizes of paper and tracing cloth. Tracing cloth comes in rolls 30, 36, 42, or 48 inches wide, and there is thus a wide range to choose from. The standard sheet used by the U. S. Navy department, and, the writer believes, also by other departments of the government, is 21 by 27 inches. All manufacturers working on orders for the Navy must send tracings of their work on this size sheet, and some manufacturers, therefore, have adopted this size as their own standard. It can be cut without waste from a roll 42 inches wide, but it is, however, too large to be convenient for the draftsman, as it makes his work much more tiresome than a small sheet where all corners can be readily reached from one position. Besides, this sheet gives more room than is necessary for detailing one piece of ordinary size, and therefore, as many as twenty pieces are often detailed on one sheet. This is an inconvenient system, as it often happens in the shop that two or more men must refer to different details on the same drawing, and often the blue-print will be cut in pieces so that each man gets the part on which he is working. This is a common-sense way of avoiding the inconvenience of having two men working on the same blue-print, and also is a hint to the drafting-rcom to have but one detail on each sheet. A convenient size sheet could be obtained by cutting the size mentioned in two, making a size 13½ by 21 inches. Even a somewhat smaller sheet, say 18 by 12 inches would be better.

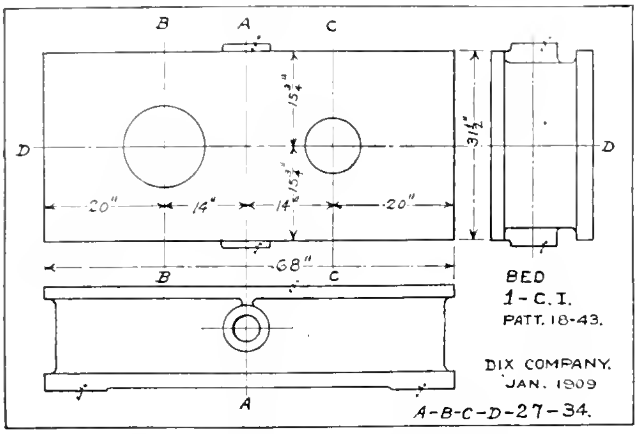

Fig. 1. Master Drawing of Simple Machine Bed.

To use a small size sheet for all assembly drawings and for detailing of large pieces, requires a method somewhat different from those ordinarily in use in drafting-rooms, but it does not add to the complication of the work of the drafting-room. Fig. 1 shows a 13½ by 21-inch sheet, and on it is drawn a bed of simple design. The bed is drawn only in outline, and shows a plan, elevation and end view. The main center lines are also drawn, as well as the main faces. The drawing is numbered according to the regular system of the drafting-room. The center lines are lettered *A-A*, *B-B*, *C-C*, *D-D*; *A* refers to a second sheet of the same size on which is drawn to a larger scale the section *A-A* of the bed. On this sheet are put all dimensions, notes and instructions necessary. In the same way sheets *B*, *C* and *D* are drawn until the bed is fully detailed. The master sheet, Fig. 1, has in the title corner the letters *A*, *B*, *C* and *D*, showing at a glance how many sheets there are in the complete set. The next piece in the construction would be detailed in a similar way, the master sheet taking the number 27-35, and having as many supplementary sheets, *A*, *B* and *C* as necessary.

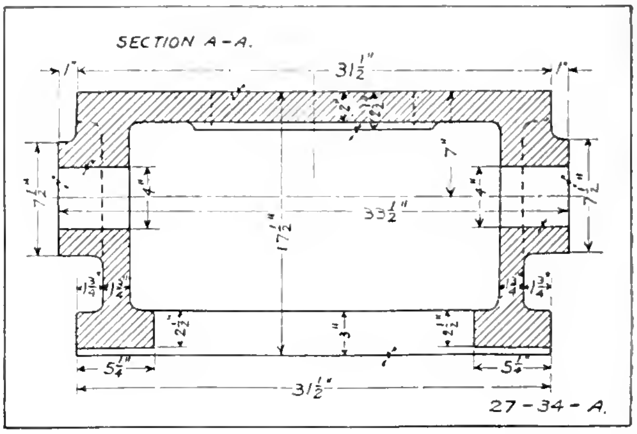

Fig. 2. Detail Section of Bed in Fig. 1.

In case there is room on one sheet for more than one detailed section, these sections will be noted on the master drawing by the letters *A-A*, *A-B*, *A-C*, etc., the letter *A* being used for each section on sheet *A*. If the piece to be detailed is too large or complicated to have the three views clearly outlined on the master sheet, then each view will be made on a separate sheet, and the plan view will be considered the master drawing; the other master drawings have the same serial number, with a number added, as for instance, 27-34-1, and 27-34-2. In this way every part of the machine will be fully shown, as well in its relation to the other parts as in detail. In fact, the main purpose of the master drawing is to show the relation of the different parts of the machine to each other. When the master and detail drawings of a machine are fully completed, they can be bound together by any suitable loose-leaf method, and if desired for reference, an index of the pieces can be made on a standard sheet, and bound with them.

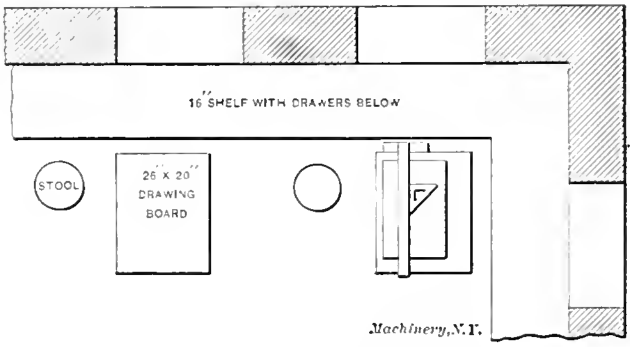

Fig. 3. Convenient Arrangement of Drafting-room.

Fig. 3 shows a convenient arrangement of a part of a drafting-room, where the small sheet system has been adopted. The designing draftsman's board is not shown. He, of course,

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* For additional information on standard drafting-room methods, and kindred subjects, see MACHINERY, February, 1908: Standard Drawing-Room Methods, and also the articles there referred to.

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must have a board as large as is convenient for the actual designing work. Running around the room, and under the window sills, is a shelf 16 inches wide, with drawers under large enough for the standard size drawing. The draftsman's tools and books can also be kept in drawers under the shelves. Being at the left hand of the draftsman, the shelf is a convenient place for reference drawings, books, etc. The working table need be but very small, as a board 20 by 26 inches will be amply large enough. The board should be mounted on a cast stand, and pivoted so that it can revolve, as a swinging board is much easier to work on.

The system of small sheets outlined can also be used for drawings of buildings, power plants, and structual designs. One drawing gives a general outline of the construction, and then the various detail drawings show successively the details of different portions of the construction.

* * *

SOME OLD-TIME PUZZLES IN WOOD.

Among the many changes incident to the introduction of machinery and the consequent passing of the old-time hand-worker, is one that, while of no economic importance, is interesting as marking a difference between the old leisurely habits of the shops of a generation or two ago, and those of to-day.

In the old days the greenhorn apprentice was subjected to a variety of tests which taxed his temper, and also his ingenuity and gumption, and a number of these, all of which are interesting and ingenious, were recently described and illustrated in *Wood Craft*, and are herewith reproduced.

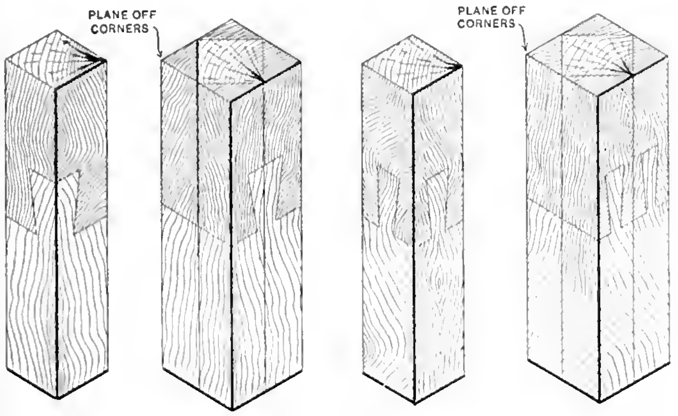


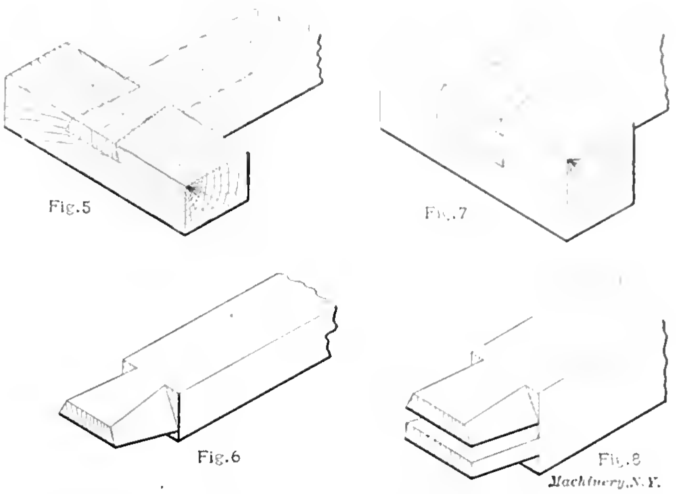
Fig.1 Fig.2 Fig.3 Fig.4

Figs. 1 and 2. Finished Dovetail Joint and the Way in which the Joint is made. Figs. 3 and 4. Finished Joint with Two Dovetails, and the Method of making the Joint, which is the same as for Fig. 1.

The tests of the learner's skill and ingenuity were of a useful nature, and generally in the direction of some little problems in tool-work lying outside the everyday tasks of the shops. Very often these took the form of a puzzle joint, one of the first to be shown to the budding craftsman being the mystifying dovetailed splice shown in Fig. 1. When formed of two different kinds of wood having a sharp contrast in their colors, this joint presents a very puzzling appearance, especially if glued up so that it may not be taken apart. If left loose, however, the mystery vanishes, for it is then readily seen that the joint is a simple dovetail running diagonally through the pieces. The fitting of such a joint would be a difficult matter if the dovetail pin and socket were cut diagonally, as shown in the finished joint, but is an exceedingly simple thing if done as illustrated in Fig. 2, across the square way of the pieces. The joint is fitted thus, and after being put together, the corners of the square block are planed down to the center lines as indicated by the lines on top of the piece, thus giving the completed joint the appearance so puzzling in Fig. 1.

Fig. 3, which shows a complete dovetail on each face of the finished joint, is a more difficult-looking puzzle, though made in a manner precisely similar to the joint illustrated in Fig. 1. This joint is made by fitting a pair of dovetails side by side as in Fig. 4, the corners being afterwards planed off as in the case of the first joint. Care must be taken to lay out the dovetails evenly on each side of the central line of the blocks. Of course, it should scarcely be necessary to add that a good fit throughout is required, or yawning joints will give the trick away when the piece is planed off at angles of 45 degrees to the original faces of the block.

Another dovetail puzzle is shown in Fig. 5, which is a T-joint apparently put together in an impossible way. Fig. 6 reveals the secret of its construction, which needs no further description. Sometimes this T-joint has a tenon in addition to the dovetail, and appears as in Fig. 7, the details being made plain by Fig. 8.



Figs. 5 and 6. A Deceptive Dovetail and the Way in which it is made.

Figs. 7 and 8. A Joint Similar to the One shown in Fig. 5, with the Addition of a Tenon.

Some years ago an enterprising firm of soap manufacturers whose name is a household word on several continents, gave away as an advertisement some millions of another wood puzzle that was a favorite among the old hand-workers in days gone by. A sketch of it is shown in Fig. 9, and it will be seen to consist of a hammer-headed key-piece inserted through another piece, both being absolutely solid, and without joints. The apparently impossible task of passing the large hammer-head through the narrow mortise, is accomplished by selecting a piece of soft white pine for the key, and thoroughly boiling or steaming one end of it until it is quite soft. It is then squeezed in the jaws of a powerful vise, and slipped quickly through the mortise, when it immediately begins to swell and with a little soaking will resume its former size and shape.

The concluding example is notable because of the fact that it has found its way from the workshop to the pages of more than one treatise on descriptive geometry. The puzzle, as usually stated, says that three holes are to be cut in a piece of wood—one round, one square, and one triangular, and another piece of wood is to be cut so that it will fit each hole. A piece about ¼ inch in thickness is selected, and the holes, *a*, *b*, *c*, cut in it as in Fig. 10. The circle *a* is equal in diameter to the side of the square *b*, which is equal to the base and altitude of the triangle *c*. A cylindrical block is then turned or planed to fit the circular hole. By cutting this cylinder *a*, Fig. 11, to the same length as its diameter, it will just fill the square hole *b*, and by paring off on opposite sides until it is triangular in section in one of its dimensions as at *c*, the third condition is fullfilled, and a piece is formed which will fit each hole. Fig. 11 shows the required block for the purpose, *a* being the cylinder to fit the circle at *a*, Fig. 10, *b* the square plug, and *c* the triangular piece.

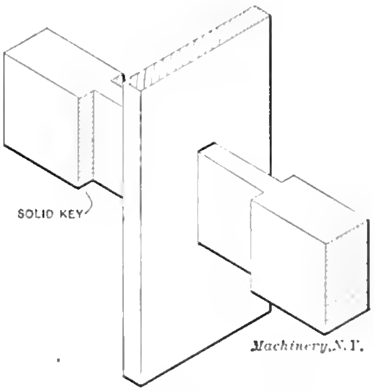


Fig 9 A Combination which seems Impossible.

THE ENGINEER AND THE PEOPLE.*

In a paper read before the American Society of Mechanical Engineers, entitled "The Engineer and the People," the author, Mr. M. L. Cooke, proposed a plan for obtaining a larger measure of cooperation between the society and the general public, which should receive the endorsement and aid of every member. The present-day conditions which seem to demand a broadening of the lines of professional activity, were pointed out, and specific recommendations made which, if adopted, would doubtless greatly extend the engineers' field of usefulness and make him a "special conservator of the public's interest in matters involving engineering." Said the author, in speaking of the object of the society: "The distinguished authors of the constitution of the A. S. M. E. stated its object in a way to permit of an almost indefinite expansion of function. 'The object of the society is to promote the arts and sciences connected with engineering and mechanical construction.' "That the constitution, however, imposes no duties on the membership, except those of a purely professional interest, witness as follows": 'The proper means for this purpose shall be the holding of meetings for the reading and discussion of professional papers and for social intercourse; the publication and distribution of its papers and discussions; and the maintenance of an engineering library.' "The library may be made in the future to minister to the requirements of the laymen interested in technical matters, but up to this time its direct influence on the interests of the people is almost negligible. A radical and in every way salutary change can be brought about in the society's relations with the general public by the appointment of a committee to be known as the "Committee on Relations with the Public." The work of this committee would, of course, have to be done within carefully thought out and definitely prescribed limits. It would doubtless seek to establish such relations with the lay press as would make its device and help sought when engineering matters are up for public discussion. It would also doubtless seek to give publicity to the fact that the society stands ready to offer disinterested advice through its council to government officials—municipal, state or national. In most cases, of course, this assistance would not be so much to answer engineering questions as to counsel with government officials to the proper procedure to obtain answers. This committee might also provide for a course of lectures for the general public, to be given under its supervision in the Engineering Societies' Building in New York, or under the auspices of local engineering societies at other places. Another important part of the work of such a committee would be to arrange that a fair proportion of professional papers presented at the various meetings of the society should be of direct use and value to the public as well as to the mechanical engineer. The cumulative effect of these, and of such other lines of work as would soon suggest themselves, would be very marked.

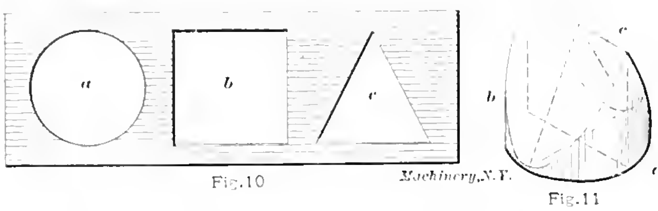


Fig.10 Fig.11

Figs. 10 and 11. Piece with Round, Square, and Triangular Holes, and Plug which fits them all.

"The matter of the conservation of our natural resources will afford, probably for years, a practically limitless field for investigation and earnest discussion. The questions involved are so momentous as to warrant the engineer in seeking ways of cooperation with the national and state governments for their solution. No better way could be found for our society to assist in this work than to provide in its meetings and publications a forum for the discussion of those phases of the general problem in which the mechanical engineer is especially qualified to speak. The records of engineering in the early days of the last century show that engineers had not then learned how to cooperate with one another. Up to a comparatively recent date the professional knowledge of the engineer was his own property, and he felt that in imparting any of this knowledge to another engineer that he was doing himself a decided injury. The large number of engineering societies, with the fundamental object of the free exchange of engineering data between their members, shows how thoroughly engineers have learned that the general policy of giving freely of their knowledge to their fellow practitioners, increases rather than diminishes their effectiveness and, in proportion, their earning power. In proposing the appointment of this new standing committee, the writer suggests only the extension of this cooperation to include the public. There is good reason to believe that engineers have as much to gain from cooperation with the public as they have undoubtedly gained from the cooperation with one another. It is no longer possible for any profession or craft to corner information and hold it for its own use. Broadly speaking, those who seek information in any field can obtain it, or at least enough to answer their immediate purposes, and therein lies a danger. This danger would not in itself constitute a sufficient reason for the engineer to take the public into his confidence, for, after all, it is public opinion and not the dictum of the engineering fraternity which finally decides the large questions of engineering practice. How much better it would be to join forces with the people to work out with them their problems and to build up in the lay mind such a confidence in our devotion to the people's cause that they will be willing to let us lead in matters where our training especially qualifies us to lead. Only by educating the public to understand and appreciate the work of the engineer, can the public be made to demand the best that can be devised and executed by trained and skillful men. This will have a twofold beneficial effect on the profession, in that it will make more work for the engineer, and will give the public that general acquaintance with engineering matters which will make it suspicious of short cuts.

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* Extracts from a paper by Mr. Morris Llewellyn Cooke, read before the December, 1908, meeting of the American Society of Mechanical Engineers.

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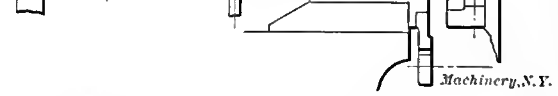
MULTIPLE SPINDLE SHAFTING LATHE.

In the December 25th issue of *Engineering* (London) is described a multiple turning and grinding lathe for finishing shafting, built by Messrs. MacDonald, Swinburne & Co., Barrhead near Glasgow. The peculiarity of the machine, as shown by the accompanying diagram, is that it holds four shafts simultaneously. One of these, at *A*, is in position for insertion or removal. The indexing of the revolving head- and tail-stocks next brings the shaft to position *B*, where it is turned. The third position, *C*, is an idle position. At *D* it is being ground by a traversing emery wheel. When it arrives at *A* again, it is removed. The shafting enters the end of the bed of the machine, below the tail-stock, being carried in by a rolled conveyor; a mechanical lifting arrangement then raises it to position *A*, where it is clamped in place. The same rolled conveyor removes the work after it has been completed. Suitable arrangements for steady rests for both turning and grinding operations are provided so that these operations may be simultaneously performed in accordance with the best practice, both as to speed and accuracy. The machine will take solid or hollow shafting up to 4 inches in diameter and 22 feet long, and will finish within a limit of 0.00025 inch.



Multiple Turning and Grinding Lathe.

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—3.

GEARING.

R. B. BROWN.

The gearing may be regarded as one of the most important details of crane design, since on its merits rest the efficiency and safety of the crane. A few years ago all lifting machinery was worked by wheels having cast teeth, but with the introduction of electric driving, and higher speeds, machine-cut gearing became necessary. The adoption of cut gears has grown to such an extent that a large quantity of cranes are now supplied with machine-cut gears throughout. In deciding how many of the gears of a crane ought to have the teeth machine cut, some consideration should be given to the work the crane is likely to have to do. If the speeds are high, or the crane is going to be in continual use, it will pay to have as many of the gears machine cut as possible, because the subsequent saving in electric current will soon pay for the extra first cost.

For constantly-working high-speed cranes up to seven-tons load, it will be found the most satisfactory to have machine-cut gears throughout, including the barrel wheel and pinion. For all sizes above seven tons it is not advisable to machine cut the barrel gear and pinion even for the best class of work, partly owing to the fact that it is desirable to shroud the pinion of this pair of wheels; and as the speed is low, the loss in power due to friction is not worth consideration. For cheap cranes, and those required for intermittent working, as in engine rooms for instance, it is only necessary to have the first reduction for each motion machine cut.

Raw hide or buffoline motor pinions have been found suitable, and are to be recommended for the first reduction for cranes up to twenty-tons load. The gear with which this pinion meshes should be of cast iron, since it has been found that the strength of raw hide and cast iron teeth are about the same. The principal advantages of raw hide pinions are that they run almost noiselessly and do not require any lubricant. A gear case need not be provided for this reduction unless the crane is working in a very damp location. For cranes above twenty tons the motor pinion ought to be of machine steel, running with a cast iron or steel gear, preferably in an oil bath, the latter taking the form of a cast iron gear case.

It is generally found advisable to make small machine-cut pinions of machine steel, the blanks usually being cut from ordinary rolled bar, or forged to size. When this is done, the pinion teeth are considerably stronger than those of the gear, if this is made of cast iron, and about equal in strength to those of a cast steel gear.

For cranes up to twenty tons the barrel gear and pinion can be of cast iron; above this size cast steel is preferable, and in all cases above seven tons the pinion should be full shrouded, thereby making the teeth about equal in strength to those of the gear. For cranes above twenty tons it is considered good practice to make all pinions of steel, whether they are machine cut or not; while for cranes which are very severely handled and constantly on full load, as for instance steel works and forge cranes, the purchaser will probably find it most satisfactory in the end to have steel gears throughout for all motions. It will be found satisfactory for ordinary work to have cast iron gears for cranes up to twenty tons, and above this size and up to forty tons to have all pinions and the barrel gear of steel and the remainder cast iron. Cranes above forty tons should preferably have steel gears throughout.

In order to keep down the size of the crab in every way, the pinions should be kept as small as possible consistent with smooth running, but at the same time no pinion should ever have less than twelve teeth, since below this size pinions run badly and are very weak, and cutters for a smaller number of teeth are not usually on hand.

Strength of Teeth in the Gears.

The most important question concerning the gearing lies in the strength of the teeth, and a great variation is found in practice in the stress to which the material is subjected. Upon examining the practice of various firms, one finds that while some stress the cast iron barrel gear teeth to one ton per square inch, and the steel gear teeth to three tons per square inch, others work to as much as three and six tons per square inch, respectively. Now the average ultimate strength of cast iron and cast steel subject to bending as in a tooth is eighteen and thirty tons, respectively, but it is possible for either of these values, and particularly that of cast iron, to be considerably reduced by a lack of homogeneity in the metal, which may never be detected even if it is not wholly internal. With due consideration to the above fact, one is justified in allowing a factor of safety of 8 for cast iron, and 6 for steel for slow running.

Several convenient tables have been compiled for rapidly arriving at the pitch and width of the teeth, but before referring to these it is advisable to calculate the strength. The teeth of gearing used for crane work are of the involute pattern with radial flanks which gives a fairly short tooth with a broad root, and are consequently of the greatest strength.

Prof. Unwin states that the load which falls upon one tooth lies between one-half the full load and the total load, and is generally taken at two-thirds the full load, but if the pinion is small, it is common practice to consider the full load as taken by one tooth. When the pinion is of steel and the gear of cast iron, or the pinion is full shrouded, the gear teeth can be considered weaker or equal to those of the pinion, and the strength calculated accordingly to suit the shape of the teeth in the gear. Prof. Unwin also states that the agreed percentage of the full load will act, at one particular period, on the full length of the tooth, and this should be allowed for.

In calculating the strength of a tooth, it must be regarded as a cantilever, and made strong enough to resist the consequent bending moment. As an example, find the stress in the teeth of a steel barrel gear having 108 teeth of $1\frac{3}{4}$ inch circular pitch by 5 inches wide, and keyed onto the barrel of a 30-ton crane; diameter of barrel, two feet, fifteen tons load on the barrel. The diameter of the gear is approximately 5 feet.

$$\text{Load on tooth} = \frac{15 \times 2}{5} = 6 \text{ tons.}$$

$$\text{Maximum load at full length of tooth} = \frac{2}{3} \times 6 = 4 \text{ tons.}$$

$$\text{Full length of tooth} = 1.09 \text{ inch.}$$

$$\text{Bending moment} = 4 \times 1.09 = 4.36 \text{ inch-tons.}$$

$$\text{Modulus of tooth at root} = 1.03.$$

$$\text{Stress} = \frac{4.36}{1.03} = 4.2 \text{ tons per square inch,}$$

which is a suitable working stress for slow running cast steel gears.

Some makers shroud the barrel gear and pinion to the pitch line, but if the strength has been calculated as shown above, this form of shrouding does not add to the strength required to resist bending, because if the bending moment and modulus are taken at the pitch line, they will be in similar proportion to those found at the root. The principal value of half shrouding is in minimizing the tendency the teeth have to break across the corner, especially with cast gears where the teeth may not bear evenly together, or may not be parallel to each other.

TABLE VI. ALLOWABLE FIBER STRESS IN GEAR TEETH.

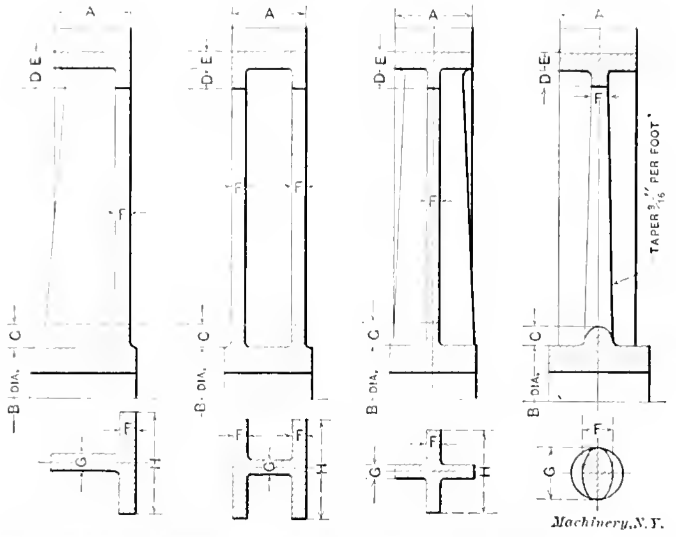
Material	Speed at Pitch Line in Feet per Minute.							
	100	200	300	600	900	1200	1800	2400
Cast iron........	4800	4200	3800	3200	2400	1920	1600	1360
Cast steel	12000	10500	9600	8000	6000	4800	4000	3400
Gun-metal	7200	6300	5760	4800	3600	2880	2400	2040
Machine steel ...	19200	14410	11200	9600	7200	5760	4800	4080

For heavy cranes, say 30 tons and upwards, double helical gears for the barrel gear and pinion have been used with advantage, since they insure a freedom from shock. That helical gearing is much stronger than spur gearing there is no

doubt, but there are many opinions as to their relative values. Since the points of contact on a well made tooth of this type at any moment are distributed over the whole of the working face, from root to point, the average leverage of the whole load is only half that of ordinary spur gears. Then, again, the developed width of these teeth is more for a certain width of wheel, and in calculating the strength, this can be taken into account. It is not safe, however, to allow in full for all these advantages over ordinary spur gears, owing to the fact that in practice it has been found difficult to make the apexes of each pair of teeth run in the same plane, and hence the load may be thrown on one side of the gear only. This difficulty may be avoided to some extent by allowing a little lateral play on the pinion shaft whereby the pinion will adjust its position to suit the gear, and consequently equalize the stresses somewhat. In the absence of any reliable data on the strength of these gears, they are seldom considered as more than one and one-half times as strong as ordinary spur gears.

TABLE VII. DIMENSIONS OF GEAR RIMS AND ARMS.

P = circular pitch; b = bore.



Form of Arm.	A	B	C	D	E	F	G	H (at rim)
T section.........	$3P$	$1\frac{7}{8}b$	$\frac{5}{8}P$	$\frac{9}{16}P$	$\frac{1}{2}P$	$\frac{1}{2}P$	$\frac{1}{8}P$	$2\frac{1}{4}P$
I-section..........	$3P$	$1\frac{7}{8}b$	$\frac{5}{8}P$	$\frac{9}{16}P$	$\frac{1}{2}P$	$\frac{1}{2}P$	$\frac{1}{8}P$	$2\frac{1}{4}P$
+-section........	$3P$	$1\frac{7}{8}b$	$\frac{5}{8}P$	$\frac{9}{16}P$	$\frac{1}{2}P$	$\frac{1}{2}P$	$\frac{1}{8}P$	$2\frac{1}{4}P$
Oval section......	$3P$	$1\frac{7}{8}b$	$\frac{5}{8}P$	$\frac{9}{16}P$	$\frac{1}{2}P$	$\frac{1}{2}G$	$2\frac{1}{8}P$	.....

In calculating the pressure on the teeth of any pair of gears, it is, with the exception of the barrel gear and pinion, more correct to allow for the load due to the maximum torque of the motor, than to take the reaction from the load, since this latter does not allow for the resistance due to the friction of the intermediate gearing.

The stresses to which gear teeth may be subjected depend principally on the pitch line speed, and the nature of the work to be done; *i. e.*, whether running under a steady load in one direction, or subject to varying loads and quick reversal, as in cranes.

The most convenient way for calculating the strength of gear teeth is by the Lewis formula. This formula is:

$$W = SPFY,$$

in which

W = force at pitch line in pounds,

P = circular pitch,

S = allowable fiber stress for the material used, in pounds per square inch (see Table VI),

F = width of face of gear,

Y = the factor known as the Lewis outline factor which varies with the number of teeth and the form of gear tooth.*

Applying this formula to the previous example, we have: $S = 12{,}000$ (from Table VI); $P = 1.75$; $F = 5$; and $Y = 0.118$ for 108 teeth and 15 degree involute gearing. Consequently,

$$W = 12{,}000 \times 1.75 \times 5 \times 0.118 = 12{,}390 \text{ pounds.}$$

Dimensions of Arms, Rim and Hub.

The proportions of the arms, rim and boss of a gear are often determined by practical considerations of casting, but at the same time the strength of the arms may be calculated and it is well to do this for large wheels transmitting heavy loads. There are several different kinds of sections of arms in use. The I-section is probably the most extensively used for machine molded gears in England, but it is not as commonly used in the United States; it is very strong but it is the most expensive, since the space between the arms must be cored. The T-section and +-section are often used, but are not as strong as the I-section. Oval and rectangular sections are coming more into use, and possess the advantages of strength, cheapness in patterns, and simplicity in molding—an advantage which, in turn, gives good castings.

To calculate the strength of the arms it is necessary to find the bending moment at the root; it is generally agreed that each arm takes its share of the peripheral load, therefore, the bending moment in each arm equals the load at the pitch line in tons multiplied by the distance from the pitch line to the root of the arm in inches, and divided by the number of arms. This quantity divided by a maximum of 2 tons for cast iron and 4 tons for cast steel gives the modulus required by each arm at the root, which can be found from the usual formulas for each section. For small gears it is hardly necessary to make this calculation, but proportion each part of the arms, rim, or boss to some function of the pitch. There are several tables of these proportions used in practice, and Table VII may be taken to represent a fair average.

The number of arms generally adopted in crane practice is:

Four for gears up to 3 feet diameter.

Six for gears from 3 feet to 6 feet diameter.

Eight for gears above 6 feet diameter.

Gears below one foot diameter are generally made with a solid plate web, possibly relieved with some holes. The thickness of this web should be about one-half the pitch, and the proportion of rim and boss should remain practically the same as for the armed wheels.

* * *

Several months ago we received a letter from an educator stating that a man was wanted to take charge of the school work of his institution, in machine design, and that the salary would be from $1,400 to $1,600. A man was required who was competent as a machine designer, being one who had had charge as chief draftsman, or in similar capacity, of all the designing for some concern manufacturing engines, pumps, machine tools, etc. In short, this man must be one who is able to design good-looking machines by the instinctive process as well as by the cut-and-dried rules of design.

It is hardly necessary to say that a first-class machine designer who not only has the qualifications gained by long experience, but also the analytical mind, the clearness of expression and magnetic quality that would fit him for a teacher, probably would be difficult to secure at double the salary offered. The low salaries offered by many leading engineering schools for important positions tend to fill the instructor ranks with men of only average ability, whereas such men should, in our opinion, be superior in education and mental force. It is little wonder that students graduating from some of our famous institutions are poorly fitted for engineering work until they have passed through a trying-out process. They have not felt the mental stimulus of a master mind.

* * *

Some experiments which will prove valuable in aeronautics have been carried out by Professor Albert Frank of the Hanover Technological Institute in Germany. The report, as given in the *Zeitschrift des Vereines deutscher Ingenieure* states that 236 square feet of side surface develop no more resistance to the air than does one square foot of front surface placed perpendicular to the direction of motion. This indicates that comparatively small propeller surfaces are required as compared with the surfaces of the planes themselves in an aeroplane, to force the machine through the air.

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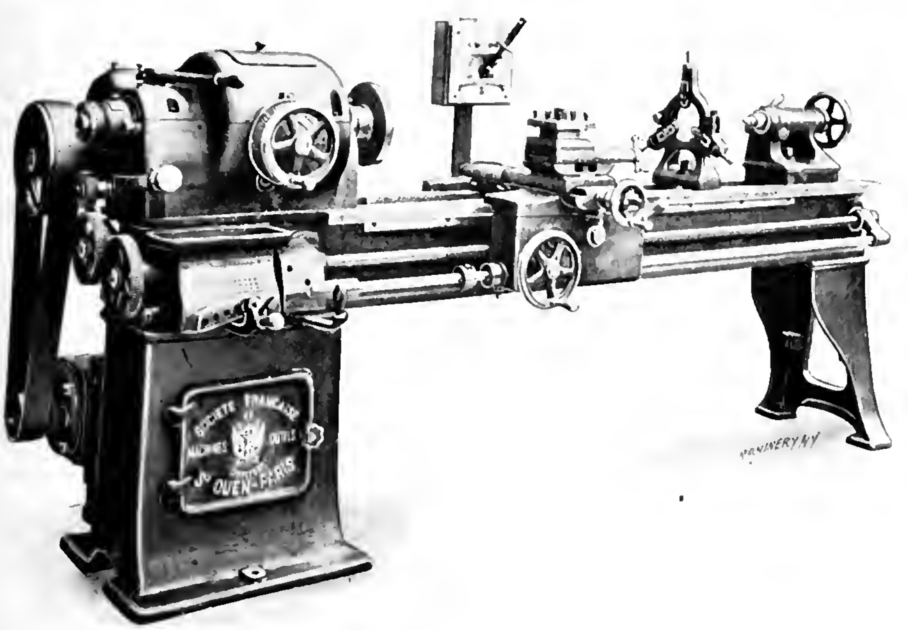
* A table of the outline factors used in the Lewis formula may be found in Kent's "Mechanical Engineers' Pocket-book," page 901, and also in MACHINERY'S Reference Series, No. 15, Spur Gearing, page 45, and in MACHINERY'S Data Sheet No. 22, July, 1903.

SOCIETE FRANCAISE DE MACHINES-OUTILS SINGLE-PULLEY-DRIVE LATHE.

As our readers know, a machine tool building concern has recently been organized in France for the manufacture of machine tools of the most advanced type, particularly those applicable to automobile work. It will be remembered that Mr. Kylin, in his letter in the July issue of MACHINERY, stated that they were building a geared head and a cone-head lathe, a turret lathe of the Potter & Johnston type, an automatic dowel pin machine and a spur gear planer designed by Monsieur Mardin, the manager; and that they intended to take up the making of planers and vertical boring and turning mills. We show herewith an illustration of the geared head lathe manufactured by this firm. It appears to be of original design, and presents a number of features of interest.

The first noticeable departure from American practice to strike the eye, is the use of rectangular ways in place of the V-sliding surfaces to which we are accustomed. The carriage, steady-rest and tail-center, are supported by the same flat surfaces, the carriage being guided by the outer edge of the ways, while the two heads are confined between the inner edges. This is in accordance with approved European usage. The bed is of heavy and rigid section, mounted on a cabinet base at the head-stock end.



Single-pulley Lathe with Motor Drive, manufactured by Societe Francaise De Machines-Outils.

The head-stock is of the single pulley type, and is provided with an unusually convenient arrangement for changing the speeds. The hand-wheel at the front of the enclosed head-stock gives eight changes of speed in geometrical progression, with no other movement than turning it from one position to another, as indicated by the large dial attached to its hub. The back gear arrangement doubles this number of speeds. It is controlled by the lever seen projecting forward over the rear spindle bearing. This may be used for starting and stopping the machine as well as for changing the speed. The single pulley drive has all the well-known advantages of this arrangement in avoiding the necessity for a complicated counter-shaft, allowing flexibility in the placing of tools, and making the matter of driving the tool by an electric motor a very simple one. In the case shown, the motor is mounted at the rear of the cabinet base, and is belted to the driving pulley. An ingenious and convenient feature is the mounting of the starting box on a support at the rear of the carriage. On long beds this is more convenient than mounting it in a fixed position on the machine.

The spindle is of high carbon steel and ground to size. The boxes are of hard bronze with cylindrical bearings and conical exterior surfaces, and are adjusted to fit the spindle by being shifted axially in their conical seats in the head-stock. A ball thrust bearing running in oil takes the axial pressure on the spindle.

A geared feed is provided, through the quick change box shown. This provides for six changes. The gears connecting it with the head-stock stud provide four more combinations, which give 24 changes of feed in all. This number, of course, may be multiplied indefinitely by using special gears. A splined feed rod and a lead screw are provided as in approved modern practice, it not being necessary to use the lead screw for turning, as is the case on many European makes of lathes. The feed rod has an endwise movement which operates a disengaging clutch, providing an automatic stop for the carriage. This is operated by the striking of the carriage against the adjustable stop collar shown on the feed rod. The disengaging clutch, thus controlled, is operated by the handle shown just at the right of the quick change handle. This serves also to connect the feed screw, it being impossible to throw the feed rod and the lead screw into action at the same time. The apron has double walls, giving firm support to all the mechanism which it contains. It provides for cross and longitudinal feed and for thread cutting. It is impossible to engage either of these three movements until the other two are disengaged, thus obviating all possibility of accident on this score. The use of the positive geared feed permits also, through the positive power cross-feed, the cutting of spirals on face-plate work.

The tool-post is four-sided, and may be swung like a turret to any one of four positions, in either of which it is positively locked by a bolt. This is especially useful in repetition work, as it permits the continuous changing of tools, and bringing them back exactly to their former position. As is common in foreign lathes, the compound rest is regularly provided, and is usually used for plain straight turning; when set parallel with the ways of the lathe, as shown, the workmen employ it for the fine longitudinal adjustments of the tool. The tail-stock is cut away to allow this, as is common nowadays in American practice. The tail-stock is so arranged as to permit its being released from the bed for a new longitudinal adjustment without disturbing its cross-wise adjustment.

The machine is provided with small and large face-plates (the latter being provided with holes instead of slots), the necessary gears and wrenches, a center rest, and follow rest. A reversing counter-shaft is provided for belt-driven machines, and an attachment plate for electric motors when the machine is to be electrically driven. A device for truing the centers is also furnished.

* * *

In the quarrying of granite, large laminations or sheets of granite are separated from the main rock by an interesting operation called the "lifting" process. A groove is cut to the required depth all around the section of stone to be separated from the main body of the rock. In the center of the area to be lifted a drill hole two or three inches in diameter is sunk six or eight feet in depth, according to the required thickness of the stone. At the bottom, the drill hole is enlarged into a pocket, by exploding a charge of dynamite. Then some powder is exploded in the pocket thus formed. This will start a horizontal crack or cleavage, and as new charges of powder, increasing in size, are exploded in the cavity, the drill hole being plugged at every blast to confine the gases and cause constant force to act upon the stone, the crack will extend say from 75 to 100 feet in all directions from the lift hole. A pipe connecting with air compressors is then cemented into the hole, and air, of a pressure from 70 to 80 pounds, is pumped until the crack or cleavage extends to the edge of the rock. Sheets of stone of large size can be thus lifted, thereby affording the quarrymen a plane to work to, so that the stone can be drilled and split to proper sizes for the purposes required.

CLEARANCE OF MILLING CUTTERS.*

HARRY A. S. HOWARTH†

The object of this article is to show graphically the factors that determine the clearance which should be ground on milling cutters. This will be done by drawing the cutting curves for a given cutter working under an exaggerated feed per revolution. The discussion will cover the following points:

1. A cutting edge leaves behind it, in the work, a curved path which lies within the circumference of the cutter. The angle between this curve and the circumference determines the clearance required.

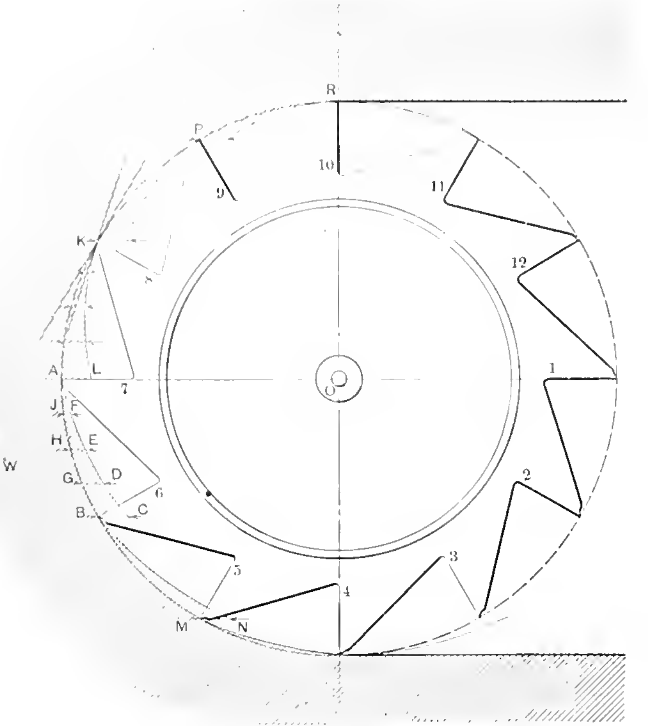


Fig. 1. Principle of Action of Milling Cutter.

2. This angle depends upon the feed, depth of cut, cutter diameter, and spindle speed.
3. Cutters with radial faces cut with a top rake equal to the clearance angle.
4. A coarse tooth cutter can mill a flat surface if it runs true.
5. Chattering is peculiarly dependent upon clearance, relation of tooth pitch to depth of cut, and combinations of pitch and spindle speed.
6. The pitch of cutter teeth depends upon the degree of finish wanted, depth of cut, amount of metal removed, and properties of the material being cut.
7. The diameter of a cutter should not be larger than that necessary to insure rigidity under the working conditions.
8. Repeated grinding necessitates an increase, each time, of the apparent clearance, it being gaged by the depth of the heel of the cutting edge below the cutter circumference. Excessive grinding necessitates slower feeds and speeds.

Clearance Angle.

In Fig. 1 is shown a cutter assumed to be 6½ inches in diameter. It has twelve teeth, and is represented cutting its way through a solid block of metal so that the teeth are cutting during one-half of a revolution of the spindle. The work W is fed against the cutter at the rate of four inches per revolution of the spindle, i. e., 1/3 inch per 1/12 revolution of the cutter.

Let us examine tooth No. 7. Its point *A*, while turning from *B* to *A* has cut the path *C D E F A* in the work *W*. When *A* was at *B*, the point *C* on the work was also at *B*. To make this clear, imagine the cutter to revolve backward and the feed to be reversed. As *A* turns to *J*, which is one-quarter the distance to *B* on the circumference, the point *F* in the work recedes to *J*. The distance *J F* is 1/4 × 1/3 = 1/12 inch. Similarly, if *A* moves to *H*, the point *E* recedes to *H*. The distance *E H* is 1/2 × 1/3 = 1/6 inch. Following up this method, we have *D G* = 1/4 inch, and *C B* = 1/3 inch. These distances are measured parallel to the direction of the feed, and the curve *A C* is part of a cycloid.

As the work feeds against the cutter each tooth thus leaves behind it a curved parth which lies within the circumference of the cutter.

At the point *K* in Fig. 1 draw a tangent to cutting curve *L K*. This represents the direction of motion of the cutting edge *K* with respect to the work at this instant. Draw also a tangent to the circumference of the cutter at *K*. This represents the direction of motion of the cutting edge *K* with respect to the spindle. The angle between these two tangents represents the minimum angle of clearance at *K* which will allow the work to advance toward the cutter at the rate of feed assumed, *i. e.*, 4 inches per revolution of the spindle.

Factors Determining the Clearance Angle.

It is evident from the cutting curves drawn that the angle between the two tangents will not be the same at *M*, *B*, *A*, *K*, *P* and *R*. It also appears that the angle is maximum at a point, above the center line *A O*, and in the neighborhood of *K*. It seems clear that tooth No. 8 requires more clearance to cut at *K* than tooth No. 6 requires to cut at *B*. Yet these teeth are symmetrically opposite with respect to the center line of the cut. This fact has a significance which will be noted later.

It is theoretically impossible to feed work at a given rate against a cutter unless the shapes of all the teeth back of the cutting edges conform to that cutting curve which makes, with the circumference of the cutter, the maximum angle corresponding to the given feed.

In order to find graphically the exact point which under the given conditions requires the greatest clearance, the single curve shown in Fig. 2 may be drawn. This represents the path that would be cut by a single tooth making a complete revolution while the work moves a distance equal to *Z R* or *U V*. Suppose the center of the arbor is at *V* and the single tooth is at *R*. Consider the cutter as advancing toward the work. When *V* moves to *X* and the cutting edge moves to *Q* directly ahead of *X*, the cutter has made a quarter turn. If the feed is 4 inches per turn, the distance *V X* = 1 inch. As *V* advances from *X* to *Y*, *R* moves from *Q* to *S* directly above *Y*, and *X Y* = 2 inches. In this manner the tooth describes the path of the cycloid *R S Z* while the spindle advances 4 inches or from *V* to *U* and makes one complete revolution.

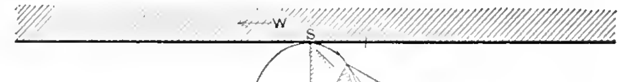


Fig. 2. Path of Milling Cutter Tooth, when Feed is less than Circumference of Cutter.

Assume the cutting edge to be at some point *A*. The corresponding position of the spindle is *B*. Construct the two tan-

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* The following articles on milling cutters have previously appeared in MACHINERY: A Milling Cutter Working on a New Principle, March, 1904; The Shaping, Grinding and Hardening of Milling Cutters, December, 1904, engineering edition; Tool Making: Milling Machine Cutters, January and February, 1905; Milling Cutters, April, 1906; Cutters of Cold-rolled Steel, July, 1906; Milling Machine Output, October, 1907, engineering edition; Setting Angles for Milling Angular Cutters, November 1908, engineering edition; New Type of Milling Cutter, December, 1908; Development of a High-Speed Milling Cutter with Inserted Blades, December, 1908, engineering edition; Efficiency Tests of Milling Machines and Milling Cutters, December, 1908, engineering edition.

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gents at A; $C A$ is tangent to the cycloid; $A D$ is perpendicular to the radius $A B$. Angle $C A D$ is the clearance angle required at A. A few similar constructions at points Q, E and S, etc., show by comparing the angles that the position of greatest required clearance for this case is at some point E.

The position of greatest clearance E varies with the ratio of the feed to the diameter of the cutter. If the diameter is kept constant and the feed reduced, point E will approach Q. It reaches Q when the feed is zero. Thus the limiting position of clearance E is at the center line $Q V$ when the cutting curve becomes a circle and U and V coincide. At this limit the clearance angle becomes zero.

When the feed per revolution is increased so as to equal the circumference of the cutter, the cutting curve becomes as shown in Fig. 3. Here the limiting position of greatest clearance is S_1 at the apex of the curve. At this point the clearance becomes 90 degrees.. This is shown by drawing the series of clearance angles as before mentioned.

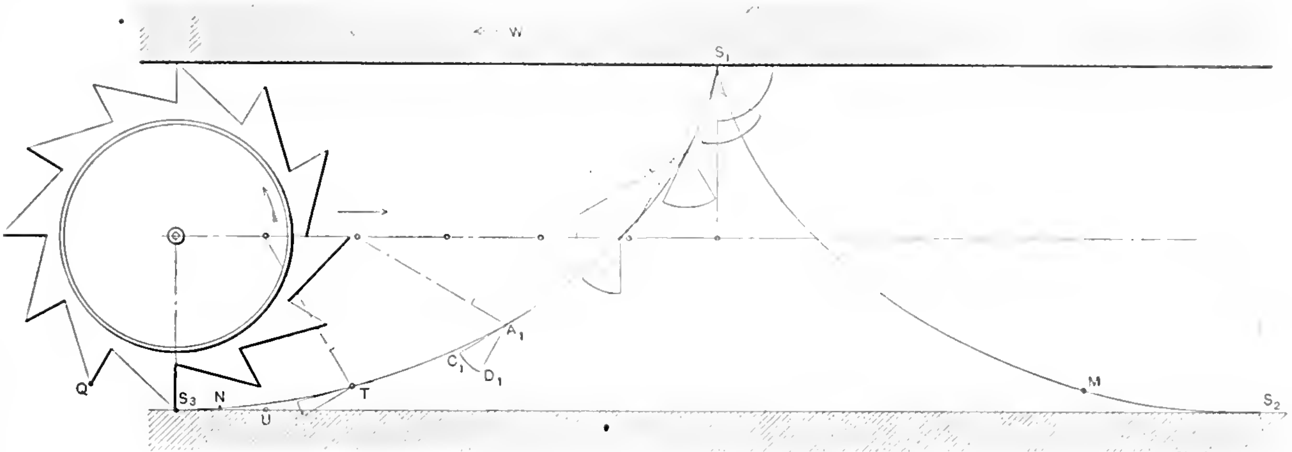

Fig. 3. Path of Milling Cutter Tooth, with en Imaginary Feed equal to the Cutter Circumference.

Of course, these two extremes are impossible cases practically, but under certain conditions they are approached, as when a cutter with no clearance whatever is put to work; and when a cutter is started in the wrong direction over a piece of work and draws the work under it at a speed equal to its circumferential speed.

The conclusions resulting from the previous discussion are as follows:

(*a*). The point of greatest clearance rises from Q to S (see Fig. 2) as the rate of feed is increased from zero to the cutter circumference per revolution of the cutter.

(*b*). The greater the ratio of the feed per revolution to the diameter of the cutter, the greater is the clearance required. This clearance does not depend on the number of teeth in the cutter.

(*c*). The cutting curves shown represent the minimum limit of the clearance which must be ground on cutters running under the conditions assumed. Practically more clearance must be used in order to avoid rubbing the heel of the tooth when cutting.

(*d*). The discussion so far has assumed the cutter to be milling a slot of a width equal to its diameter. This is not always the case. The cut may vary from the diameter of the cutter down to practically nothing. The less the depth of cut below the point K, Fig. 1, the less is the clearance required on the cutter for a given ratio of feed per revolution to cutter diameter. For light finishing cuts very little clearance is therefore necessary.

(*e*). Hence it is evident that a cutter ground for a light surface cut will not work properly on a deep cut unless the feed is correspondingly reduced. Conversely, a cutter ground for a deep cut can be fed much faster on a light cut.

Positive Rake of Milling Cutter Teeth.

Since milling cutters for steel and iron are almost all made with radial faces, the idea is prevalent that the cutting action of the teeth is much the same as that of a planer tool which has no top or side rake, cutting as shown in Fig. 4, with the face of the tool at right angles to the direction of feed. This analogy is nearly true for slow feeds; but if we examine in Fig. 2 the angle which the face of the tooth makes at E with the tangent $E H$ to the cutting curve, we see that for this coarse feed the tooth has considerable top rake as indicated by the angle a. This fact throws some light onto the reason why coarse feeds are more efficient than fine ones for removing metal. By efficiency we mean the capacity for removing metal, as measured in such terms as pounds of metal per horse-power per hour. On all tools, where practicable, rake is used because of its distinct advantage as a power saver. Consideration will be given later to the relation of coarse feed to the number of teeth in a cutter.

Milling cutters whether with fine or coarse teeth will produce a very flat surface no matter whether the feed be fast or slow. This is evident by examining the cutting curves in Figs. 2 and 3 at the point R, Z, S and S_2. They are nearly flat. In Fig. 3, as the tooth S_3 moves to T, the tooth Q moves to U in a path similar to the end of the cycloid at $M S_2$. The two curves would cross midway between U and S_3 at a point N. The height of N is very little above the line S_3U. For fine feeds this height would become infinitely small.

The ridges so often thought to be due to coarse feed are due to the cutter being run out of true, *i. e.*, eccentric. This action is caused by a number of things such as untrue spindles, sprung arbors, and cutters with holes too large for the arbor, or even by cutters ground on sprung arbors, etc. The common effect of all these causes is that the cutter mills deeper at one part of the revolution than another. The number of turns it makes in crossing a piece of work may be found by counting the ridges produced.

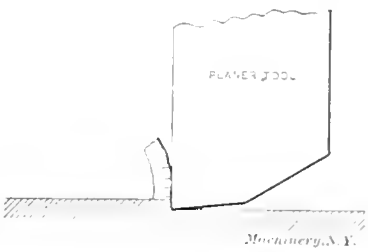

Fig. 4. Planer Tool without Front Rake

It is thought by many that a spiral tooth cutter will mill a flatter surface theoretically than a straight tooth cutter. This is only true practically, because the spiral action prevents vibration. Theoretically, the only difference would be that the ridges produced by one would be parallel to the spindle while the other would be diagonal.

Chattering.

Chattering is due to variations of pressure between the cutter and the work. When a corner of the work advances toward a cutter, as in Fig. 5, point A, the first tooth to strike it springs back as it cuts. As it passes the corner it jumps forward. This action is repeated by each tooth and it sets up a vibration of the cutter and arbor which continues until the cut is well under way, as at C, Fig. 5. If the cutter has excessive clearance, the vibration will cause it to feed deeper than necessary at the instant when the cutter vibrates toward the work. This action causes the formation of notches. These notches or grooves once formed are apt to follow clear through the cut and keep up the chattering.

The vibration is begun by the intermittent action of one tooth. Soon two teeth begin to cut part of the time (see position *B* in Fig. 5). Here the pressure variation becomes due to the difference between one tooth and two teeth. As soon as three teeth begin cutting part of the time, the pressure variation is between two and three teeth, and so on. The more teeth bearing on the work at one time, the less is the pressure variation.

We have assumed above the use of straight face cutters; but they are not always used. The best practice recommends cutters with a slight spiral. Then the initial shock is reduced and the first tooth takes an appreciable time to perform its cut. On wide cuts it is practical to have the second tooth begin cutting before the first finishes its cut. Still there exists a variable pressure which can cause vibration, though it is not so great as with a straight face cutter.

A given combination of cutter and arbor will have a definite period of vibration, just as a violin string of given length, thickness and tension will vibrate at a definite rate and produce a certain sound. Sometimes the spindle speed and cutter pitch are such that they cause chattering that matches closely to the period of vibration of the cutter and arbor. They may be said to be in tune, though the noise that results is frequently anything but music. This can happen with spiral cutters as well as with straight tooth cutters, though the action will not be so pronounced.

The remedy is twofold: Reduce the clearance, if excessive; change the spindle speed. A change of feed will have little effect except as it tends to make use of excessive clearance. Using a cutter of different diameter will frequently help, beause it breaks up the noisy combination.

Number of Teeth.

The considerations that govern the number of teeth in a cutter are as follows:

(*a*). Degree of finish required.
(*b*). Depth of cut.
(*c*). Amount of metal removed per revolution.
(*d*). Kind of material being cut.

There are other considerations that depend more or less on these, and these four depend a great deal on each other.

(*a*). A fine tooth cutter will produce a better finish for a given speed and feed than a coarse tooth cutter. Since finishing cuts are light, the use of a coarse tooth cutter would cause chattering because of the variation of pressure due to the probable action of one or two teeth intermittently, as before noted; hence finer tooth cutters are better for finishing.

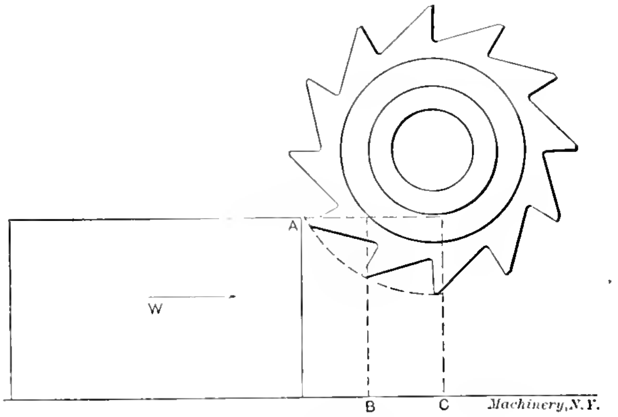

Fig. 5 Action of Cutter, just Starting to Cut.

(*b*). The deeper the cut the more teeth of a given cutter will be in action at one time. There is no object in having this number too large. In fact, it is a distinct disadvantage, because the feed has to force all the teeth into the work.

(*c*). The amount of metal removed per revolution depends on the rigidty of the work, *i. e.*, the method of holding it, and its capacity to withstand the pressure of the cut. The space between two cutter teeth has to carry the metal removed by one tooth during its cut. The area of this space varies as the square of the pitch of the teeth. Hence the relative ability of the space to carry away metal becomes greater as the pitch increases. Coarse teeth are therefore best fitted for rapid cutting. It might seem that coarse feeds require extra power in proportion as they are increased. This is not so, because the top rake or wedge-like action of the teeth makes it easier for them to enter the work. As the feed is increased the top rake is increased, hence the resistance increases at a slower rate. It might be mentioned that the top rake is equal to the theoretical clearance required at the point under consideration. This is true when the face of the tooth is radial.

(*d*). The kind of material to be milled affects the pitch of the teeth in general, as follows: The harder the metal, the fewer the teeth or coarser the pitch; the softer the metal, the finer the pitch, because the cutter must have some support at its cutting edges or it will enter the work too eagerly. For soft metals, such as brass, the additional precaution is taken of making the teeth faces slant ahead of the axis of the cutter instead of radial. This reduces the top rake. The spiral of cutters is more rapid on cutters for soft metals, because of the greater danger from chatter.

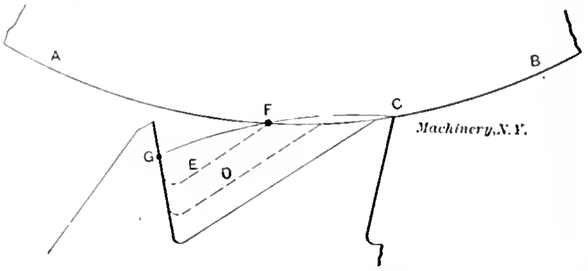

Fig. 6. Effect on Clearance caused by repeated Grinding of Cutter Teeth.

Diameter of Cutter.

For a given feed per tooth and a given pitch, a reduction of the diameter of the cutter has the effect of increasing the necessary clearance and the resulting top rake. It also decreases the torsional strain on the arbor, the shearing stress in the cutter key, and the frictional force in the spindle taper. It reduces also the strain thrown on the driving gears of the spindle, and a saving of metal in the cutter is affected, but since the number of teeth are fewer, they are used oftener and wear out more quickly. Experience seems to prove the advisability of using cutters as small as possible without reducing too much the rigidity, or the reasonable allowance for recutting.

Grinding Cutters.

Consider a given cutter running always at the same feed per tooth. In Fig. 6 two teeth are drawn with the cutting curve *C F G* between them. The arc *A B* represents the position of the grinding wheel when grinding the clearance which was necessary when the cutter was new. The dotted lines *D* and *E* represent the flank of the tooth at two stages of its life before recutting. When regrinding has brought the flank to *E*, the heel of the tooth *F* will lie on the cutting curve. To lower this point below the cutting curve requires a smaller wheel. But this has the effect of weakening the cutting edge at *C* by reducing the angle of the point. This makes overheating more likely to occur.

Cutters should seldom be ground away so much as shown here because the space between the teeth is reduced so much that it will not carry the chips away properly. When the distance *F C* becomes half the pitch, the chip space becomes nearly one-fourth what it was originally.

The previous discussion seems to suggest the necessity of having some means of modifying the clearance ground on a cutter so that its performance will be uniform after successive grindings. In this way the maximum results would become more nearly possible, because another of the uncertainties in the use of milling cutters would be eliminated.

* * *

"Alas!" confessed the penitent man, "in a moment of weakness I stole a carload of brass fittings."

"In a moment of weakness!" exclaimed the Judge. "Goodness, man! what would you have taken if you had yielded in a moment when you felt strong?"—*Exchange.*

MAKING SAWS.

ETHAN VIALL *

Owing to the fact that many of the machines used in saw manufacturing are designed and made by each firm for its own use, and also to the fact that many of the processes in saw making have been developed along independent lines, there are many things in a saw factory which are not generally known, and the processes are often regarded as trade secrets. However fallacious this policy of secrecy may be, it is followed by nearly all saw manufacturers; yet it is safe to say that not one firm is in ignorance of the important processes and methods used by its competitors.

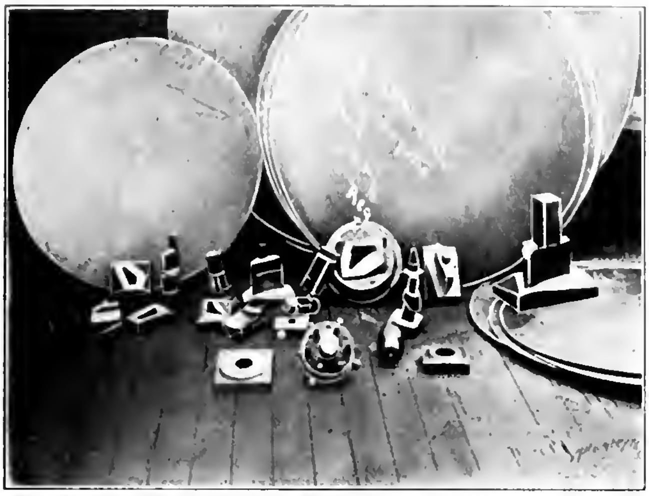
Fig. 1. Steel Disks for Circular Saws, and Punches and Dies for Center Holes and Teeth.

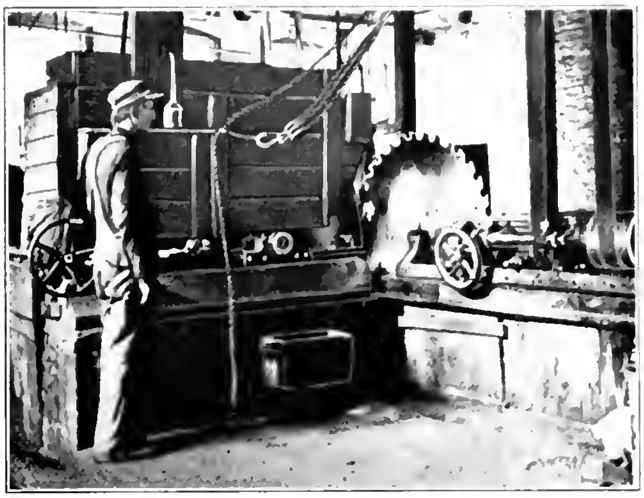
Fig. 2. Machine for Grinding the Sides of Circular Saws


Fig. 3. Hammering and Tensioning a Circular Saw.

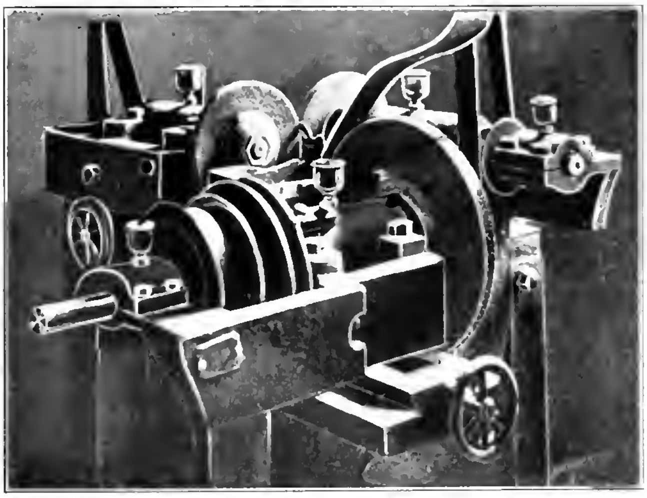
Fig. 4. Special Three-wheel Grinder for Grinding the Teeth of Inserted Tooth Saws.

E. C. Atkins & Co., of Indianapolis, Ind., is one of the few saw manufacturers realizing the futility of trying to keep their machines and processes secret. This firm, which is one of the largest and oldest manufacturers of saws in the United States, through the courtesy of Mr. Atkins, the superintendent, gave the writer the opportunity of taking a number of photographs, and obtaining the information necessary to give the readers of MACHINERY an idea of how the Atkins saws are made. This company turns out thousands of band saws, but the main product is large circular and large band saws. The circular saws are of two general types, the solid and the inserted tooth.

The steel for the saws, which is made especially for the firm, comes in circular disks or in long strips or bands of the proper size and standard gage for the various standard circular and band saws made. A number of the steel disks from which the circular saws are made, are shown in Fig. 1. Several center hole and tooth forming punches and dies are also shown in this engraving.

In working up the steel disks into saws, the center hole is first punched in a punching press, and in the next operation the teeth are cut. The operator selects a tooth-forming punch and die corresponding to the number of teeth required. These are set up in the press and an indexing disk of the same number of teeth as required in the saw is placed on a stud, as shown at A in Fig. 5. The saw blank is then placed over this indexing disk and securely clamped by means of a nut on the stud. The carriage holding the blank is then moved in or out, and the entire fixture moved to the right or left, until the disk is in the correct position for the punch to cut the teeth at the proper angle and depth. The teeth are then rapidly cut, the spacing being obtained by the indexing plate. All of the circular and inserted tooth saws are cut out by using this kind of punch press jig.

When hardening the saws, they are laid flat in a special gas furnace, and heated slowly. When evenly heated, the saw is drawn out and placed on the lower plate of a grated clamp, as large or larger than the saw, and a similar grated plate is lowered from above. The saw is thus kept flat, and prevented from warping, and is quickly lowered into a large tank of oil. When the saws are taken out of the hardening bath, they are placed in the machine shown in Fig. 2, where the sides are ground. This machine is provided with a large grindstone, which is fed in or out by means of a hand-wheel, shown just back of the operator. The saw is placed on an arbor mounted on a carriage which automatically feeds it across the face of the grindstone. The grinding begins at the outer edge of the saw, and as the operation proceeds, and the grindstone is gradually fed in toward the center, the saw is made thinner in the center than at the edge. This method provides a free-cutting saw with little tendency to bind.

While grinding, the saw revolves in the same direction as the grindstone, but more slowly, as belt-driven rolls, one on each side of the saw, act as brakes, and thus make grinding possible. The practice of running the saw in an opposite direction from that of the wheel, usually followed in grinding small milling saws, would be practically impossible in this case, owing to the leverage caused by the size of the

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* Associate Editor of MACHINERY.

saw and the width of the grinding wheel. Besides, it is doubtful if there be any advantage in running the saw and wheel in opposite directions.

During the grinding process, water pours down between the saw and the stone, and only a few minutes are required to grind the sides of the largest saws, with no danger of drawing the temper. After grinding the sides of the saw, it is placed on an arbor in another machine, and while revolving rapidly, is polished by holding a polishing pad with a wooden handle against the side and feeding it back and forth on the top of the rest, as shown in Fig. 6. Flour of emery is used on the pad for polishing. Then the teeth are touched up on a special grinding machine, as shown in Fig. 7.

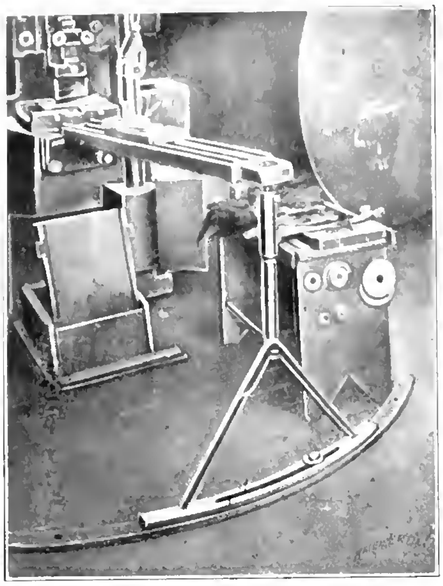


Fig 5. Indexing Jig used when Punching Circular Saw Teeth.


Fig 6. Polishing Circular Saws.

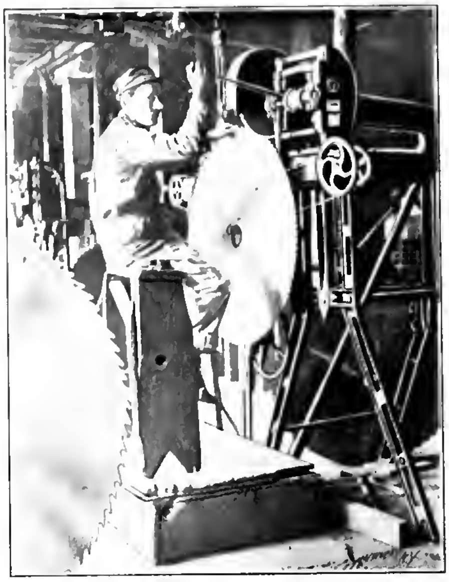
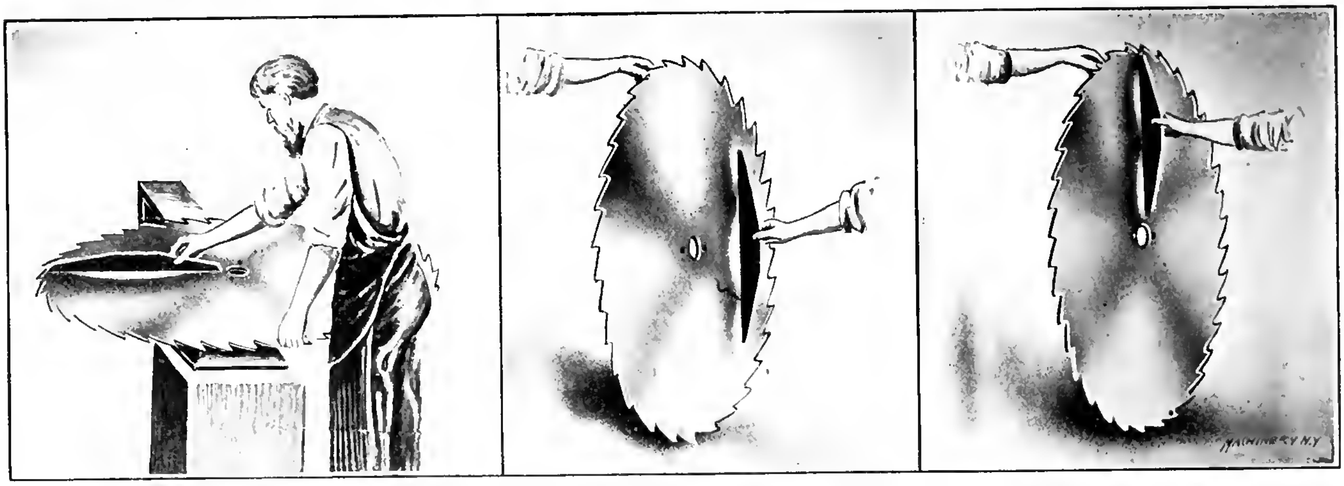


Fig. 7. Grinding Machine for Touching up the Teeth of Circular Saws after Hardening.



Figs. 8, 9 and 10 Testing the Sides of a Circular Saw to Determine the need of Hammering and Tensioning.

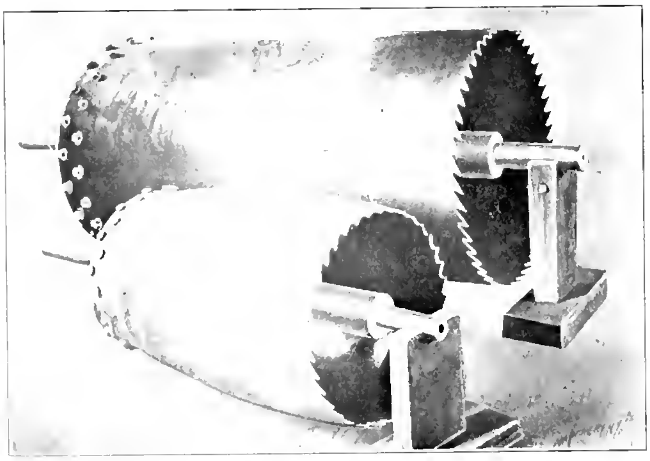


Fig 11 Barrel Saws.

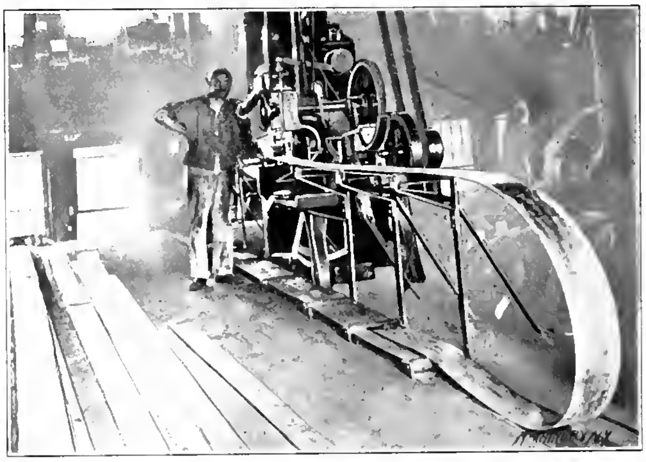


Fig. 12. Punching the Teeth in Band Saws.

One of the most important operations on the saw is the hammering and tensioning. This work is tedious—or at least it looks so—and it takes long practice to become an expert. Twenty-five or thirty men are employed in this department, and a large majority of them are well past middle age, and have been doing this work for years. Fig. 3 shows the shape of hammers and the anvil used for hammering the large circular saws. As few mechanics outside of saw-mill men know what "tensioning the saw" means, the following is quoted from a pamphlet of instructions issued by E. C. Atkins & Co. for their customers.

"For the benefit of our patrons and sawyers using our saws, we take pleasure in explaining the general principles involved in the hammering and tensioning of circular saws. The practice taught by masters of the art thirty years ago, when only saws of small diameter were used, was that a circular saw, to do proper work, should be left firm between the center and the

rim, and open as to its whole diameter, whereas experience has shown that it is best to open out the body of the saw between the center and the rim to the extent required for the speed the saw is to run.

"Very high speed and thin saws require that the saw be opened out until it takes a strong push or pull to throw the center either way when the saw is standing upon the floor. When the saw is in proper tension and is shaken, the body only of the saw should vibrate, while the rim should be nearly or quite steady.

"Gumming a circular saw, or alternate heating and cooling of the rim, will permanently expand a saw at the rim, and in consequence it will become too stiff in the center or body, and run 'snaky.' A few strokes of a round-faced hammer on both sides of the saw at the proper place will restore the tension. In Fig. 17, the portion of the saw to be hammered is indicated by the dotted lines. The same treatment is required if the saw is put up for too low speed. The rule is that it must be more open or 'limber' in the body of the saw for fast speed than for slow; for hard than for soft wood.

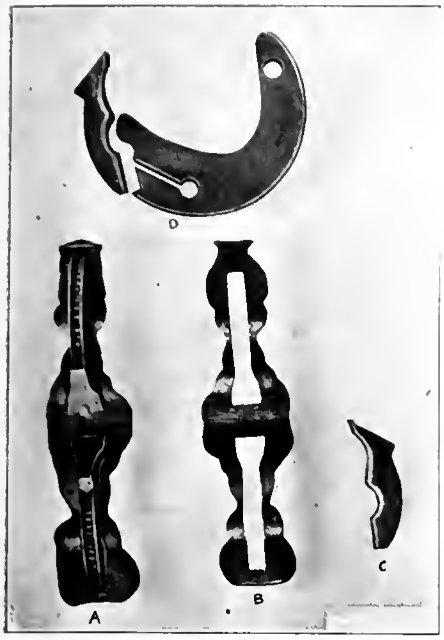


Fig. 13. Forging for Tooth and Holder for Inserted Tooth Saws.

"When the saw is standing on the floor and shaken with the hand and the center and rim both vibrate, it requires more hammering on the line next to the rim. When opening out the body of the saw, do not hammer within 6 inches to 10 inches of the center.

"Observe the motion of the saw when on the mandrel and running up to full speed; if it runs wavy on the rim, it needs opening out on the dotted lines. If it runs steady and true out of the log, it is the fault of the hanging, lining, fitting or management if it does not run steady and true in the log.

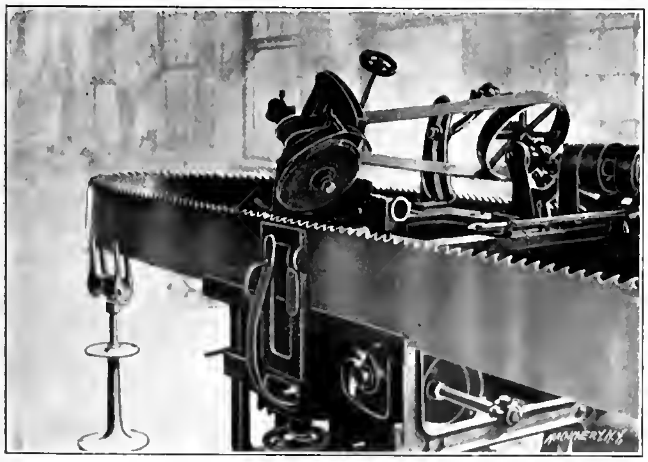


Fig. 14. Large Grinding Machine for Band Saws.

"Fig. 8 illustrates the examination of the saw with the straight-edge in adjusting tension: the center of the saw resting on the anvil, the rim back of the anvil supported on a narrow bench extending from the anvil to the wall, and the opposite point raised with the hand, the straight-edge extending from the center toward the rim of the saw. If the saw is properly opened in the body, the portions indicated by the dotted lines in Fig. 17 will drop away from the straight-edge equally all around the saw.

"To equalize the tension, the parts that drop least require hammering until the tension is even and all parts indicated by the dotted lines drop equally all around the saw, the center line dropping a little more than the others.

"Hammering to take out lumps should always be done on the high side or on that side which touches the straight-edge. Lumps or ridges upon or near the rim may be found with the straight-edge by examining that part of the saw, with the center of the saw resting on the anvil, but lumps or ridges in the body should be found with the saw standing perfectly perpendicular upon the floor, Figs. 9 and 10. Mark the high spots with chalk, and hammer where marked, on an anvil.

"Allowance must be made for change in tension produced by the blow of the hammer, as every blow stretches and opens the saw at the point struck.

"Lumps usually run in ridges and should be hammered out with a cross peen hammer, the peen following the ridge in the direction in which it runs as discovered by the straight-edge. Round lumps may be hammered down with the round face hammer, or with a cross peen hammer, by changing the position of each blow so that the strokes cross each other. The strokes should be directly on the lump or ridge."

Fig. 15. Inserting the Teeth.

The foregoing extract will not only give a good idea of what hammering and tensioning means, but it will also give a fair idea of how it is done.

In the inserted tooth circular saws, the cutting teeth are forged in pairs, as shown in Fig. 13, where *A* is the forging untrimmed, *B* the part trimmed off, and *C* the tooth. At *D* is shown the tooth and holder ready to be put into the saw.

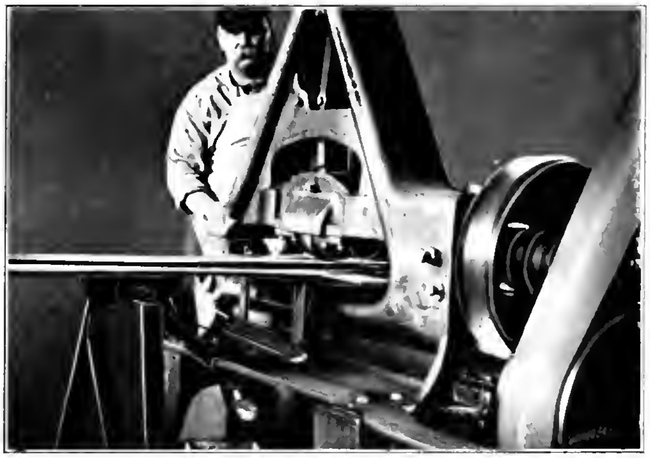


Fig. 16. Tensioning a Band Saw by Rolling.

The teeth are ground on both sides and on the cutting edge at one operation, on a special three-wheel grinder, shown in Fig. 4. The manner in which the tooth-holder or "shank" is inserted is shown in Fig. 15, one tooth being already in place at *E* and another just being put in with a wrench at *F*. The saw is held in position by a stud which passes through the center hole and by a clamp, operated by a hand-wheel, which grips the rim.

A special form of saw called the barrel saw, which is used

for sawing out barrel staves, is shown in Fig. 11. In these saws only a narrow strip at the edge is made of saw steel, the body being made of a cheaper material, to which the saws are riveted. The cutting blades are made in the same way as a band saw, with the ends lapped and brazed.

In making band saws, the teeth are cut in a punch press, as shown in Fig. 12, the teeth being set against a stop the right distance from the punch, and the feeding being done by hand. These saws are hardened by fastening them to a "dummy" strip, which is slowly drawn through a gas furnace and into an oil tank. The whole operation is continuous and practically automatic. After hardening, the band saws are ground by feeding them under a large grindstone. The table is tilted so as to grind the saws thinner at the back.

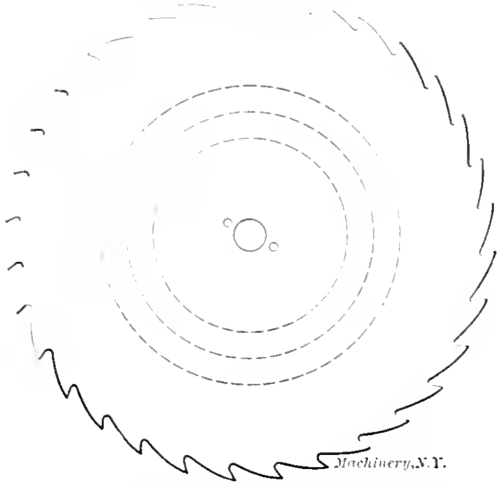
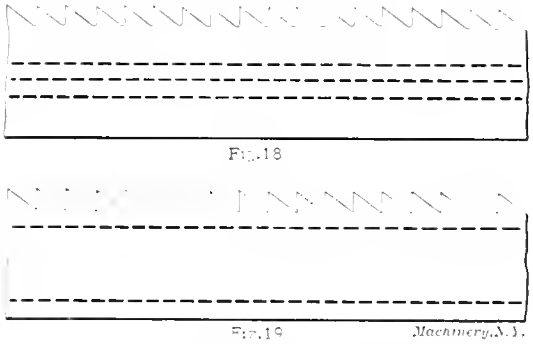


Fig 17. Diagram Indicating the Lines along which a Circular Saw is Tensioned

An automatic band saw tooth grinder is shown in Fig. 14. This grinder will take saws of any size and length; for small saws of similar type, smaller machines of the same design are used. These smaller machines are common in wood-working shops.

The manner in which band saws are rolled to give them the proper tension is shown in Fig. 16. To run properly, a band saw must be open in the middle, and it is rolled as shown by the lines in Fig. 18. If it is too open, it is rolled as shown in Fig. 19.

Hand saws and cross-cut saws are both ground thin on the back, the same as the band saws, and in the same way. They are heated and held in long clamps while being dipped in the hardening oil bath. The teeth on the hand saws are set with a light hammer. The men engaged in this work, the setters, use their hammers as steady as the ticks of the clock and never miss a tooth.



Figs. 18 and 19. Lines along which a Band Saw is Tensioned.

* * *

The length of new railways opened in the United States last year was 3,214 miles, showing a decrease of 1,998 miles, or 38 per cent, as compared with 1907. The largest new construction on the part of any one company was 790 miles of track involved in the Chicago, Milwaukee and St. Paul Railroad's Pacific Coast extension. The railway network of Canada was increased last year by 1,250 miles, and that of Mexico 435 miles.

JIGS AND FIXTURES—12.

BORING, REAMING AND FACING TOOLS.

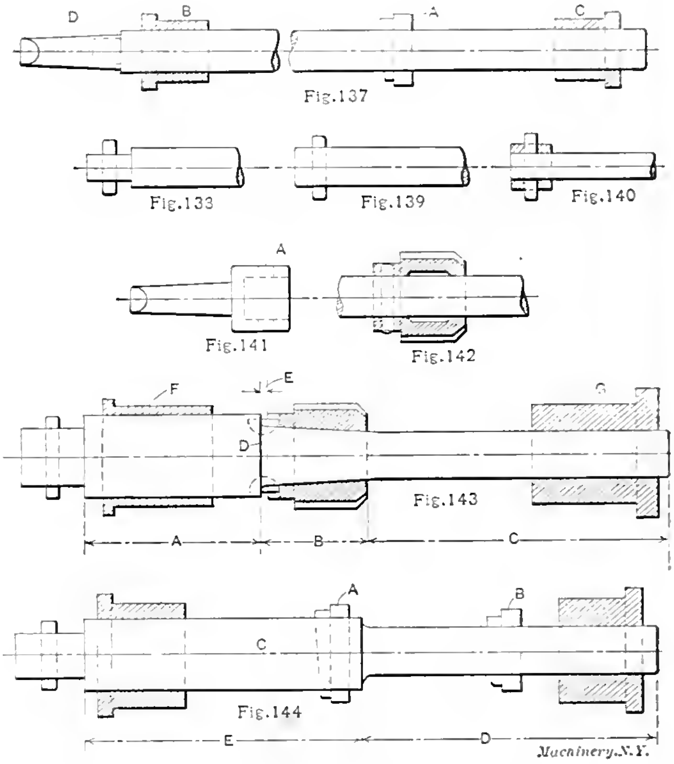
EINAR MORIN *

More or less elaborate tools or sets of tools are required for the various boring operations performed with or without boring jigs. These tools comprise boring, reaming and facing bars, boring and facing cutters, solid or shell reamers, boring and facing heads, bushings, stops, drills, collets, and knuckle or universal joints.

Boring Bars.

The general requirements of a boring bar are that it must be as heavy and rigid as possible, straight, and ground concentric, and a good running fit in the bushings. When the bar has been turned and once ground to the right size, it should never be put in a lathe and filed, or emery cloth used on it. Boring bars are made from machine steel and are not hardened. Sometimes small bars are made from tool steel and hardened, in order to give them additional stiffness. Shanks for reamers, and facing bars, should be made in the same way as boring bars, but if possible, should be even stiffer.

The most common type of boring bar is shown in Fig. 137, the cutter *A* being located at about the middle of the bar, and the bar being guided at both ends by bushings *B* and *C*. The bar is provided with a taper shank at *D*, fitting the spindle of the machine or a collet connected with a knuckle joint. It is quite common practice to turn down the end of the bar, as shown in Fig. 138, to fit the knuckle joint or collet shown in Fig. 141. Sometimes, of course, the bar can be left full size, as shown in Fig. 139, and sometimes the end is even made larger than the bar, by forcing on a collar, as shown in Fig. 140, in order that the end may fit the driving collet. A key is passed through the end of the bar for driving it; this key fits in the slot *A* in the collet shown in Fig. 141.



Figs. 137-144. Boring Bars of Different Types.

The bar shown in Fig. 137 can also be used for facing purposes, the cutter *A* being taken out, and a facing cutter inserted. The same bar can also be used for a special shell reamer, when this has a straight hole, the reamer being held to the bar by a taper pin, as shown in Fig. 142. Standard shell reamers have a taper hole, and for these, the bar must be turned with a taper part, as shown in Fig. 143, where the part *A* is turned up to the largest size possible (generally 1/32 or 1/16 inch under the diameter of the reamer); part *B*,

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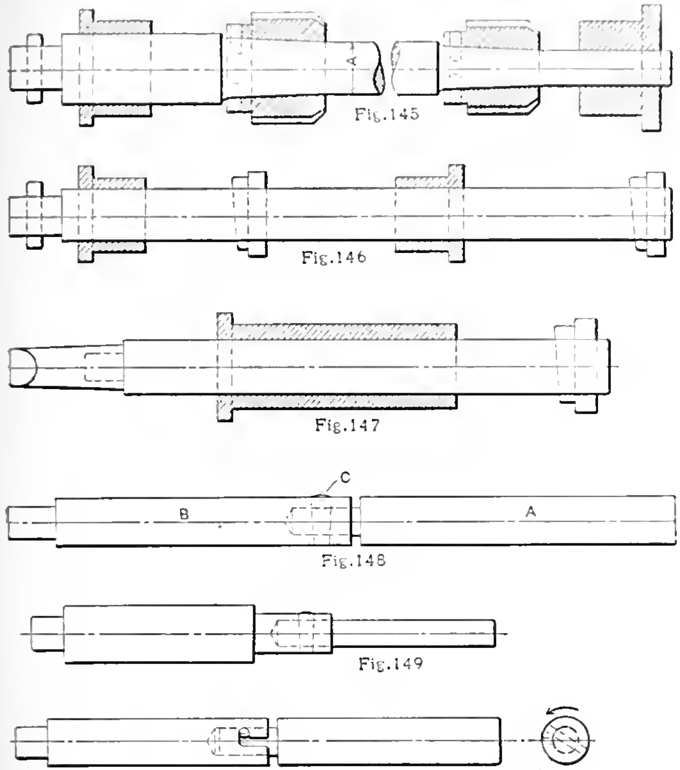
* Address: Borlänge, Sweden.

being turned to fit the taper hole in the shell reamer, is left long enough to permit the reamer being pressed up tightly without touching the shoulder *D*. As a rule, the taper part is so dimensioned that ⅛ inch will be left at *E*, between the shoulder of the bar and the back of the shell reamer, when this is forced up as far as possible. The reamer is driven by keys or pins entering in a slot cut across the end of the reamer. The part *C* of the bar is turned down to some standard size, just below the size of the small end of the taper hole in the reamer. The bushings *F* and *G* may be made with the same outside diameter, fitting the same size lining bushings in the jig, their inside bearings being made to fit the large and small diameters of the bar.



Figs. 145-150. Other Designs of Boring Bars.

A boring bar used for boring out two holes of different size may be made as shown in Fig. 144; *A* and *B* are the cutters for the two holes, and part of the bar *C* is turned down for a length, *D*, to suit the small hole. The part *E* can then be made of as large diameter as permissible for boring out the hole for which the tool *A* is used. By making the bar in this way, a more rigid construction is possible than if the part *E* were turned down to the smaller diameter required by the hole bored by cutter *B*. There may be more than two holes of different sizes in succession, and then the bars may have a greater number of steps; if there is but a slight difference in the sizes of the holes to be bored out, it hardly pays to turn down steps on the bar. The stepped bar may also be used for facing bars. While these small matters may seem unimportant and elementary, they must be taken into consideration when designing a set of expensive tools for boring jigs which are to be in constant use.

Reamer bars used for reaming out two or more holes simultaneously may be made as shown in Fig. 145, providing the diameter *A* is large enough for turning the taper portion for another shell reamer of smaller size. Should the diameter be too small to permit this, an extension can be provided, or a separate bar used for the smaller reamer. The principle of stepped bars can be applied also where the cutters are placed as illustrated in Fig. 146, where one boring cutter or facing tool is placed at one end, the bar still being guided by two bushings.

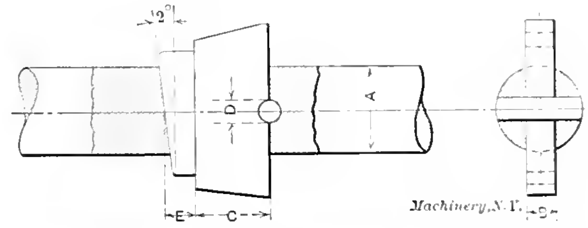
A boring, facing, and reamer bar used almost as commonly as the one already described, is illustrated in Fig. 147. The principal features of this bar are that the cutting tool is always located at the end of the bar, opposite to where it is driven, and that there is but one bushing for guiding. This bushing should be as long as possible to give a good bearing, and prevent the bar from wobbling. Sometimes, as illustrated in Fig. 121, January issue, the jig is made with two bearings which, however, are on the same side of the cutter, and a comparatively short distance apart.

Sometimes a bar must be made in two parts. The reason may be that one solid bar would be too long to permit of its being pushed into the jig from one side. Another reason may be that the cutting tools are too large to pass through some intermediate hole. The two parts of the bar may be connected with a taper pin, as shown in Fig. 148, the end of bar *A* being a sliding or driving fit in the hole in section *B*. This bar should be ground after the two parts are assembled, so that they will run exactly true with each other. A stepped bar made up of two sections as shown is Fig. 149. In Fig. 150, another method of connecting the two sections is shown; when this method is used the two bars can be put together and taken apart very rapidly. This method can also be used to connect two bars by a separate piece, as shown in Fig. 151, the two sections being bored out to fit the intermediate piece, which has two pins *A* and *B*, driven into it, and transmitting the motion from one section of the bar to the other, as indicated. It is evident that two bearings would hardly be sufficient for this class of boring bars. When these bars are used, three or more bearings should be provided. This type of bar, however, is not used to a very great extent.

Cutters for Boring Bars.

The cutters used in boring bars vary widely. The cutter *A*, Fig. 152, is commonly used. It cuts with both ends, and is centered by the two flats *B*, milled or filed on the bar; a slot is provided in the cutter, which fits these flats of the bar. After the cutter has been put in place, it is tightened by the key *C*. and is turned to the correct diameter required, and then hardened. A more modern arrangement is shown in Fig. 153. The cutter here is a plain rectangular piece of steel, cutting with both ends. It is centered by the pin *A*, which is driven into a hole drilled so that one-half of it passes through the slot in the cutter. As in the former case, the cutter is turned down to the right diameter when in place. It is tightened down by the key *B*. This way of locating the cutter centrally has proved very satisfactory. In Table X are given dimensions of cutters for different bar diameters.

TABLE X. BORING AND FACING CUTTERS.

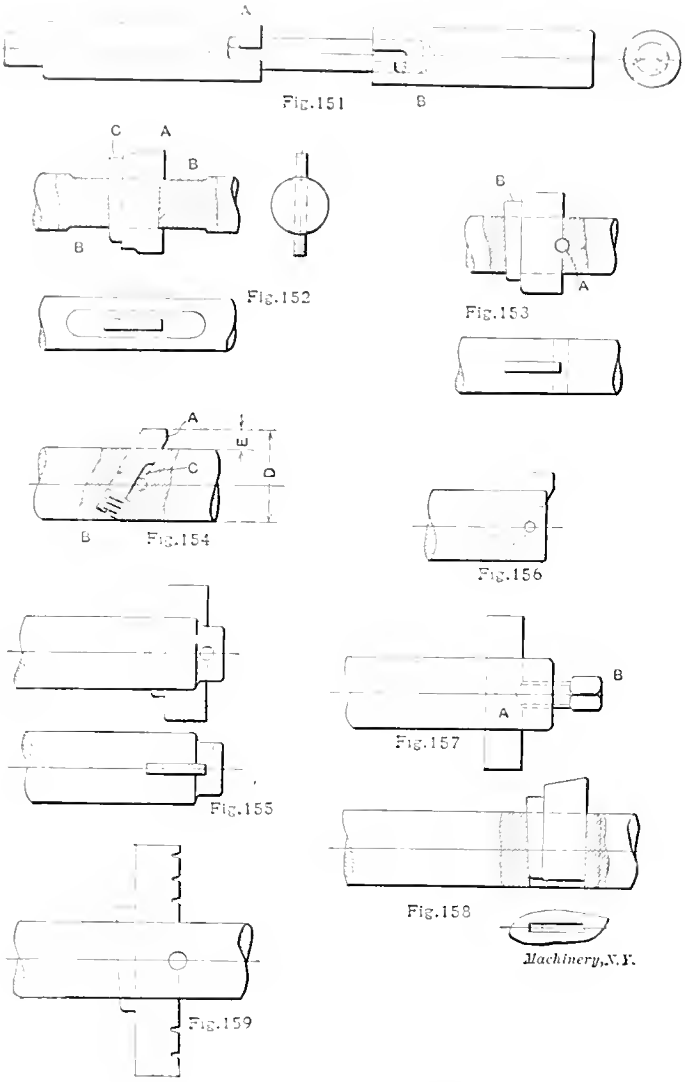


A	B	C	D	E
¾ to 15/16	¼	¾	3/16	¼
1 to 1 ⅜	5/16	¾	3/16	¼
1½ to 2 ⅜	⅜	⅞	¼	¼
2½ to 3	½	1	¼	5/16
3½ and larger	⅝	1¼	5/16	⅜

Facing cutters may be located and held in place in the same way. They are longer than boring cutters, being intended to finish a boss or seat around a hole, but otherwise they are made to about the same dimensions.

Single-ended boring cutters, as shown in Fig. 154, are used to a great extent, and it is claimed that they give a more perfect hole. The illustration shows a common way of securing the tool; the cutter *A*, which is made of drill rod or other round tool steel stock, fits a hole bored at an angle of sixty degrees with the axis of the bar, and is adjusted by the headless set-screw *B*. When adjusted, the cutter is held rigidly in place by the pin *C* provided on one side with a flat tapering portion, which fits against the flatted side of the cutter, as shown in the engraving. This cutter is very easily set by taking a measurement *D* with a

micrometer. Subtract from the dimension *D* the diameter of the bar, thereby obtaining dimension *E*. Now add *E* to *D*, thereby obtaining the diameter of the hole which will be cut. The screw may have to be adjusted a few times, to obtain the desired result. Table XI gives dimension for this kind of cutter, and also for screws and pins used with them. The two kinds of cutters referred to may also be used on the ends of the bars, as shown in Figs. 155 and 156. The cutter of the type shown in Fig. 153 may be held in either of the two ways shown in Fig. 155 and Fig. 157. In the latter case, the cutter is spotted at *A*, and held by a pointed screw *B*. This method, however, does not always insure very accurate results. The simplest kind of single-ended cutter, and the manner in which it is held is shown in Fig. 158. It may be used in any kind of bar, and, with ordinary care, good results may be obtained even with this simple tool. The variations possible are many, and the examples shown simply indicate the most common practice.



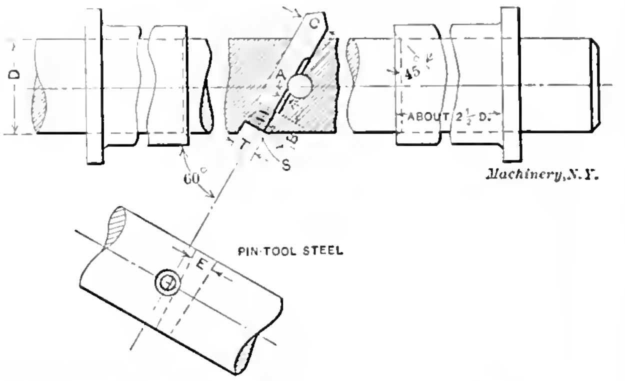
Figs. 151-159 Different Types of Cutters and Methods of Fastening.

Facing cutters may be made similar to boring tools, or they may be made with teeth, like end milling cutters, as illustrated in Fig. 161. In this engraving, one of the cutters *A* cuts with both sides, while the cutter *B* cuts with one side only. The bar is provided with a slot and with notches for locating and holding in place the various cutters, as shown at *C*. A pin *D* is driven into the cutter, and enters the notch, thus driving the tool. The cutters can also be held on the bar by taper pins, but the putting in place and the removal of the cutters would then be much slower.

Different cutters are commonly used for roughing and finishing. To make it easier to remove the metal with the roughing cutter, it may be made with every other tooth beveled in opposite directions, as shown in Fig. 160, where *A* is one tooth beveled towards the center, and *B* the next tooth beveled outwards. Using a cutter of this kind will produce a surface as indicated at *C*, which must be faced square by a finishing cutter.

In order to face the work to correct dimensions, stops are sometimes provided which strike against some finished surface on the jig which stands in a given relation to the finished surface on the work and the cutting edge of the facing cutter. Such a stop may be made as shown at *E* in Fig. 161, and be held and located in the same way as the facing cutter. The stops are made of machine steel, case-hardened, and ground on the bearing surface. When facing up a wide surface with an inserted blade facing tool, it is often the practice to cut small notches in the blade, as shown in Fig. 159, the cutting edges on the one end overlapping the notches on the other. Very often the holes to be bored are too large to permit of cutters, such as previously described, being used, and then it is necessary to provide the boring bars with a boring head. A simple boring head is illustrated in Fig. 162, where *A* is the head held on the bar by a taper pin; *B* is a boring tool which fits in a slot in the head, and which can be adjusted out and in by the screw *C*, which passes through the shoe *D*, which also fits the slot, and against which the cutter is located, as illustrated. The cutter and shoe are held by the bolt *E*. The bolt is milled flat on one side so that a hook is formed for binding the cutter and shoe. Two or more cutters may be used in these boring heads. At *F*, in Fig. 162 is shown a facing tool used in the same head as the boring tool. No adjusting shoe is necessary in this case, as the facing cutter bears directly against the bottom of the slot in the head, and against the boring bar, and is held by a bolt *G*, milled with a tapering flat on one side, which wedges the cutter into its seat. More complicated boring heads are provided with a small slide for adjust-

TABLE XI. BORING BAR CUTTERS.

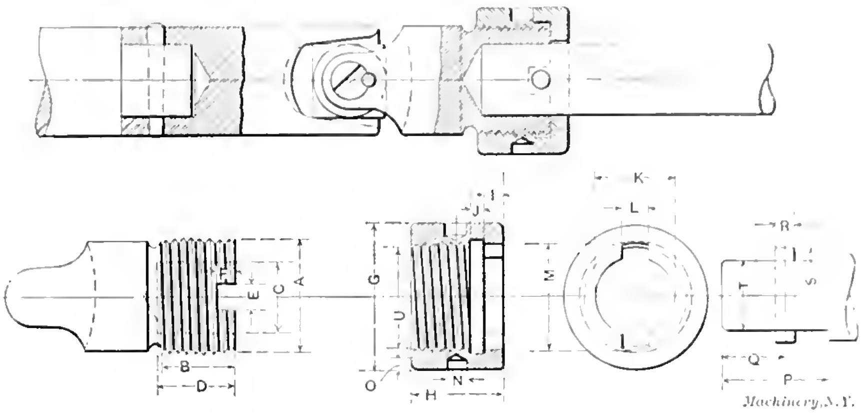


D	C	E	A	S	T	B
Diameter of Bar.	Diameter of Cutter.	Diameter of Pin.	Depth of Milled Down Part.	Diameter of Screw.	Diameter of Counter-bore.	Length of Thread.
3/8	1/8	1/16	1/64	1/16	1/8	5/64
7/16	1/8	3/32	1/64	1/16	1/8	5/64
1/2	1/8	3/32	1/64	1/16	1/8	5/64
9/16	1/8	1/8	1/32	1/8	5/32	1/8
5/8	3/16	1/8	1/32	1/8	5/32	1/8
11/16	3/16	5/32	1/32	1/8	3/16	5/32
3/4	3/16	5/32	1/32	1/8	3/16	5/32
13/16	1/4	5/32	1/32	3/16	1/4	3/16
7/8	1/4	5/32	1/32	3/16	1/4	3/16
15/16	1/4	3/16	1/32	3/16	1/4	1/4
1	1/4	3/16	1/32	3/16	1/4	1/4
1 1/8	5/16	7/32	1/32	1/4	5/16	5/16
1 1/4	5/16	1/4	3/64	1/4	5/16	5/16
1 3/8	3/8	1/4	3/64	1/4	5/16	5/16
1 1/2	3/8	9/32	3/64	5/16	3/8	3/8
1 5/8	7/16	5/16	3/64	5/16	3/8	3/8
1 3/4	7/16	5/16	3/64	3/8	7/16	1/2
1 7/8	1/2	11/32	1/16	3/8	7/16	1/2
2	1/2	3/8	1/16	7/16	1/2	9/16
2 1/8	9/16	13/32	1/16	7/16	1/2	9/16
2 1/4	9/16	13/32	1/16	1/2	9/16	5/8
2 3/8	5/8	7/16	5/64	1/2	9/16	5/8
2 1/2	5/8	15/32	5/64	9/16	5/8	11/16
2 5/8	11/16	1/2	5/64	9/16	5/8	11/16
2 3/4	11/16	1/2	5/64	5/8	11/16	3/4
2 7/8	3/4	17/32	3/32	5/8	3/4	7/8
3	3/4	9/16	3/32	5/8	3/4	7/8

ing the tools, and some are made similar to the box tools used in turret lathes.

The reamers most commonly used in connection with the boring jigs are shell reamers of standard make. Many concerns have been in the habit of making their own shell reamers with inserted blades, designed about as shown in Fig. 163; *A* is a machine steel body, and *B* a tool steel blade, which is made tapered as shown, and driven into place. When the blades are inserted in the body, the reamer is ground. The reamer can be re-ground when dull, and kept to standard size, by forcing up the blades along the taper. The bodies of very large inserted-blade reamers are made of cast iron.

TABLE XII. BORING BAR COUPLINGS.



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U. Bore	Threads per inch	Used for Bars.
3/4	1/2	1/2	7/16	3/16	5/32	1	5/8	1/8	3/32	17/32	3/16	11/16	9/64	1/8	3/4	3/8	1/8	21/32	0.499	0.6610	16	1/2 to 5/8
1	1/2	5/8	9/16	1/4	7/32	1 3/8	5/8	5/32	3/32	21/32	1/4	15/16	11/64	5/32	7/8	15/32	3/16	7/8	0.624	0.9110	16	5/8 to 3/4
1 1/4	5/8	3/4	5/8	5/16	9/32	1 5/8	13/16	3/16	1/8	25/32	5/16	1 5/32	13/64	5/32	1 1/8	1/2	1/4	1 1/16	0.749	1.1615	12	3/4 to 1
1 1/2	13/16	1	7/8	7/16	13/32	2	1 1/16	1/4	1/8	1 1/32	7/16	1 13/32	15/64	7/32	1 3/8	11/16	3/8	1 5/16	0.999	1.4115	12	1 to 1 1/2
2 1/2	7/8	1 1/2	1 3/8	9/16	17/32	3	1 1/8	1/4	1/8	1 17/32	9/16	2 3/8	19/64	7/32	1 7/8	1 1/8	1/4	2 1/4	1.4985	2.4115	12	1 1/2 to 2
3	7/8	1 5/8	1 3/4	11/16	21/32	3 1/2	1 1/4	1/4	1/8	1 29/32	11/16	2 7/8	21/64	7/32	2 5/16	1 7/16	3/8	2 3/4	1.8735	2.9115	12	2 and over

Bushing for Boring Jig.

Lining bushings for boring jigs are made of machine steel, case-hardened and ground, and the loose bushings are often also made of machine steel. They may, however, be made with equal success from cast iron, which wears well, and has less tendency to stick to the steel bar. The bushings for boring jigs may be made with facilities for removal, similar to those described in the May, 1908, installment of this series. In Fig. 164 is shown a bushing having two pins driven into the head, to facilitate removal, and the pin *A* over which the half-round slot in the edge of the head fits, prevents the bushing from turning. Slots, as shown at *B* are sometimes provided to permit cutting tools to pass through.

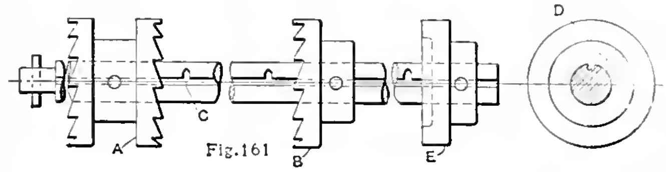


Fig.161

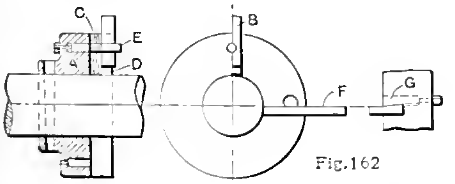


Fig.162

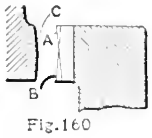


Fig.160

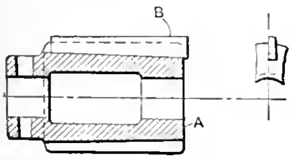


Fig.163

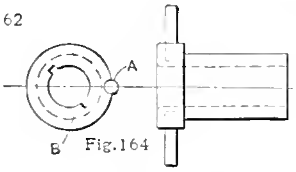


Fig.164

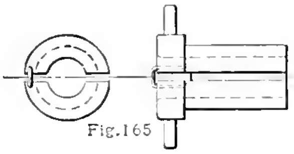


Fig.165

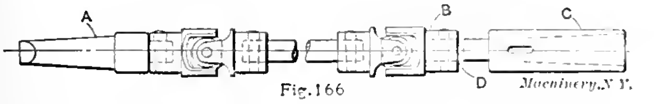


Fig.166

Figs. 160-166. Facing Tools, Boring Heads, Boring Jig Bushings, and Universal Joints for Driving Boring Bars.

In places where it is impossible to put in bushings before the bar is put in, or over the end of the bar after it is put in, a bushing made in two halves can be used, as illustrated in Fig. 165. The writer has seen this kind of a bushing in use in the Pratt & Whitney Co.'s shops, where it probably was originated, and it worked very well. The two halves are held together by a wire passing through the head flanges at one side as indicated. A bushing of this type can be put right over the bar at any place, and pushed into the lining bushing.

Knuckle Joints.

When boring bars are provided with a standard taper shank, this may be put directly into the spindle of the machine, but in that case the jig must be lined up very accurately with the spindle, and this sometimes takes more time than is permissible. It is better to use knuckle or universal joints for connecting the live spindle with the boring bar. These are constructed as indicated in Fig. 166, and are made in different sizes, for the different sized bars for which they are used. The shank *A* fits into the machine spindle. The end of the knuckle joint *B* is provided with a hole *D* into which fits the end of the collet *C*, which, in turn, takes the shank of the boring bar. The hole *D* may also take the end of the boring bars directly. The method of driving the bar from the knuckle joint may be either by a taper pin as shown in Fig. 166, or by the means shown in the engraving in Table XII, where dimensions are given for a coupling of good construction, connecting boring bar and knuckle joint.

* * *

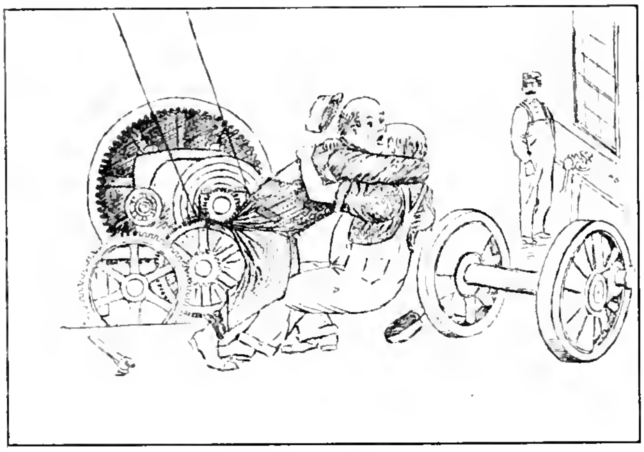
Constant improvements are being made in machines used for aerial navigation. Wilbur Wright, since the breaking of the driving chain of one of his propellers while in flight, has made an arrangement by which both propellers are connected by a chain so that if either of the driving chains should break both propellers will still continue to revolve, and there will be no danger of accident from the gyroscopic action. The superiority of the Wright brothers' machines is attributed by Sir Hiram Maxim, whose pioneer work in aeronautics has attracted wide attention, to the fact that the Wright machine uses two propellers turning in opposite directions, whereas Farman's and Delagrange's machines are equipped with a single propeller run at a very high speed. When these latter machines are turned sideways the gyroscopic action tends to make the machine turn over about a transverse axis. This accounts for the difficulties which these inventors have had in properly navigating in circles and curves. It is reported that the Russian government is negotiating with the Wright brothers for the purchase of some of their aeroplanes. The Russian government requires a three hours test flight, but the inventors consider this unnecessary, as a one-hour test flight would demonstrate the practicability of the machine equally well, provided sufficient fuel was carried for the machine to remain in the air for three hours.

SHOP SCRAPS.

PEACEMAKER

"Scrap" is a very general and common term around the shop, but usually the sense in which it is used makes its meaning clear. Everyone familiar with shop work is more or less familiar with the shop "scrap," as it is commonly called, and can, no doubt, recall instances of such "monkey work," or may even remember of having themselves taken part in one of these star performances. It was, of course, the other fellow's fault, but it is poor business, at best, as experience has proven a great many times. The scrap habit is not prevalent in every shop, but there are some shops in which it is continually prevalent among a certain class of men, when the foreman's back is turned. This foolishness not only takes the time of the parties engaged in the scrap, but it distracts the attention of other workmen, and as a consequence much time is lost, which, as we know, is not to the advantage of the company.

Discipline in a shop usually depends as much on the man in charge as it does on the men themselves. It is not necessary for a foreman or superintendent to knock a man down with a piece of two-inch pipe in order to assert his authority, as I have seen done in a large tube mill. The best disciplined shop that I have ever seen, and in which a shop scrap of any kind was almost unknown, was one in which the "boss" made himself one of the boys, yet he had very little to say except on business. He never tried to appear in the least way above his workmen, and he had always the respect and admiration of every man and boy in the shop.



"Help! Help! Pull, Gus, pull!"

Although shop scraps are not at all necessary, we have them nevertheless, but they do not all come to and end so suddenly or in such Sunday-school story-book fashion as did a shop scrap which recently caused considerable amusement as well as a little excitement. Pat Hagerty, who ran the big driving-wheel lathe, never had much love for his shop neighbor, Gus Goodheinz, since the time he was accused of setting an alarm clock behind Gus when the latter had fallen asleep over his job on the boring-mill. If these men were on speaking terms at all, they were usually engaged in a wordy scrap whenever the foreman's back was turned, and this of course furnished much amusement for some of the boys in the immediate neighborhood. Occasionally Gus or Pat would get an apple core on the head, or possibly a rotten tomato in the back of the neck, which had no other effect than to make the surrounding air blue for a while and to renew the scrap with more vigor than ever. It happened that these scraps had never come to blows as it seemed that Providence had moved in a mysterious way His wonders to perform, and the foreman always put in an appearance just as the boys expected to see one or the other ready for the hospital.

Not only did Gus and Pat differ in opinion as to what a man's nationality should be, but they also disagreed on political matters. Although these men had not been on speaking terms for some time, each had been making sarcastic and slurring remarks within hearing of the other about the chief candidate he was supporting for the fall election. This of course caused considerable ill feeling, but nothing had been said strong enough to cause them to break their long spell of silence until the morning after election. The dark gray dawn of the morning after found Pat in an irritable mood, as he had lost the greater part of his night's sleep watching election returns only to see his hero defeated. On the other hand, Gus was in the best of spirits and was on the job fifteen minutes early with his overalls on, his sleeves rolled up and all ready for business. In order to avoid as much "kidding" as possible, Pat did not care to put in an appearance at the shop that morning until it was absolutely necessary, and entered the shop door just as the whistle blew. Neither looking to the right nor the left, he made a bee-line for his machine, and giving it a few hurried glances to see that things were all right, grabbed the starting lever and threw it over with a bang. Gus, who was standing nearby with a broad smile on his moon face, could hold in no longer. Calling across to Joe on the 10-foot planer, he shouted "Hey, Joe! It 'pears to me that it is about time some of these fellers around here were startin' on their journey up Salt River this mornin' after gettin' walloped the way they did yesterday."

This was too much for Pat, who, of course, overheard the remark. He looked about and the foreman was not in sight. Turning on Gus like a shot out of a gun, he "ripped" off some remarks that would not look well in print, and in an instant Gus's happy smile had faded. There was all indications of a lively scrap as he stepped over in front of Pat at the end of the latter's lathe, but Providence again seemed to interfere and in an instant Pat felt a tug at his rear, and before he realized what was going on, he was being pulled into the gears of his lathe. With a wild and desperate effort he threw his arms about his opponent's neck, and Gus waking up to the situation at the same time, threw his arms about Pat and began pulling like a bull-dog with a death grip, while Pat was yelling at the top of his voice, "Help! Help!! Pull, Gus, pull!!" After a frantic struggle Gus succeeded in pulling his victim from the tenacious grip of the gears in such a condition that he was hardly presentable to the large audience which was rapidly gathering to see what all the noise was about.

It is needless to say that this ended the scrap and that the boys gave Pat the laugh when they had learned the trouble and saw that he was not seriously hurt. Pat, with a sickly grin on his face, was backed up against a post for self-protection, and was so badly scared that he could hardly speak, while Gus in an excited and gesticulating manner was trying to tell the curious crowd how it all came about and how he saved his victim from an "awful death."

Pat was badly in need of a few "glad rags," and would probably have had the disgrace of going home in a barrel had it not been for kind-hearted Gus, who willingly consented to loan his unfortunate neighbor a pair of overalls which he happened to have in his tool-box.

The foreman who was on the scene shortly thought the whole thing a good joke, and when he explained the cause and effect to the superintendent he said he guessed their experience was reprimand enough, and a mild lecture would not only be unnecessary but would be entirely out of place after the practical lesson the boys had had.

That night after work, for the first time in a year, Gus and Pat walked home together. No one has yet learned what was said in the confidential talk that took place that evening, but Pat and Gus are now good friends, and every evening they are seen strolling peacefully home together.

* * *

An example of the effect of superheated steam on cast iron pipe fitting is mentioned in the *Engineering Record.* A twenty-inch tee recently removed from a main steam line in an electric railway plant in Baltimore, which had been in service three years carrying steam of 160 pounds pressure, with a superheat of about 500 degrees F., was found to have grown nearly three-fourths inch in length, and was fully one inch larger in diameter than when installed. The outer surface of the fitting was covered with fine cracks, some of which had opened up in places to one-eighth inch, and steam had begun to leak through the larger of these cracks.

METHOD OF MAKING MASTER TOOLS FOR EYELET SETS.

WARREN E. THOMPSON.*

The manufacture of tools or "sets" used in special machines called "eyeletters" for putting eyelets in shoes, corsets, pocketbooks, and other like products, is, in a way, a business in itself, as special machines and fixtures, as well as men who are specialists, are required. The method is one of the master tool methods of making forming tools and manufacturing tools that may be duplicated at any time. The processes described may be applied to the making of formed cutters by designing machines for the work embodying some of the principles shown.

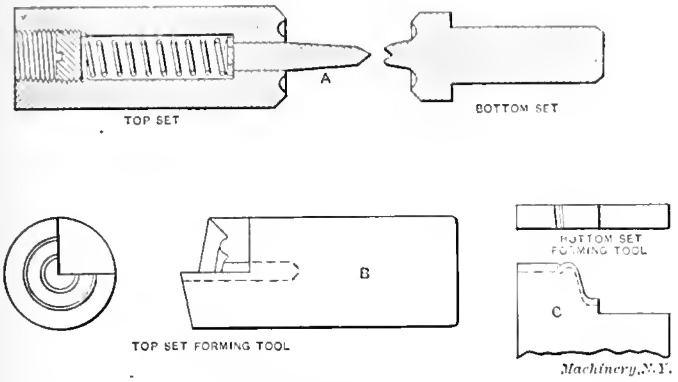
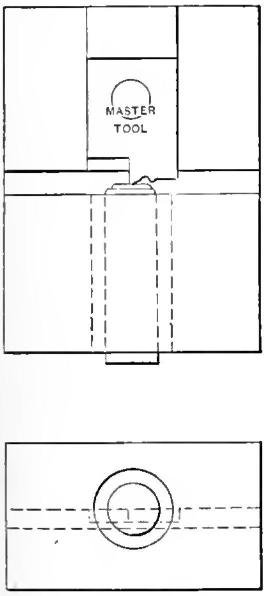


Fig. 1. Tools or Sets for Round Eyelets, and Forming Tools by which they are Formed.

Eyelets are made by special machinery in an endless variety of sizes and styles. The round eyelet is the most common and the oval is used to a much smaller extent, but enough to make it important as far as the manufacture of the tools is concerned.

Stock used for Sets.

Tool steel drill rod is used in most cases to make all sets except the oval bottom set; drill rod is used because it needs no sizing and stands severe usage. The oval bottom sets are made of both tool and low carbon steel; 35-point carbon steel, pack-hardened in new bone, is used to the largest extent, as the dies are not damaged or worn as fast as when using tool steel, and the sets thus made have given satisfaction wherever used. All stock is cut off and finished on the screw machine, ready to have the end formed.



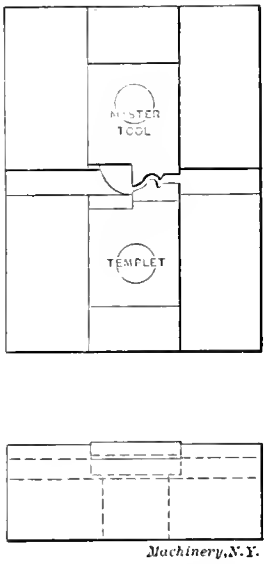


Fig. 2. Filing Jig for Templets and Master Tools, with Arbor for Holding the Eyelet. Fig. 3. Filing Jig for Master Tools.

Master Tools for Round Sets.

In Fig. 1, *A* is a section of a pair of sets for rolling the round eyelet. The top set is threaded at the back end to take a spring tension screw and to hold it in the machine. The pilot is made a few thousandths larger than the inside of the eyelet on its largest diameter; this enables it to take an eyelet from the raceway used on the eyeletter and hold it until the work is slipped into position. When the machine is in operation, the spring pilot is pushed back into the set and on the return leaves the work on the bottom set. Both sets must be made to conform to the eyelet used, and a slight change from the forms found correct will produce defective work.

Usually the tool-maker is furnished with a number of eyelets from which it is easy to select one that is perfect. This eyelet is mounted in an arbor as shown in Fig. 2. If necessary, beeswax may be used to hold it firmly in place, but in all cases the eyelet must be central with the arbor. This arbor fits a jig as shown, and its axis is exactly central with the slot or groove guiding the tool. The tool is then filed, as shown, to fit the head of the eyelet. This fit is made as close as possible, using a double eye glass to test with. The tool is then hardened and the face ground smooth, after which the form is stoned if necessary to a fine fit on the eyelet.

Often the top set for an eyelet is furnished to the tool-maker, and in this case a templet is made first. The same jig is used, and the templet made a perfect fit to the set. Templet stock of the same thickness as the tool stock should be kept at hand. It is milled away so as to leave only 1/32 inch to file.

The master tool for the bottom set is filed in a jig, Fig. 2, in the same way as the top set. The making of the first bottom set requires considerable experience. A blank is prepared and turned to what is judged to be about the correct form. It is then tested in a bench machine and the roll it makes on the eyelet is noted. The form is corrected until a perfect roll is obtained, and the master set is then hardened and polished.

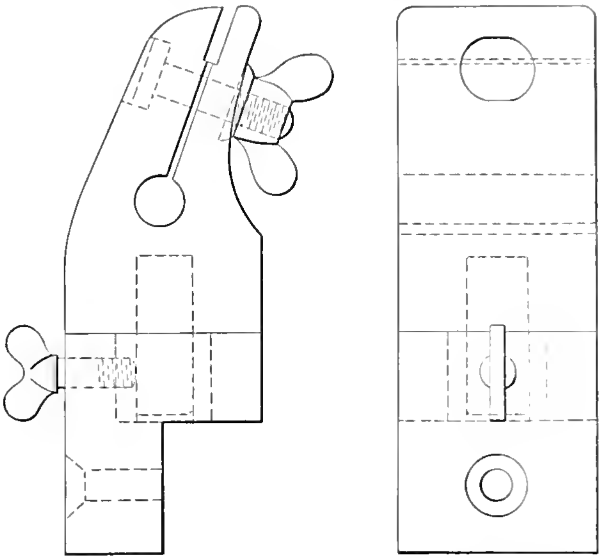


Fig. 4. Vise for Holding Templets and Master Tools when Filing.

In case a templet for the top set has been made, the jig shown in Fig. 3 is used to produce a master tool. This jig is simply a block of steel having two slots or grooves in line and in such relation to each other that the bottom of the top slot is about 0.005 inch below the face of a tool in the lower slot. The tool is filed and stoned to a perfect fit, and a tool having the same contour as the required set is thus produced. All tools are drilled in a plain jig with a standard hole.

The bench fixture or vise, Fig. 4, is provided for the convenience of the tool-maker when filing. It is made of hard wood and swivels in any position on a steel rod which is driven into the vise, and which rolls in a steel bushing having a thumb-screw for locking purposes.

Circular Forming Tools.

A top set forming tool is illustrated in Fig. 1, at *B*. The stock for these tools is first cut off and milled and a small hole drilled in the front end. The machine for making the tools is shown in Fig. 5. This machine consists of a cast

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iron base planed and bored to take a tool slide and spindle. A spring chuck with draw-bar is fitted into the spindle, and a cam is held to it by screws. This cam is held against its mate by the spring shown, and the hand wheel is keyed and held by a lock nut. The cam used has a rise of 5/32 inch.

The tool in the tool slide is quickly adjusted by loosening a lock nut, and is then slowly fed into the work by the feed screw. The tool set in position has its face in a line with the axis of the spindle, and hence produces a form exactly the same as that of the eyelet. The first circular tool produced with each master is used to produce another circular tool of the same contour as the master, and this circular master is then used to produce all manufacturing tools. A cam having a throw of 3/32 inch is used in the duplication of the master in another machine of the same type.

Flat Forming Tools.

On account of the teat on the bottom set and the consequent difficulties encountered in making circular tools, flat tools are used. These tools are planed in the machine illustrated by Fig. 6. This machine has a cast iron base planed and bored to take two tool slides and the spindle. The spindle carries two cams, one of which operates the planing head and the other the tool relief. The tool slots are in alignment and the stationary tool is moved by the feed screw. The ram has a uniform downward motion for three-quarters of a revolution, and the other quarter returns it to the starting point. The two cams are so arranged that the tools are separated just before the return and are in position again before the down-stroke commences. The tools have 20 degrees end clearance and 4 degrees side clearance and the slots are planed at these angles.

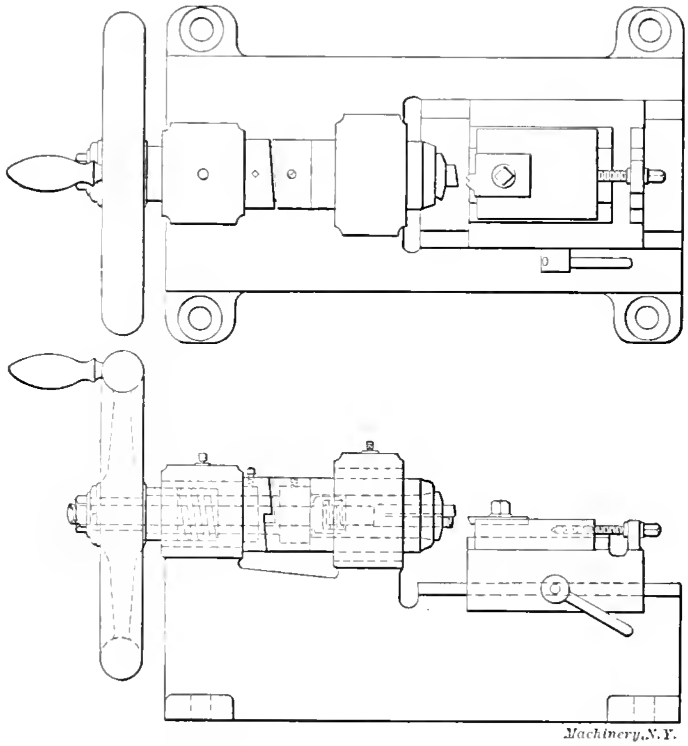

Fig. 5. Machine for Making Circular Tools Formed on the End.

The master tool previously fitted to the set is bolted to the ram, and a blank, roughed near to shape, bolted into the carrier. After the form is planed smooth all over, it is hardened and stoned. This tool is then used as a master for making the manufacturing tools, the first master being used but once, except in case of breakage.

The master tools should be kept in covered trays carefully separated, as the slightest nick or imperfection on the cutting edge destroys their value. The manufacturing tools are used in small bench lathes in special holders.

Oval Sets.

Oval sets, on account of their shape, are much more expensive to make than the round ones, and it requires considerable experience to construct the tools properly.

Oval top and bottom sets are shown in Fig. 7. As the oval eyelets do not break as evenly as the round eyelets when rolling, the bottom set has six or eight cutting edges in the form. These sets are stamped under a 100-pound drop hammer. The top sets have the form milled and the pilot hole broached.

The machine illustrated in Fig. 9 is used for making all of the plain oval forms in the top sets, trial bottom sets, "hubs," and other trial tools. It consists of a cast iron bed planed to take two slides, one for the cutter bushing carrier and the other for the work and feed mechanism. The work is driven by a worm and worm-wheel, and its position is regulated by a cam working on a roll set into the bed. This cam is held against the roll by a helical spring. The position of the cutter guiding bushing may be regulated by the set-screws shown, and its position determines the size of the oval form produced. The cutter is held in a drill press.

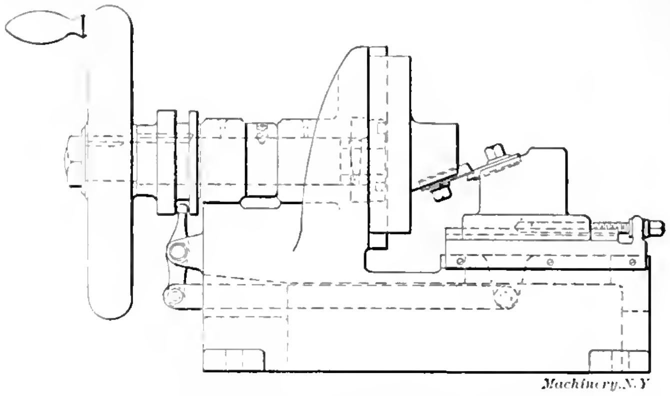

Fig. 6. Machine for Planing Flat Formed Tools.

Oval Master Dies.

A cam is first made of the same outline as the eyelet. This is placed in the machine and a cutter of about the correct form for the bottom set put in the drill press. A trial set is then milled and tested, using the device in Fig. 9. The cutter and setting of the bushing is corrected until a satisfactory set is produced. A piece of tool steel is now put in the machine and milled. It is of the same form as the trial set, and is hardened. This piece is called a "hub," and is used to produce a master form. The teat of the hub is made 1/16 inch longer than the set to provide clearance in the die. The ends of the stamped sets are finished after stamping.

The master form is made of $1\frac{1}{4}$ inch tool steel. This is held in a block by set-screws and the block is held in the stamp with the master blank aligned with the center of the "hub" holder. After setting, the master blank is heated to a good red heat on the formed end. It is then quickly clamped in a fixture and struck one good blow with the hub. This is usually sufficient to get a perfect impression, but in cases where it is not, the master has 1/64 inch turned from the face and is struck another blow cold. This impression must now be polished and the requisite number of grooves cut in it to form the splitting edges on the set. The divisions are made with dividers, as accurately as possible, and the cuts made with fine files. The master is then hardened and polished. Another hub is struck from this master and the manufacturing dies made from this hub.

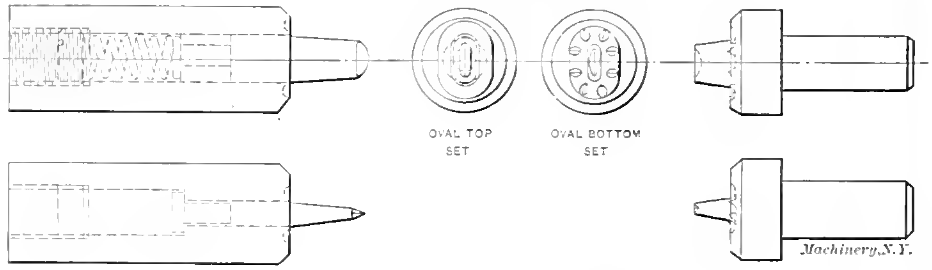

Fig. 7. Top and Bottom Set for Oval Eyelets

The fixture shown at Fig. 10 is used in stamping the sets. The rack and pinion are made 8 pitch with a long hand lever for operating. The hole and counterbore are ground and afterward lapped large on the top end. The die is held in a cast iron body by large case-hardened taper pins. Plenty of oil is used when stamping as this prevents excessive sticking of the set after stamping.

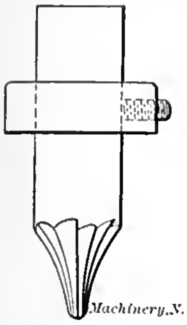
Machinery,N.Y.

Fig. 8. Cover for Oval Eyelet Tools.

A cutter for use in making a hub is shown at Fig. 8. The cutter for blanks to go under the stamp is made nearly flat at the point.

Oval Top Sets.

The jig shown in Fig. 11 is used for making the oval pilot holes. The work is held between V-blocks, one of which is movable in the leaf and tightened on the work by a screw. Three bushings are used, one with an eccentric hole, one central, and one for the broaches. The holes are first drilled with the eccentric bushing guided by the keys in opposite slots in the bushing head. The center is then cut out with a small end mill using the concentric bushing. The hole is then broached with the broach shown, using oil. After the hole is finished, the groove is milled in the machine Fig. 9. The depth of the groove is governed by the collar on the cutter. The spring pilots are turned and milled close to size and file finished.

The sets, after hardening, are polished with a lap running at high speed, using fine emery. A templet is made for every correct cutter for purposes of duplication. All tools should be stamped with the necessary data regarding their use and purpose.

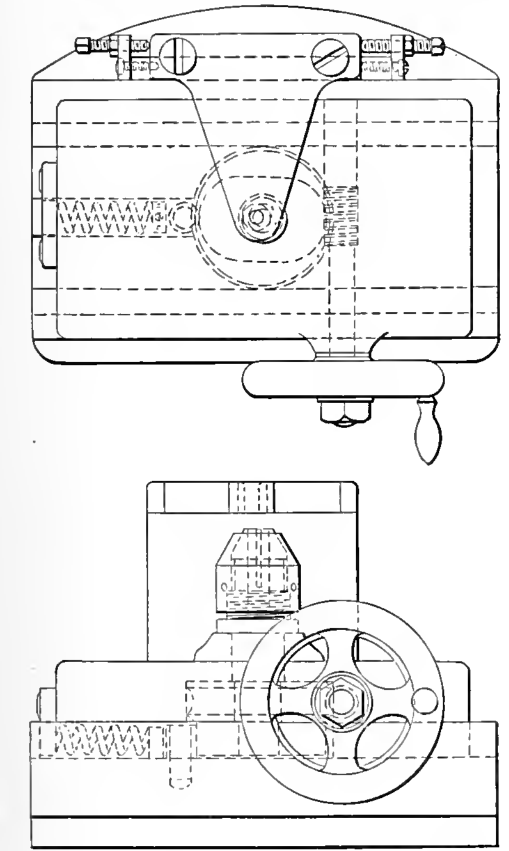
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Fig. 9. Device for Making Plain Oval Top Set Forms.

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A painting by Max Lievermann pictures a group of peasant spinners at work and incidentally shows one of the great fundamental differences between a primitive people and American and other peoples that have risen to commanding positions in the industrial world. It appears that the type of spinning wheel shown requires two people to operate it—one to turn the wheel and the other to spin. Our American grandmothers were not so prodigal with labor, their wheels being so made that the spinner both drove the wheel and did the spinning. The uneconomical use of labor is a trait which distinguishes a primitive, unprogressive race from people who, through economical use of labor, increase and develop productive capacity. If two persons are required to spin, it is only by unceasing labor for weeks that the family is able to produce clothing enough to clothe it for a year, because the other members must produce food to support the spinners while at work. The American spinning wheel, driven by one person, was only one step in the great advance that we have made in productive capacity. The prodigality of the primitive people in the employment of labor means everlasting poverty, while on the other hand, the increase of productive capacity through the development of modern machinery means that wealth is constantly accumulated, inasmuch as each worker produces much more than he consumes. In the primitive life the family is barely able to produce what the members require for a poor living, with all members of the family working who are able. Such a people will never develop a commerce of importance, neither will literature, art, or the other evidences of civilization become highly developed.

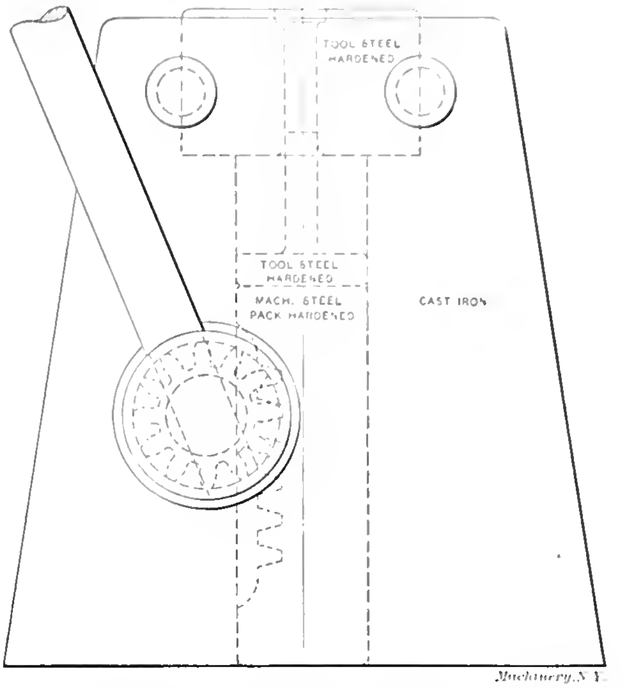

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Fig. 10. Fixture used in Stamping Oval Bottom Sets

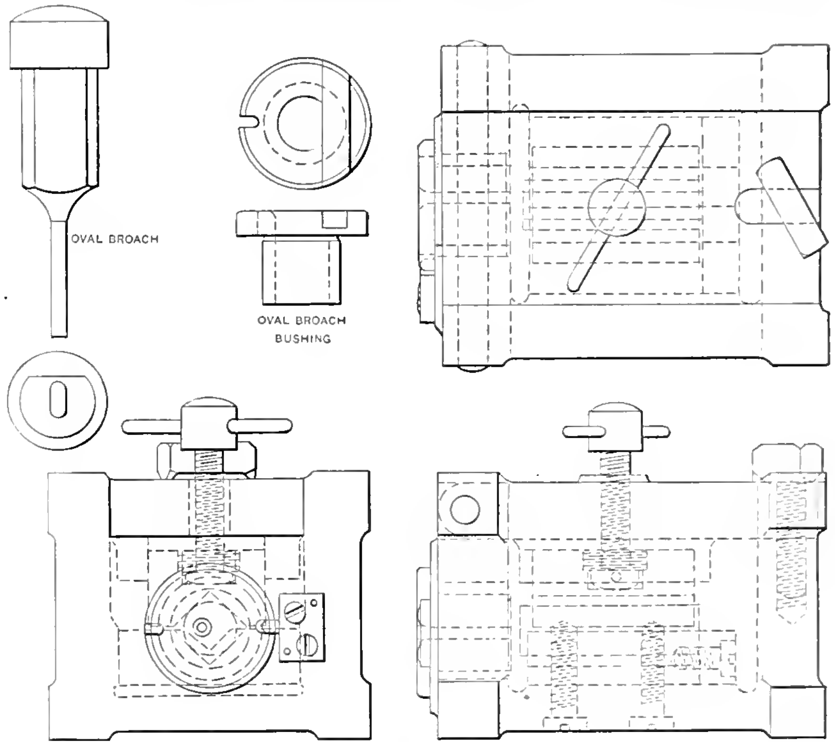

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Fig. 11 Fixture for Making Oval Pilot Holes.

NOTES ON THE ECONOMICAL WORKING OF THE BLACKSMITH SHOP.*

JAMES CRAN †

In [illegible] machinery for the blacksmith shop, a practical blacksmith who has had experience on the class of work for which the machines are intended, should be consulted, so that the equipment selected would be in proportion to the work to be done. It is not uncommon to find blacksmith shops equipped with hammers out of proportion to the work to be done, either too small or too large. In either case, it is evident that the working of the blacksmith shop is uneconomical. It is poor economy, in equipping a blacksmith shop, to provide it with too few steam hammers in proportion to the number of forges, as it requires the smiths to wait for their turn, and the time thus wasted will in the long run be worth a great deal more than the interest on the original investment in one or more additional steam hammers. Not only is this waiting for the use of tools uneconomical in regard to the time wasted, but the steel is, in many cases, injured by having to wait too long in the fire after it is hot enough for working. If steel is thus left in the fire, it may get a pitty and rough appearance when the forging is completed, and in the case of tool steel, the surface will be decarbonized to a certain extent, and the tool will not give as good service when used for a cutting tool.

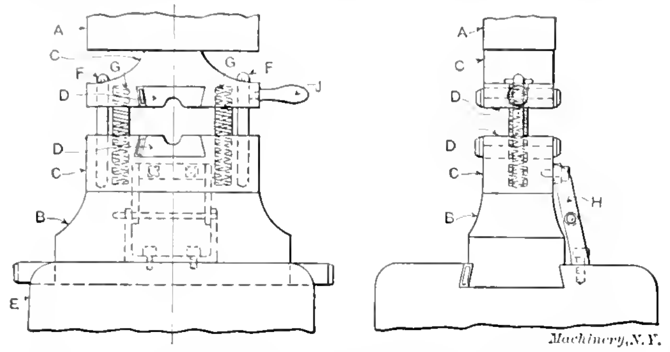

Fig. 1. Special Dies used for Economical Forging in the Steam Hammer.

The economy of the blacksmith shop is also largely affected by the condition of the material supplied to the shop. If the blacksmith shop is supplied with material in long bars, these can be cut into the right lengths for the required forgings, and there will not be any waste, excepting, perhaps a small piece on the end of each bar. If, on the other hand, the material is supplied to the smith in short lengths or in odd pieces, there will most likely be a small portion of each of these pieces wasted, and weight for weight, a great deal more material will apparently be used for completing the same number of forgings, when using short stock than when using long bars.

It should not be forgotten that in most cases forging to shape is cheaper than machining to shape. Since high-speed steel became commonly used, the forging of spindles and similar work has been largely done away with, except in cases where large collars are formed on the spindle, for the reason that, using high-speed steel tools, the excess material can be removed so quickly that it is supposed to be simpler to turn these parts directly from the bar. However, even when using high-speed steel tools, it is seldom that work of this character can be machined from the bar as quickly and economically as it can be forged to the approximate shape, providing the blacksmith shop equipment is up to date. Not only is there a great deal of material wasted when turning off a large amount from the bar in order to form a shoulder or a collar, but the wear and tear on the machines where the work is performed and the time consumed outbalance, in many cases, the cost of rough-forging. Often a single blow from a steam hammer, when an inexpensive former or die is used, will do more to put the piece of iron or steel in the approximate shape required than could be done by an hour of machining.

If the blacksmith shop equipment is adapted to carrying out the forging of more or less complicated shapes, the scrap pile can generally be turned to good use, and considerable economy can be exercised in the use of new stock. Old pieces of machinery, which may be useless for the purpose for which they were originally made, may still contain good material, which can be used to make other forgings, of smaller dimensions, and may even save considerable work in the re-working as compared with the use of new stock. Lathe and planer tools, when too short for service, are quite often consigned to the scrap pile, when they could just as well be turned over to the blacksmith to be drawn down to smaller sizes and used for smaller work. Even the smallest sizes of tools, when worn down too short, can be drawn out and used in toolholders or for boring bar cutters. Considering that high-speed steel costs anywhere from 60 to 80 cents a pound, and that a blacksmith can draw down to smaller sizes from 150 pounds to 300 pounds in a day, this would indicate a considerable saving in the steel tools. Of course, the scrap is always worth money, but the difference between the price of scrap and of new steel is too great to permit disregarding economy of this kind.

In order to help increase the efficiency, and to improve the quality and reduce the cost of work done in shops that are provided with only one steam hammer, the writer designed the steam hammer attachment shown in Fig. 1, which can be used for drop forging, swaging, forming collars, etc. This tool can also be fitted with shear jaws and used for cutting up material for forgings; or punches and dies can be fitted to it, and the tool used as a punch press. Being attached to the die chair of the hammer with jointed straps *H*, it can be used without removing the ordinary plain dies which can be used at any time by folding the attachment back in the open space between the hammer frame and the dies. This attachment can be used for all purposes that spring swages and other spring tools are used for, and will do superior work, because its being attached to the hammer prevents it from wobbling around while being used, as spring tools do. In making quantities of duplicate forgings, the attachment is a decided advantage over ordinary methods, both in the amount and quality of the work done. The blacksmiths' helper, not being required around the hammer to hold tools, can devote the most of his time to heating and handing the hot pieces to the smith. Should another smith want to use the hammer while the attachment is in position it can be folded back out of the way until he has worked his heat, and be placed in position again immediately after he has left the hammer. In the device shown, *A* represents the top die and *B* the lower die of the hammer. The parts *C* are holders for the dies *D*; *E* is the die chair, and at *F* are shown guide pins keeping the holders *C* in alignment. The springs *G* hold the dies open when no pressure is applied on the top, and *J* is a handle by which the attachment can be turned back out of the way when the plain dies are to be used.

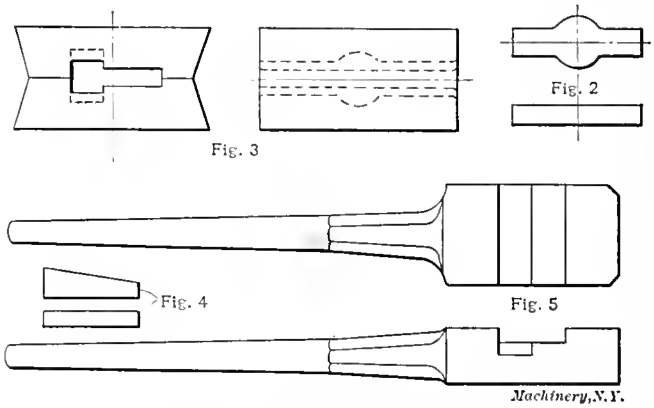

Fig. 2 Fig. 3 Fig. 4 Fig. 5

Figs. 2 to 5. Examples of Blacksmith Work and Simple Tools for Same.

The die holders *C* can be made either from steel castings or forged from machine steel. The lower dies *D* should be made from steel from 0.60 to 0.75 carbon and hardened. If the attachment is made so that the spiral springs *G* will keep the dies a couple of inches apart, a jet of compressed air or a small pipe connected with the air supply from the blower could be used to keep the impressions of the dies free from scale and would improve the appearance of the forgings.

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* For previous articles on this subject, see "Welding," December, 1908, and articles there referred to.

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Forgings of the style shown in Fig. 2 can be made in open dies, as shown in Fig. 3, which do not form any flash or fin, the only parts which need trimming being the ends of the forgings. The impressions are made wider than the forgings they are to shape, so that when a blow is struck by the hammer, the metal has room to spread. One impression shapes the forging edgewise, and the other brings it to the right thickness. When work of this kind is changed from one impression to the other at each alternate blow of the hammer, it can be completed in a very short time, and very close to size.

For forgings of the kind shown in Fig. 4 only one die or tool, as shown in Fig. 5, is necessary, the top die of the hammer being all that is required to form the top side of the forging.

The simple tools shown are used as examples to indicate how work can be done economically in the blacksmith shop. The economy of the blacksmith shop depends largely upon the tools and the general equipment, but, of course, it is also required that the tools be handled intelligently, and the economical working depends in the last instance upon the class of men employed. Any department in the shop, and not least the blacksmith shop, requires men who understand how to use the appliances furnished to the best advantage. It is a mistake to think that the cheapest help procurable is good enough for the blacksmith shop. On the contrary, the economical working of the blacksmith shop requires the very best class of men.

* * *

ARBORS FOR HOLDING WORK IN THE MILLING MACHINE.

A.

The arbors regularly used in milling machines for holding work between centers are invariably too long for certain classes of work, or in other words, they permit of too many pieces being held between the collar at one end and the nut on the other. The longer the arbor, the more it will spring when the nut on the end is tightened, and when under the pressure of the cut. No matter how true each separate piece placed on the arbor may be, if several of them are put together, they will invariably be "out of true," and the amount of "out of true" will increase with the number of pieces held. This spring in the arbors is very serious in some cases, especially when the pieces milled are to be finish-turned or ground after milling.

An example which may be cited is that of screw slotting cutters. The teeth are generally very fine and of very shallow depth. Suppose that a number of these had been milled on an arbor which springs out of true when the cutters are tightened in place. When we now come to grind the outside of these cutters true with the hole, we will find that when the teeth are properly ground on one side, they are almost entirely ground away on the other side, or, in other words, the width of the land on the one side is out of all proportion to the width of the land on the other side, as shown exaggerated in Fig. 1. In this illustration the dimension *A* indicates the diameter of the blank, turned true before milling. *B* shows the condition of the cutter after having been milled on the arbor sprung out of true. As it is milled so that the top of the teeth present a sharp edge, the teeth will all appear of the same depth, but the cutter runs out of true a dimension equal to *E*. When grinding the cutter true with the hole after hardening, the lowest teeth are, of course, just cleared as shown at *G*, getting the proper shape, but on the other side an amount equal to the amount that the saw runs out must be ground away, leaving hardly any teeth at all, as shown at *H*. The loss in diameter, equal to two times the amount *E*, which the cutter runs out in the first place, should also be noted.

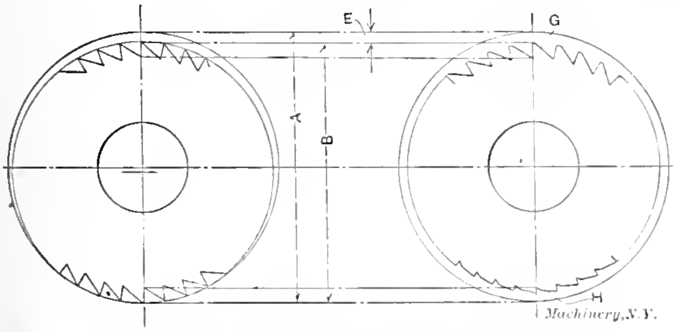
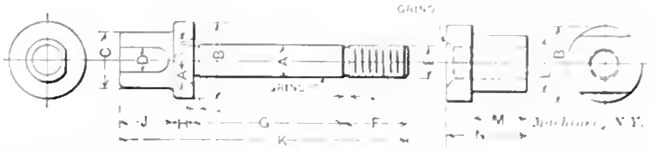


Fig. 1. Effect of Milling Screw Slotting Cutters on Arbors which are sprung out of true, owing to Excessive Length.

In order to avoid the difficulties mentioned arbors should be made rather short and stiff. The accompanying table gives well proportioned arbors for accurate work. These arbors may be considered too short, where work simply "good enough" is produced, but for the purpose for which they are intended, they will be found superior to arbors of ordinary length. On the other hand, the length has been made great enough, so as to answer all reasonable practical manufacturing requirements. They are more especially designed for turning and milling screw slotting cutters. This will account for the large diameter of the collar or shoulder *B*, at the end of the arbor, as well as the large diameter of the collar on the nut. These diameters are, of course, arbitrarily selected, and may be made to suit any requirements, but screw slotting cutters, being very thin, require all the support that can be provided sidewise. These arbors should be made of tool steel, hardened, and ground as indicated in the illustration accompanying the table. The nuts may be properly made of machine steel, casehardened, and ground on the face coming next to the work.

TABLE OF ARBORS FOR HOLDING WORK IN THE MILLING MACHINE



A	B	C	D	E	F	G	H	J	K	L	M	N
1/4	3/4	11/16	1/4	1/4-24	1/4	1 1/4	1/4	3/8	3	9/16	1/4	1/4
3/8	1	15/16	3/8	3/8-20	3/8	1 3/4	1/4	1/2	3 1/8	5/8	3/8	3/8
1/2	1 1/8	1 1/16	3/8	1/2-20	1/2	2	1/4	15/16	3 15/16	3/4	1/2	1/2
5/8	1 1/4	1 3/16	1/2	5/8-12	5/8	2 1/4	3/8	1	4 1/4	1	5/8	5/8
3/4	1 1/2	1 7/16	1/2	3/4-12	1	2 1/2	1/2	1 1/8	5 1/2	1 1/4	11/16	3/4
7/8	1 3/4	1 9/16	5/8	7/8-12	1 1/8	3	5/8	1 1/4	6	1 1/4	13/16	1
1	2	1 3/4	5/8	1 -12	1 1/4	3	3/4	1 1/4	6 1/4	1 1/2	15/16	1 1/8
1 1/8	2 1/4	2	3/4	1 1/8-12	1 1/4	3 1/2	3/4	1 3/8	7 1/4	1 1/2	15/16	1 1/8
1 1/4	2 3/8	2	3/4	1 1/4-12	1 1/4	3 1/2	7/8	1 3/8	7 1/4	2	15/16	1 1/8
1 3/8	2 1/2	2 1/8	7/8	1 3/8-10	1 3/8	4	1	1 3/4	8 1/4	2 1/4	1	1 1/4
1 1/2	2 1/2	2 1/8	7/8	1 1/2-10	1 3/8	4	1	1 5/8	8 1/2	2 1/4	1	1 1/4
1 5/8	3	2 1/4	1	1 5/8-10	1 3/8	4 1/2	1 1/8	1 5/8	8 7/8	2 3/8	1	1 1/4
1 3/4	3	2 1/4	1	1 3/4-10	1 1/2	4 1/2	1 1/8	1 7/8	9	2 1/2	1 1/8	1 3/8
1 7/8	3 1/8	2 1/2	1	1 7/8-10	1 1/2	5	1 1/4	2	9 1/4	2 5/8	1 1/8	1 3/8
2	3 1/8	2 1/2	1	2 -10	1 1/2	5	1 1/4	2	9 1/4	2 5/8	1 1/8	1 3/8

* * *

In a consular report, Consul Albert Halstead of Birmingham, refers to the primitive methods of chain manufacture still in vogue in the so-called "black district" in England. The chains are forged by individuals in or at their own homes. Those engaged in the trade are not organized in any unions, but each works for himself individually. They purchase iron rods of the required size, from the iron merchants, bring them home on a wheelbarrow or carry them home on their shoulders; and on a little forge at the back of the house, the links of the chains are made from these rods. The forged chain is then carried, thrown across the shoulders, to the merchants, who pay for it by weight. The makers of the chains are entirely at the mercy of these middle-men merchants. The tools used in making the chain are not many. The chain is made wholly by hammer and without finishing tools. Of course, the chain is not high grade, the links vary in shape, the weld is apt to be imperfect, and the chain is not tested. Small-sized chain from 3/16 to 1 inch in diameter is made chiefly by women, girls and boys, and by old men whose vigor is so much lessened that they are unable to do the heavier work. The women working on chain making earn from thirty to forty per cent of what the men earn making the same sizes. In some cases, the percentage is as low as twenty-five per cent.

THE NEW YORK CENTRAL LINES APPRENTICESHIP SYSTEM.

It is gratifying to note that the leading railroads of the country have realized the necessity of apprentice systems in the railroad shops. The New York Central Lines have a well-organized system for educating apprentices, and in an address before the Pittsburg Railroad Club, the superintendent of the apprentice school of this road, Mr. C. W. Cross, gave an interesting account of the results obtained, and the effect of the training of apprentices in the company's shops.

The one most noticeable from the installation of the new apprentice system has been the increased efficiency of the apprentices. This is largely due to the addition of the shop instructor, although the benefit of the class-room work is also apparent. Under the old system the foreman was expected to see that the boys received proper instruction concerning their work, and that they performed it properly. Ordinarily the foreman is too busy to give the boy anything like the required amount of attention. With the addition of the shop instructor, who has the duty of looking after the boys, the efficiency of the apprentice has very greatly increased, with a resulting improvement both in the amount of output and the quality of the work done. There is no question but that the work accomplished by the shop instructors has more than paid for their salaries. The shop foremen, relieved of the care of the boys, can give their time to the more important details of the work. Reports from the ten shops where apprentice schools have been established show that in every case the boys are not only turning out a better grade of work than ever before, but that they are working on machines, or doing bench work, that formerly it was not thought possible to entrust to apprentice boys.

Another important advance is that the apprentice, after he has had a few months of class-room instruction, can read simple working drawings, and the third and fourth year apprentices are able to read the most difficult drawings. When one stops to consider the comparatively small number of so-called mechanics in the average railway shop who can read working drawings readily, and the necessity of being able to do this, its importance can be realized. Not only this, but the boys are able to make sketches, or drawings, of shop devices or of broken parts, which it is oftentimes advisable to have for record at the local shop or for transmission to the mechanical engineer's office. During the past year the apprentices of the New York Central Lines made 1,344 drawings, which have been placed in the files of the New York Central Lines drawing rooms for use and record.

The criticism may be made that this work will unfit the boys for remaining in the shop. A certain percentage of the boys will, of course, wish to be transferred to the drawing room, but anyone who is familiar with the difficulty of securing satisfactory draftsmen for a railroad drafting room, who have had the necessary shop experience to handle the work required of them to advantage, will realize that it is very desirable to have a few of the boys graduate from the shop to the drawing room.

It is often desirable to conduct tests of tools or devices, or to determine the efficiency of various kinds of machines or other apparatus. The training which the boys have received in the class room has enabled a number of them to be used to great advantage during the past year in assisting on or conducting such tests. The benefit to the apprentice and the company is mutual. Another effect of the new system is the better discipline over the boys and the effect which this has had on the shop as a whole. At several of the shops the boys have organized apprentice or debating clubs. It is the practice to prepare papers on different topics and to discuss them. The class-room training helps the boys to take part in these meetings and has been the means of developing them to a considerable extent.

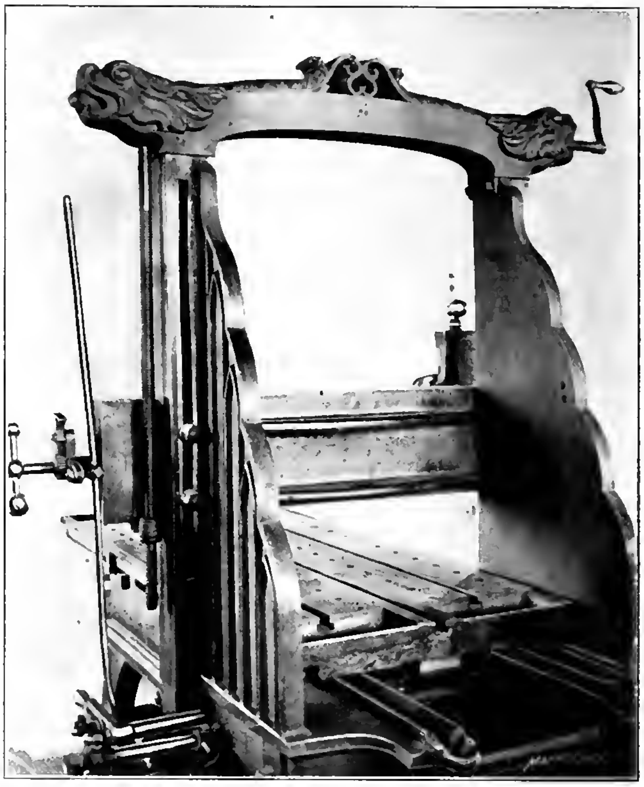
At several shops where it was formerly hard to obtain enough apprentices or to get a good grade of boys, little difficulty is now experienced, as the boys are assured of being given a thorough training in the trade and of having greater opportunities of advancement than formerly. It has been the practice for apprentices to occasionally make visits to neighboring shops of other roads or to some of the other shops on the system. Several of the boys obtained ideas which they put into use at once. One boy who was working on a boring mill changed to the method of fastening the tires on the table to correspond to the method he had seen at Schenectady. He did this without waiting for definite directions from the instructor, and soon found that he was able to gain one tire in his day's work. The impression made on the minds of the boys by observing the methods of experienced workmen prove much more lasting than when these same methods are explained ever so clearly by their instructors. It is a paying proposition to the company to allow either boys or men to visit other shops where work of a similar kind is being carried on. The boys, after the above-mentioned trips, were asked to write letters to the shop foreman as to their observations and what they had learned. These demonstrated the benefits which were gained.

* * *

PLANER WITH ELABORATE ORNAMENTATION.

H. P. FAIRFIELD.

Highly ornamented machinery has, of course, gone out of style, but at one time there must have been considerable rivalry between the builders of machines, as to who could get out the most artistic machine patterns. The accompanying illustration, which shows an old planer that has been in service since about 1855 and is yet a "planer," is an excellent example of the vast amount of unnecessary artistic pattern work formerly done by some machine tool builders. As will be seen, the ornamentation of the sides of the housings is after the pointed or Gothic style of architecture, while the ends of the elaborately carved tie-piece across the top, represent gargoyles. This planer was built by the Thayer-Houghton Co. of Worcester, Mass., afterward the New York Engine Co.



Example of Artistic Pattern Work as practiced in the Early Days of the Machine Tool Industry.

* * *

The utilization of the water power available in Switzerland has now been placed under the direct supervision of the state, which will take the necessary steps to safe-guard the interests of the public. The transmission to foreign countries of power generated in Switzerland is subject to the approval of the state, and the royalties will be paid by private users of water power, to the Government. This development is one more step towards the recognition of the right of the whole people to natural resources exploited by private enterprise.

ITEMS OF MECHANICAL INTEREST.

INTERESTING FEATURES OF AN ELECTRIC COAL-PUNCHER.

One of the difficulties encountered in producing an electric coal-puncher, except in the solenoid types, has been in the conversion of the rotation of the motor into reciprocating motion for the drill. Where the blow is directly dependent on the motor, the latter gives trouble because it is not able to stand the vibrations and strains incident to the powerful blow of the pick, and if springs play an important part in obtaining this blow, there are other troubles because of breakage and unreliability. Types with separate motors and flexible shaft connections have also been tried in order to obviate some of these difficulties, but complications were introduced which at least partially off-set the benefits derived. A reciprocating drill or coal-puncher is made by the Pnuemelectric Machine Co., Syracuse, N. Y., which uses both compressed air and electricity. The latter is the actuating power and the compressed air gives the blow. As the connection between the driving motor and the striking pick is not a rigid one, the vibrations are cushioned. The mechanical means by which the rotation of the motor armature is changed to a reciprocating motion to drive the air compressing piston, and the way in which a single air cylinder, with practically no valves, compresses the air which impels the pick-carrying piston, will be explained in the following:

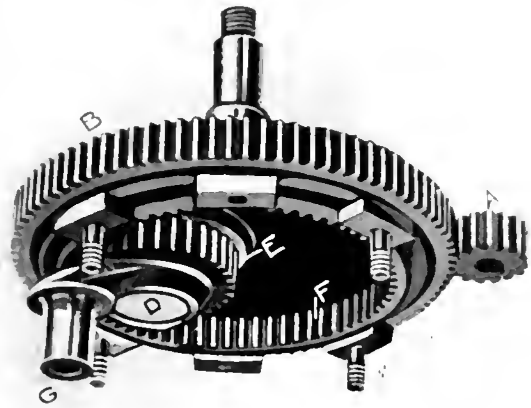


Fig. 1. General View of the Mechanism illustrated in Fig 3.

The small pinion *A* (Fig. 1) is attached to the shaft of the motor armature, and engages the main driving gear *B*, which has a solid web carrying the stud *D*, which, in turn, carries a crank pinion *E* having 33 teeth. Internal gear *F* (Figs. 1 and 3), which is rigidly fastened to the frame of the machine, is concentric with the main driving gear *B*, and the crank pinion *E* engages with this gear as shown in the illustrations. The pitch diameter of this crank pinion is just one-half that of the internal gear which has 66 teeth. The crank-pin *G* which is attached to the pinion *E* engages with the cross-head *H* to which the rear piston-rod *I* (see Figs. 2 and 3) is attached. When the main driving gear *B* is revolved by the armature pinion, the crank pinion stud *D* describes a circle in the direction indicated by the arrow, and the pinion *E* revolves on the stud and around the internal gear. When the pin *D* has moved one-quarter of a revolution, it will be in the position shown at *b*, and the pin *G*, attached to the cross-head *H*, will be in the center of the internal gear. At the completion of one-half a revolution, the pin *G* will have moved rectilinearly a distance equal to the pitch diameter of the internal gear and will be in the position shown at *c*. Similarly, at three-quarters of a revolution, the pin will be again in the center of the internal gear as shown at *d*, and at the completion of a full revolution, it will be at the point of starting as at *a*. In this way the crank pinion, as it revolves around the internal gear, gives the pin and attached cross-head *H* a rectilinear forward and backward movement.

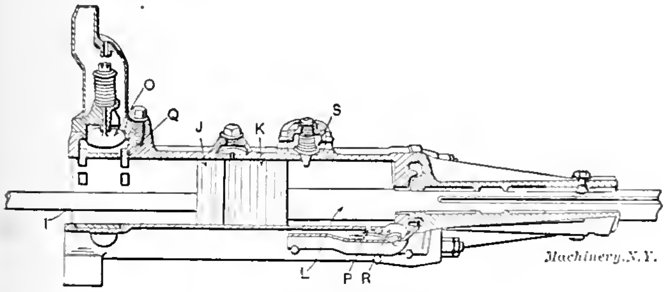


Fig. 2. Air Cylinder in which the Air is compressed and used to impel the Pick-carrying Piston.

The way in which the air is compressed and utilized to impel the pick-carrying piston forward, all in one cylinder, constitutes the most interesting and novel feature of the machine. Fig. 2 shows the cylinder, front head, and the two pistons and rods. The rear piston *J* is attached to the cross-head *H* in Fig. 3. The front piston *K* has no connection with *J*, but it is connected with the drill or pick socket by the rod *L*. The first stroke of the pick is purely mechanical. The rear piston *J* moves forward, pushing the front piston *K*. During this stroke, air is drawn into the cylinder behind the piston *J*, through the main inlet valve *O*. On the return stroke, this air is compressed and at the same time the front piston *K* is drawn back by the partial vacuum created by the piston *J*, air being admitted in front of *K* through a port *P*. When the return stroke is completed, the rear piston has passed the by-pass opening *Q* in the cylinder, which opening is between the two pistons at the time. This allows the compressed air to force the front piston forward, exactly as in any compressed air drill. In this way the first real stroke of the machine is made; that is, the mechanical stroke mentioned above is made only once or when starting from rest. On the forward stroke of the piston *K* the air in front escapes through the port *P*, but after the piston has passed and therefore closed this port, a sufficient amount of air remains to cushion the blow and prevent damage to the front cylinder head. This cushion air may leak somewhat, and to prevent an insufficient supply remaining which would have the effect of creating a partial vacuum in this space and holding the piston on the return stroke, a small inlet valve *R* is placed in the forward part of the cylinder. This allows air to flow in under these conditions before the open port is passed. When the front piston *K* has made its forward stroke, the rear piston follows, mechanically driven as before, and would compress the air which has just made the stroke of the front piston, were it not for the so-called vacuum valve *S*, which allows all air between the pistons above a certain pressure to escape to the atmosphere. The action of this prevents the two piston faces from coming together.

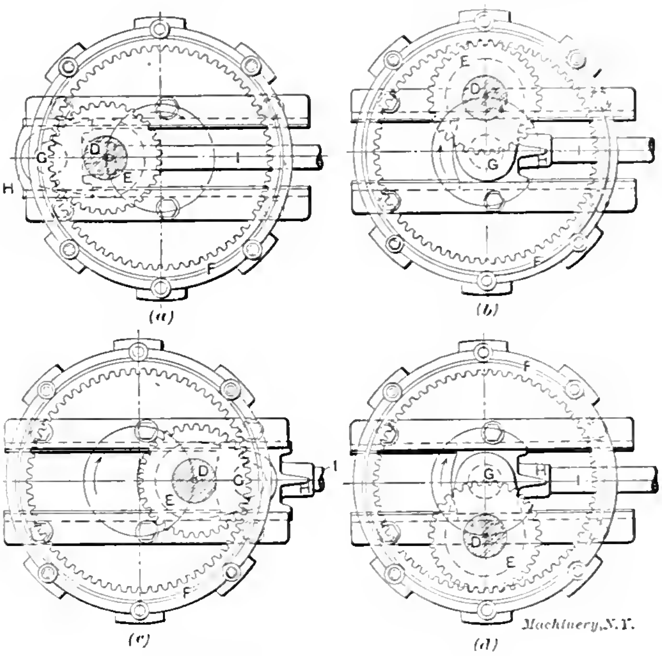


Fig. 3. Method of changing the Rotary Motion of the Motor to a Reciprocating Movement.

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SOME DEFECTS IN OUR TARIFF REGULATIONS.

The practical workings of some of the tariff regulations applying to the return of American machinery to this country for repairs, and the importation of gages, samples and other parts which are of no value to the American manufacturer except for purposes of measurement and comparison, were brought out at the recent hearings before the Committee on Ways-and-Means.

The Gisholt Machine Co. of Madison, Wisconsin, in a communication to the committee, stated that it received from a foreign customer a number of gages which were to be used for testing the tools being made for him, on which he had placed a value of $450, doubtless for insurance purposes. These gages, of course, were of no value to the Gisholt Machine Co. and it refused to pay the $200 duty demanded by the Custom House, as there was no possibility of the amount being refunded when the gages were returned to the owner, and the Gisholt Co. preferred to take its chances on getting the standards correct from drawings furnished by the customer. Another well-known tool builder, in a letter to MACHINERY, calls attention to a Custom House regulation, of a peculiarly aggravating character, applying to the return of broken parts sent for repairs. Our correspondent states that if a machine is broken in transit abroad, and the buyer asks to have the part repaired, the American manufacturer cannot have the broken parts returned to him without paying 45 per cent duty on them, although they are necessarily a part of the original machine and are of no value until the repairs are made. Another manufacturer also calls attention to the custom of charging duty on gages and tools, referred to by the Gisholt Machine Co., stating that he was obliged to pay $25 on a reamer sent by a foreign customer for finishing certain holes to the required standard. The reamer was of no use to any one except the owner, as it could only be used for finishing certain holes on special machines to an odd shape and size, and, consequently, it was returned with the shipment.

In the general revision of the tariff which is now taking place, the attention of our law makers should be called to unnecessary and irritating regulations of this character, which serve no purpose except to delay and increase the cost of repairs and construction of machines for foreign shipment.

* * *

WHEN A TRUST MADE GOOD.

We have all been taught that the unwieldy organization and the enormous capitalization prevents the average trust from manufacturing as cheaply as can a concern having all its activities directed by one concentrated management. We are prone to believe that trusts are bad, and that their capitalization of wind and water places a burden on labor and on the public out of all proportion to the benefits derived. Granted that these statements are true, in general, there is nevertheless another side to the shield, surprising in aspect in one case at least.

Some years ago an important manufacturing industry was "trustified," with the exception of one large concern having an annual productive capacity nearly equal to all the plants that went into the trust. The capitalization of the latter consisted of the usual amount of water, while that of its competitor represented actual values. For a number of years both the trust and the independent concern did a big business, but the common belief was that the trust would not make as good a showing as the single plant when hard times came. The independent plant is highly concentrated and organized in an old-fashioned way, while the trust comprises a large number of individual plants scattered over the eastern part of the United States; the equipment of many of which *was* very indifferent. However, the men responsible for results early in the game began a reorganization which utilized the great improvements in machine tools, methods, and steels, that have been developed in recent years; and the trust is producing machines today with a labor cost of approximately two-thirds that of the independent concern, being able to build machines for $1,000 apiece less than its competitor, and still make a good profit.

It is needless to say that the independent company referred to is a horrible example of misapplied methods. New machines, new steels, handling appliances, etc., are used; but the plant as a whole has not been reorganized systematically, nor the advanced modern methods made an integral part thereof. Present day improvements have been grafted onto old methods in a way that has resulted in no marked increase of productive capacity per unit of labor employed, and the modern engineering ideas which have been usually so potent a force in cost reduction have not been advantageously employed by the independent concern.

This seems to be a case where the necessity for earning dividends on watered stock has resulted in reducing the cost of a product to the user; but it should be understood that the machines referred to are not protected by patents and that the industry is one that cannot be monopolized.

* * *

As has been previously stated in these columns, the new British Patents Act requires that all patents granted in Great Britain be worked in that country. If they are not worked in Great Britain, the patents may be revoked upon application of parties who would themselves enter upon the manufacturing of the patented products. Ten applications for revocation of patents have so far been filed with the Patent Office, and two revocations have already resulted. These, of course, are subject to appeal before the courts. It appears that a great many manufacturers of patented articles both in the United States and on the European continent do not intend to manufacture their goods in the United Kingdom, but will depend upon their manufacturing facilities in the home countries to make it possible for them to compete with English manufacturers who would eventually take up the manufacture of their goods in Great Britain. Except in some special instances, it is evident that the British manufacturer who undertakes to manufacture foreign patented articles would place himself in an untenable position, because he would have to depend upon the British home market entirely for his sales; it would not be possible for him to obtain any foreign markets as long as the article is patented in other countries.

A CHANGE IN RED TAPE DESIRABLE.

Our reference last month to the lack of mechanical experience which frequently impairs the purchasing agent's value, is emphasized by a recent letter from a mechanic employed in one of the government departments, in which he speaks in strong terms of the difficulty of turning out work with the files supplied by Uncle Sam, which he says are "crooked, warped, not cut to edges, corners or ends. They glaze over, and in many cases are re-cut files, some of them having broken tangs. No doubt they are files rejected by the maker's inspector, but are good enough to unload on Uncle Sam."

A certain amount of departmental red tap is always necessary in connection with government purchases; but why not let it be applied by the operating instead of the purchasing department, in the case of small tools as well as large ones? If all bids for small tools were accompanied by samples to be tested, and the contracts awarded with due regard to quality as well as price, the government would undoubtedly be the gainer, and the industry represented would be benefited instead of being injured by the award of contracts to the lowest bidder for the lowest quality of goods; for that is what it virtually amounts to in many cases when the purchasing agent has absolute control.

* * *

A PROFIT SHARING EXPERIMENT.

In the December number, engineering edition, we referred to the interesting offer to employes of the Middletown Shipbuilding Yard, England, made by Sir Christopher Furness of that company. The company sustained heavy losses during the past year, largely due to labor troubles, and Sir Christopher offered the men preferred stock, payable in installments of 5 per cent of their wages, to be deducted weekly; these shares carrying a fixed interest rate of 4 per cent, and to participate equally with the common stock in a pro rata distribution of any surplus profits over 5 per cent for the common. The various trade unions concerned have agreed to the arrangement, which is to be given a year's trial before final determination.

This proposition has been described as a profit sharing scheme, which is hardly accurate. The men pay full value for their stock, in weekly installments, receiving only 4 per cent on their investment until, as stated, the regular stockholders are paid 5 per cent. As a matter of fact, they share in the profits as the investors or shareholders in any company share in its dividends. Nevertheless, this arrangement will benefit the men indirectly, as it benefits the firm directly. Each employe will now have a stockholder's interest in the welfare of the enterprise with his desire for profits undiminished by losses incurred in labor disputes. This should ensure peace to the company and greater permanency of employment to its employes; and the habit of saving to which the men are committed under this arrangement will be of permanent benefit to a great many, who will learn, perhaps for the first time, that a small amount regularly laid by provides in due time a substantial savings account. The exercise of self-control and self-denial, the building up of character, the cultivation of thrifty habits in the individual are possibilities of the greatest importance inherent in this English experiment. It is necessary to regard the proposition from this point of view in order to appreciate it, for as a case of actual sharing in the profits resulting from their own productiveness, the proposition is rather weak from the standpoint of the worker.

* * *

THAT INDUSTRIAL DEMOCRACY.

Referring to the editorial in the January issue of MACHINERY, entitled "An Industrial Democracy," the writer feels prompted to say that not everyone who has studied industrial conditions in Germany agrees with Captain Carden as to the competition of Germany with America in the manufacture of machine tools. "The man behind the gun" is not here. Both general and industrial education here, compared with that in America, bear the same relation to each other that the savage's ceremonial suit of a silk hat and a breech-clout does to a "derby" and a plain business suit. The superior education of the employers and managers is here; but the workman is repressed industrially and socially; he has no inducement, no opportunity to come forward. Few or none start at the ash-pit and reach the manager's office.

The writer's first visit to Germany was in 1878-9; and since then, while the percentage of improvement in methods and finish is greater here than in America, because the basis of calculation is smaller, the actual progress in America is much greater; and at the present percentage rate of progress in the two cases it will take more than one generation before the two nations come together. Since January, 1894, the writer has lived, with the exception of one year in America and one in France, continuously in Germany; and has been uninterruptedly in communication with German engineers and manufacturers; has visited considerably more shops than the average American has, reorganized some, and ordered work from several; to say nothing of countless orders from individual workmen:—carpenters, locksmiths, model makers, blacksmiths, tinsmiths, plumbers, masons, etc. With the exception of about twenty shops, where the work is done on American machines, or on German imitations or modifications thereof, the German establishment is not on a level with ours in design or execution. In many of these twenty there are American or English foremen, or German foremen instructed by them. In one of the three very best German shops the leading spirit spent months in an American shop and brought back American machines as models. The work is now good enough, and original enough, for anybody; but after bringing over one special American machine he was obliged to send over for the foremen of the Philadelphia shop that built it, before he could make it work, after which he built others like it. What is considered the model German machine shop in amount, range, and quality of work, was built after an expert had visited over sixty American shops and culled the best features from each; and at first it had seven American foremen.

As regards the average German workman who is not a machine-tender—he has too many thumbs. The writer has never seen so much inexact work as is turned out by him. Captain Carden evidently never stepped into a German hardware store and compared, piece by piece, American and German tools, locks, etc.

Where Germany has the advantage of America is, among other points: 1. In low wages. 2. In granting long time on sales. Try to sell a machine tool in Germany under three months, in Austria under six, in Russia under twelve, and see "where you are at." Germans do it on the long-time basis. 3. In government ownership of railways, etc., shutting out American and other foreign competition in the matter of locomotives, cars, rails, etc. 4. In the difference of the banking institutions. Here the banks, as such, are directly stock-holders in machine shops, and indirectly interested in other manufacturing establishments; so that the latter get good credits from the banks, conditional on their buying their machinery, etc., from the bank-owned shops. These banks have branches in foreign countries, making collections more sure, and also discounting notes on condition of purchases being made where they indicate. 5. In short hauls of freight. 6. In an immense fleet of merchant vessels, sailing directly to all important foreign ports. 7. In reduced railway freights on exported goods. 8. In the love of work, as such, inherent in the German. 9. In the knowledge and use of foreign languages and business methods, enabling direct dealing with many nations. 10. In the willingness to make what the customer demands, instead of what the manufacturer thinks he ought to call for. 11. In the use of the metric system, enabling him to work in the standards of a great part of his customers, without extra trouble and expense. 12. In the neglect of Americans to patent their inventions in Germany. The writer has been offered, for example, "Trimo" wrenches bearing either the name of the German manufacturer, or the customer's, or the American trade-mark. Further willingness to oblige would be superfluous. 13. In packing goods decently for export. 14. In the absolute necessity to get trade abroad. The German is in the condition of the boy who was digging in a bank for a gopher. "Think you'll get him?" asked a passer-by. "Git 'im? Bound to git 'im. We're out o' meat!"

X.

NOTES AND COMMENT.

A consular report from Germany states that the Siemens-Schuckert Electrical Company contemplates the erection of a separate plant for the manufacturing of airships and aeroplanes.

It has been stated officially by President McCrea that the Manhattan terminal of the Pennsylvania Railroad will be able to handle traffic by May 1, 1909, and that one thousand trains a day will then be taken care of. The tubes under the rivers are practically finished with the exception of track-laying.

According to a German source the number of locomotives provided with superheaters in October, 1908, was 3,455. The Prussian State railways lead in the use of superheated steam locomotives, there being 1,789 locomotives of this type in use or in process of construction on the Prussian government railroads.

One of the speakers at the recent Conference on Natural Resources stated that the total power at present produced by prime movers in the United States is nearly 30,000,000 horse-power, of which 26,000,000 horse-power is produced by steam engines, 3,000,000 horse-power by water motors, and 800,000 horse-power by gas and oil engines.

The subway and elevated lines of the Interborough Rapid Transit Co., New York City, on Monday, December 21, carried 1,800,000 passengers, which is about 200,000 more than the maximum number for a single day last year. There was a slight diminution in the traffic on the Elevated lines for 1908, but in the Subway the volume of traffic increased 30 per cent.

A section 6,110 feet long of Boston's subway system was opened November 23. This section together with that previously constructed makes a total of 20,196 feet or nearly four miles. The section just completed cost $10,000,000 with its approaches and equipment, and has been leased to the Boston Elevated Railway Co. for a term of twenty-five years.

In a report made by Senator Flint of California to the National Conservation Commission it was stated that half the natural gas now coming out of the earth, equal to about 1,000,000,000 cubic feet per day, or more than enough to light all the cities of the United States having more than 100,000 population, is wasted by being allowed to escape into the atmosphere.

Prof. Charnock in a lecture, "Invention as a Science," delivered before the Bradford Technical College, England, called attention to the interesting difference between men and animals as regards mechanical instinct. Animals have no rotative movement, the very essential for mechanism. The fact that man can turn a crank and thus produce a rotary motion may be one reason for his ability to conceive and build mechanism.

The report of the Bureau of Railway Statistics states that the gross earnings for the fiscal year ending June 30, 1908, decreased $139,000,000. The gross earnings were $2,450,000,000 or $10,652 per mile, as against $11,383 a mile for the previous year. The operating expenses for 1908 will approximate $1,729,000,000 which is about $20,000,000 below those of 1907, so that the official returns for the year show a loss of $120,000,000 in net earnings, as compared with 1907.

The number of patents applied for in Great Britain decreased somewhat during 1908, as compared with the figures for 1907. This is ascribed to the fact that the new British Patent Act has discouraged foreign inventors from patenting their inventions in Great Britain, if they be not in a position to manufacture in that country. Of the patents issued, 1,100 relate to gas engines, between 800 and 900 to bicycles, 800 to the automobile industries, and 350 to aerial navigation. The total number of inventors was 3,586, of which 40 were women. It is a curious fact that a patent obtained by a woman, related to the cyanide process of treating ores, and apparatus for this purpose.

A subway system for transporting the mails between the various post-offices is to be established in Berlin. Two lines are projected, one of which will form a belt line in the central part of the city and will connect the main post-offices with the principal railroad stations. The second line will run between the various offices. The subways will be of small section, only 6 feet wide and 3 feet high, double tracked, the traffic being maintained by small electric cars run by an automatic system without a motorman. Between the two tracks in the subway there will be a depression which will serve as a footpath for those who need to pass through the tunnel for inspection and repair purposes. The speed of the cars will be twenty-five miles an hour.

The galvanized wire suspender ropes which are to support the main span of the new Manhattan bridge, were recently tested under the direction of the bridge department of the city of New York at the works of John A. Roebling's Sons Co., where these ropes were made. The suspended span will be attached to the ropes, which are 1¾ inch in diameter, by means of steel castings socketed to the rope ends and threaded on the outside for 5¼ inch nuts. Three pieces of the rope were broken during the test, and in each instance the socket proved stronger than the ropes, which broke at 287,000, 288,600, and 290,000 pounds respectively. The greatest load to which one of the suspender ropes can be subjected is 50,000 pounds, so there is a factor of safety of over 5 for the suspenders and sockets.

In more than one instance in American railroad history can be found records of fatal wrecks caused by the burning of a bridge in a wild or lonely district where such a conflagration would rarely be discovered in time. The Canadian Pacific Railroad has provided against the possibility of such accidents by the adoption of automatic alarms designed to stop trains in case a bridge should burn. Semaphore signals are fixed about 3,500 feet from the bridges, each way, and at each signal is attached a wire which runs to a pulley on the bridge. These wires are connected with a rope which extends beneath the bridge for its entire length. The semaphore arms are heavily weighted so that if the rope should part, as would be the case if the bridge should burn or be destroyed by a flood, the signals would fly to the danger position.

The development of the underground rapid transit system of London has been very rapid. There is in that city, at the present time, eightly miles of subway built like the rapid transit system in New York, just below the street surface, and in addition to this, there is about one hundred miles of underground tube railways which are built at a depth of from 50 to 180 feet under the surface. During the rush hours, trains are run in some of these underground railways at an interval of a minute and a half; in the New York subway, due to the fact of impractical construction of the cars, it is not possible to run trains at closer intervals than about two minutes. As regards the handling of the passenger traffic with rapidity on both urban and regular railroads, there is no question but that England sets a pace well worth following.

A bulletin on comparative tests of briquetted and ordinary coal on locomotives has recently been issued by the Technologic Branch of the United States Geological Survey. The results of the test are summarized in the following conclusions: The evaporation per pound of fuel is greater for briquetted coal than for the same coal in its natural state; the capacity of the boiler is increased by the use of briquetted coal; briquettes have little effect in reducing the quantity of cinders and sparks, but the calorific value of these is not as high in the briquettes as in the natural fuel; the density of smoke is much less than with natural coal; the expense of briquetting, under the conditions of the experiments, added about $1 per ton to the present price of the fuel, an amount which does not seem to be warranted by the resulting increase in evaporative efficiency. In terminals, however, the briquettes can be used to considerably decrease the amount of smoke.

The Forest Service of the United States Department of Agriculture has of late issued several statements regarding the waste of our lumber resources, and it has appeared from many of them as if the lumber supply of the country could not possibly be expected in the future to meet the demand. Recently, however, a report has been issued on the present condition of the country's forest resources which indicates that, under proper management, our forests may be made to yield all the lumber required in our industries and trades, and that still the forests cover one-fourth of the area of the whole country. Methods of saving, which are, in particular, emphasized are the reduction of waste in the woods during lumbering, and in the mills, preventative treatment of wood exposed to water and dampness, steps for preventing forest fires, and especially proper legislative enactments, looking towards continual replanting of the forests.

In a recent issue of the *Iron Trade Review*, some applications of vanadium steel are indicated. It is stated that locomotive springs have been made from this material with excellent results. In ship-building work, the duty of the riveting dies of pneumatic hammers is very severe, and the average life of such dies is only about ten hours. Expensive brands of steel were tried by the New York Ship Building Co., but the results were not satisfactory until vanadium steel was used. The first cost of this steel was not only less, but it is inferred from the article mentioned that the dies can be used for months without breakage. It is also mentioned that in the yards of the same company, three hundred sleeves entering in the design of certain pneumatic machines had been broken in two or three months. In March, 1908, vanadium steel sleeves were adopted, and no breakages have since occurred.

In the *Zentralblatt der Bauverwaltung* an interesting reference is made to the wear of bridge pins. An early German pin-connected railway bridge, built in 1863, was taken apart recently for the purpose of replacing it with a bridge of larger capacity. The bridge was of the Pratt truss construction, 102-foot span, and 12 feet 7 inches depth of truss at center. The pins were two inches in diameter and made of carbon steel. They were measured at the center of the seat in the chord eye-bars, and the wear was found to be surprisingly small; only three pins in the entire bridge showed greater wear than 0.004 inch, and in the three cases where the wear was greater than this, it did not exceed 0.040. This is a good indication of the permanency of a steel bridge properly designed and erected and constructed of good material. Being still in good shape, this bridge will be re-erected as a foot-bridge.

The Cunard liner *Mauretania* has recently undergone extensive repairs, and the propellers have been re-arranged, so that it is expected to be able to increase the speed at least one-half knot, and at the same time reduce the vibration of the vessel. The change consists in fitting four-bladed solid propellers, each weighing 18 tons, to the two forward shafts, while the propellers on the two after shafts still retain three blades. What it means to overhaul a large ocean vessel may perhaps be best understood by reference to the fact that the *Mauretania* was in dry dock for about nine weeks, during which time nearly 2,000 men were employed in the work of overhauling and repairing the ship. The damaged shaft, which was broken some time ago during a trip across the ocean, has been renewed, and the forward port bracket—a forging weighing twenty-six tons—has been replaced. It is stated that the cost of this work amounted to $250,000, a rather large sum considering that the vessel is practically only one year old.

It is stated in the *Scientific American* that the question of supplying ties for American railroads has become so serious that the Santa Fé system recently sent its manager of the timber and tie department to Europe and the Orient to make a study of conditions. Among other things learned during this trip of investigation, was the fact that the Japanese government began to conserve its forests three hundred years ago, and that as a result of this foresight, Japan is now in a position to sell ties to railroads in this country. There is a duty of 20 per cent of the value on ties imported to the United States. The working of the higher political mind is certainly wonderful; on the one hand there is an outcry about the excessive use of our forests, and on the other hand an attempt is made to prevent the importation of lumber from other countries by a restrictive tariff, although such importation undoubtedly would tend to save some of the timber supply in this country.

At the structural shops of Milliken Bros., Inc., on Staten Island, New York City, in the latter part of December, 1908, 143 tons of plates were punched in one day (8 hours, 47 minutes) on one machine. The plates were 13-inch flange plates for girders, ⅝ inch and 11/16 inch thick, and averaged about 32 feet in length. The average number of 15/16-inch holes was about 96 to each plate, staggered except at the ends. There were three sizes of plates and varieties of spacing; 52 of one kind, 168 of the second and 96 of the third. The total length of plate handled was 10,036 feet; weight 285,850 pounds, and total number of holes 30,384. This work was done on a multiple punch, four plates being passed through at a time. A few days previous to this, one man punched 12,740 9/16-inch holes, one at a time, in 10 hours. This was on light transmission line tower angles, on a light single stroke, quick-acting punch. These performances are believed to be records in the line of rapid punching in the bridge shop.

"There are other ways of killing a cat besides choking it to death with butter," and the conventional drill press and twist drill of the machine shop are not the only "pebbles on the beach" when it comes to the matter of putting a hole through iron. The Western plainsman uses his Winchester to perforate the wagon tire for a new bolt hole, and the blacksmith heats it and drives a punch through with three or four vigorous blows with his hammer. The boiler-maker scorns a ratchet and drill when he needs to set a stud in a boiler shell—if he is in a hurry. A hammer, cape chisel and drift in his hands are made to perforate a ⅜-inch shell and produce a smooth round hole in the time that a machinist would take to set up an "old man" and ratchet drill. The up-to-date engineer might use the oxy-acetylene torch if he had to perforate an armor plate quickly and without annealing. There are other ways too but none perhaps quite as novel as that proposed in the *Youth's Companion*: "Shape a stick of sulphur to the required dimensions of the hole, then heat the iron white-hot at the place where it is to be bored, and press the sulphur against it: sulphuret of iron is formed, and the stick passes through the metal."

Several times we have alluded in this column to the importance of the moving picture industry in America and Europe. Not only is it important as an amusement enterprise but it is acquiring much educational value and undoubtedly will become a very useful factor for improving industrial education as well as imparting general knowledge of processes difficult to describe without the visual expression. As a matter of amusement, for example, the people in Northern cities are acquainted with the life and local color of Southern cities, and *vice versa*. One series of pictures shown to a Northern audience recently illustrates the gathering, preparation and marketing of cotton. The field hands are shown on the scene gathering the snowy white product from the dark green plants. Then follows the loading of the cotton onto wagons, its transfer to the cotton gins and pressing into bales. From the gin the transfer to the wharves and loading into steamers follows, and then the scene changes to the cotton mill, the picking, carding, spinning, winding and weaving machines being illustrated in full operation. Thus in an interval of, say, fifteen minutes, an audience of ordinary individuals is shown as much and is taught as much of the cotton industry as an individual might acquire in a week or two of traveling—and all for the sum of five cents.

MODERN SWEDISH MACHINE TOOLS.

OSKAR KYLIN *

In the writer's letter from Sweden in the September, 1908, issue of MACHINERY, reference was made to some of the more prominent Swedish machine tool works, and a general review given of the present state of the machine tool industry in that country. It is the writer's intention in the present article to describe and show a few representative types of modern Swedish machine tool design.

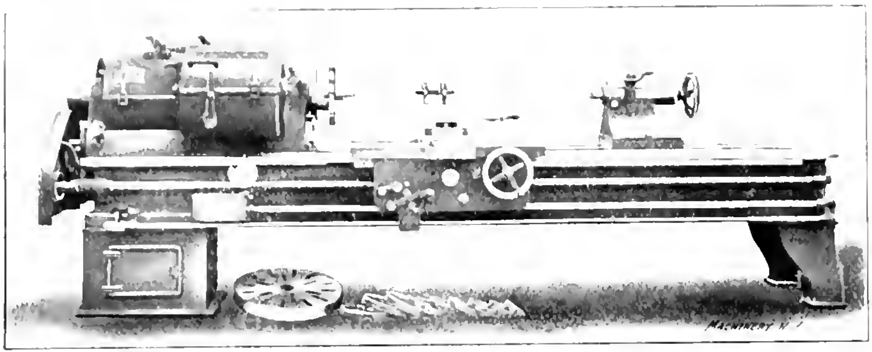
Fig. 1. Geared-head Lathe built by Lidkopings Mekaniska Verkstad, Lidkoping, Sweden.

Figs. 1, 2, and 4 illustrate machines designed and manufactured by Aktiebolaget Lidköpings Mekaniska Verkstad, Lidköping. This firm has been established for more than thirty years, but did not take up the building of machine tools until about ten years ago; at the present time, however, the works specialize on a general line of machine tools, lathes being the most prominent feature.

In Fig. 1 is shown a twenty-four-inch geared-head lathe manufactured by this company. The design is along powerful lines, in order to permit advantage to be taken of the full capacity of high-speed steel. The single pulley geared head-stock is designed with twelve spindle speeds, the largest change gears being placed on the front side in order to obtain a steady drive. The bed is made according to the American practice with V-slides, the shape of the slides thus differing from the common German practice which employs perfectly flat ways. The power feed of the machine is friction driven and the lead-screw together with its driving gears is running only when the lathe is used for thread cutting. The power feed is stopped, reversed and varied in amount by means of a knob conveniently placed for the operator. The action of the lead-screw is controlled by means of a handle placed on the apron, and a quick return is provided for the carriage when cutting screws, which saves considerable time when cutting long threads. The feed rack, as well as all gearing in the apron, is made of steel.

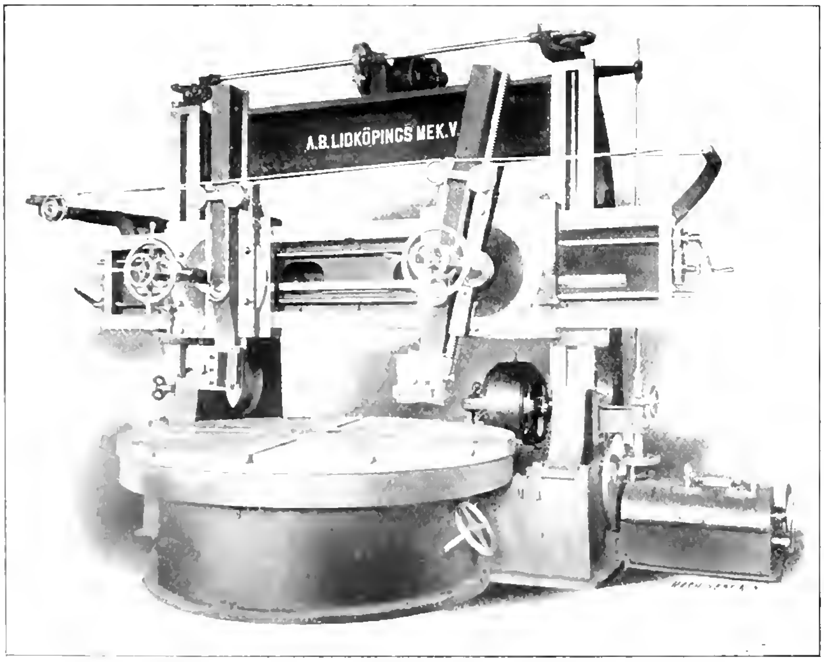

Fig. 2. Vertical Turning and Boring Mill of Swedish Manufacture.

A motor-driven vertical turning and boring mill of neat design is shown in Fig. 2. This machine is provided with a speed-changing mechanism furnishing sixteen changes of speed for the revolving table, and controlled by conveniently placed levers. The feed is friction driven, as shown on the right side of the machine and changes in feed can be made without stopping. The cross-rail of the machine is raised and lowered by means of an independent motor placed on the top of the machine as shown in the engraving. The vertical slides are balanced according to modern practice with two independent counterweights and can be set at any angle with the cross-rail required. The tool-holders are of special interest, as they permit of very accurate adjustment. They can be swiveled around a stud in the center, and have also a longitudinal slide adjustment. The machine is of very powerful design, intended to be able to stand heavy strains, and practically all gears are made of steel. This machine is also provided with cone pulley belt drive when required. In this case the cross-rail is operated from an independent counter-shaft and pulleys are placed on the top of the machine where now a motor is located.

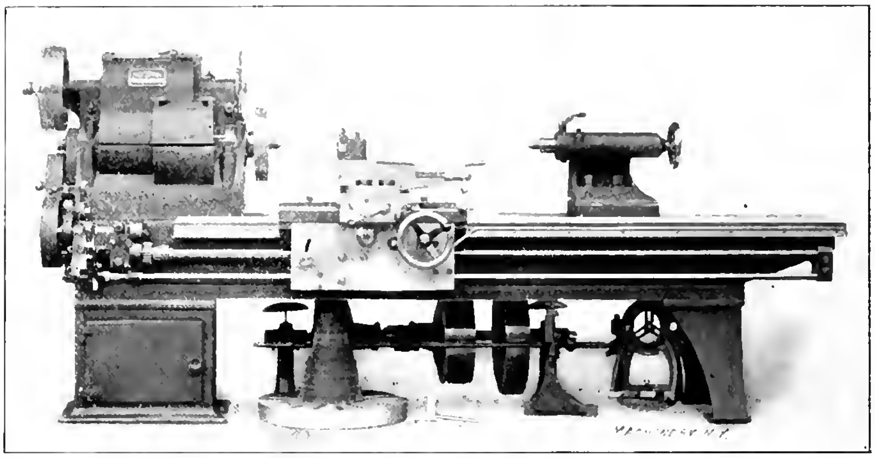
Fig. 3. Geared-head Lathe built by Kopings Mekaniska Verkstad, Koping, Sweden.

In Fig. 4 is shown a high-speed radial drill built by the same company. This machine is provided with a single pulley drive and a gear box; ten spindle speeds are obtained partly by changes in the speed box and partly by the back gearing in the spindle head. As indicated by the arrangement of the pulleys in the illustration, the power is transferred from the gear box to the spindle by means of belts. The drill spindle can be swung to any angle within an arc of slightly more than one-hundred-eighty degrees, and the auxiliary table shown mounted on the main part of the machine can be tilted to angular positions for drilling holes at angles with the base of the work.

Figs. 3 and 5 to 9 illustrate a number of machines built by Köpings Mekaniska Verkstad, Köping, the foremost machine tool building firm in Sweden. The reputation of this firm is due fully as much to the high class of workmanship exhibited in its machines as to the modern and up-to-date design. It may be said in general as regards design of Swedish machine

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tools that they do not embody all the special labor-saving features of American machines, which may be of great importance in certain special lines of manufacture, but which are often of small value for general lines of work; and the aim sought by leading Swedish firms is to design machine tools without too many complicated features, making them easy to operate and of a rigid design and good workmanship. Köpings Mekaniska Verkstad is largely specializing in the lathe line, but as will be seen in the accompanying illustrations, the firm is also making several other kinds of machine tools mainly in order to keep fully employed even when the demand in the lathe business is less heavy.

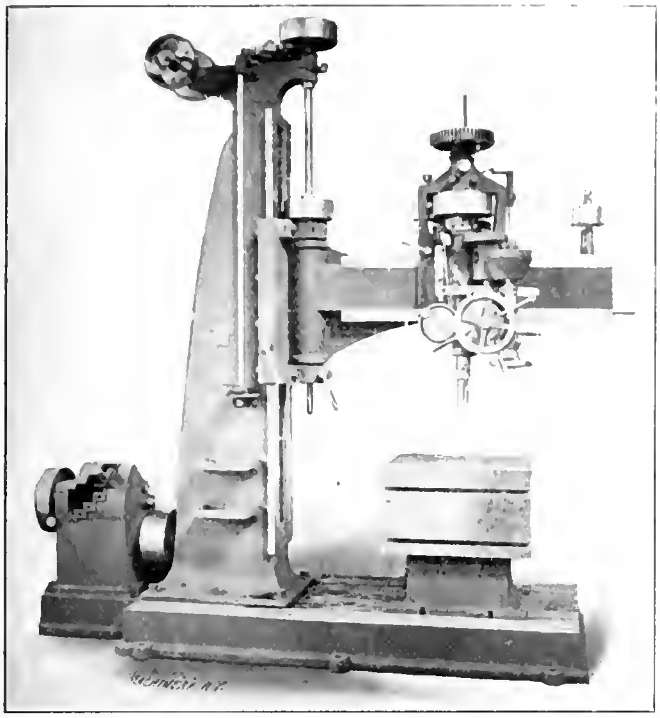
Fig. 4. Lidkoping High-speed Radial Drill.

Fig. 3 shows a high-speed geared-head lathe provided with all the ordinary features of up-to-date lathe designs. The number of spindle speeds obtainable through the change gears in the head is nine. The longitudinal and cross power feeds for the carriage and tool slide are obtained through a friction clutch arrangement. The feed is positive and gear-driven and can be easily changed while the machine is running. The lead-screw is independent of the feed for ordinary turning, the same as in all modern lathe designs, thus preventing unnecessary wear of the threads when not used for thread cutting.

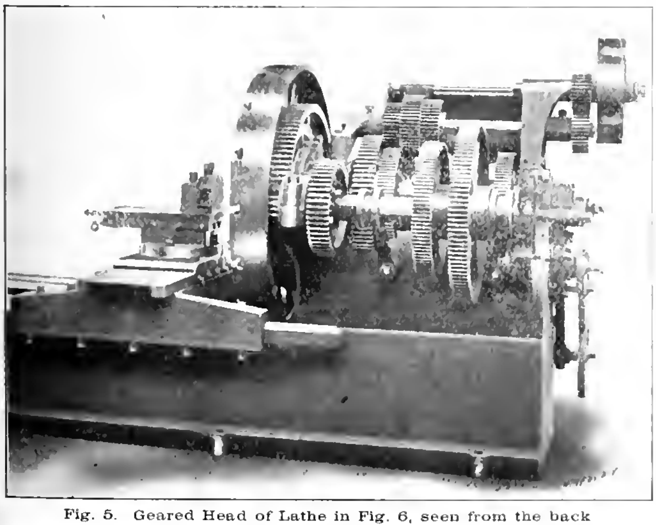
Fig. 5. Geared Head of Lathe in Fig. 6, seen from the back of the Machine.

A large, heavy duty engine lathe is shown in Fig. 6. Fig. 5 shows a back view of the same machine with the guards over the geared head mechanism removed so as to show the arrangement of the gears very plainly. In regard to guards for gearing and moving parts on machine tools, it may be remarked here that the careful covering of all gearing which is so plainly in evidence in all German machine tools is not quite so prominent in Swedish tools. In this respect the Swedish tools possess practically the same features as did until lately, the general run of American machines, where only the most important and more dangerous combinations of gearing were covered. It is to be hoped, however, that the German practice of covering all gearing with guards forming as nearly as possible an integral, or at least a homogeneous, part of the machine will become a common practice everywhere. The geared head in the machine illustrated permits fifteen speed changes for the spindle, the arrangement of gears through which these changes are obtained being plainly indicated. The feed is gear driven and consequently is positive. A novel arrangement for obtaining four different feed changes at the apron in addition to the usual changes, is introduced. This makes the changing of the feed while the machine is running very convenient to the operator. The kind of tool-post employed on the Köping lathes differs from the usual form, and is especially adapted for heavy, square lathe tools.

A machine embodying some rather interesting features is shown in Fig. 7. This side planing machine, also known as the Richard planer, is particularly valuable in cases where large castings are handled, which are often difficult to plane on the ordinary types of planers. The carriage which is provided with an exceptionally long slide is driven by a square-threaded screw engaging two adjustable nuts. The screw is driven by means of a belt on a tight and loose pulley. The reversing mechanism is provided with a bevel gear clutch reversing arrangement, a feature which has been introduced recently, and replaces the old method of reversing by means of shifting the belt from the forward to the return pulley. The small sizes of these side planers are provided with one work-table placed on a slide on the side of the machine, and the larger sizes are provided with two or more of these as shown in the illustration. This table can be easily removed when it is required to plane very large castings. A large pit is usually provided in the front of the machine so as to give ample space for large pieces to be machined. An extension for the tool-carrying arm is also provided in order to make it possible to plane surfaces which are out of reach of the ordinary arm. While the machine is substantially constructed, it is evident that on account of its peculiar design it does not permit of very heavy chips to be taken, as compared with the possibilities of the ordinary planer.

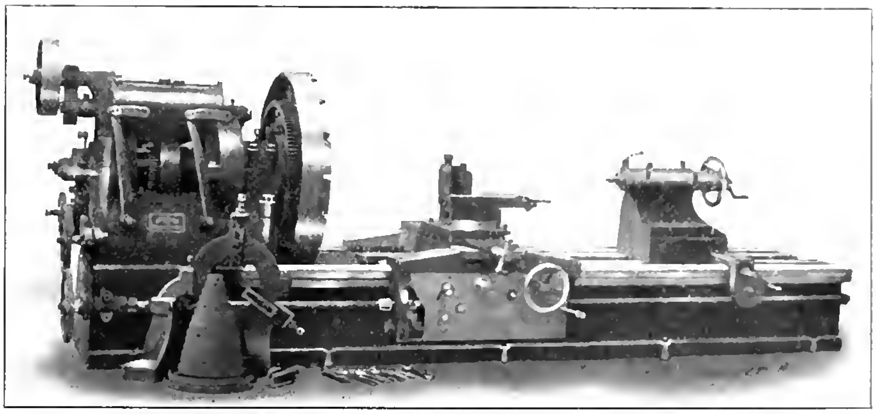
Fig. 6. Koping Heavy-duty Engine Lathe.

The universal milling machine shown in Fig. 8 is an interesting example of a high-class machine tool embodying in its design a combination of American, German and Swedish features, the first mentioned being most prominent. The machine is provided with power feed in three directions, the number of different feeds obtainable in each direction being twelve. The speed-changing mechanism permits of sixteen different spindle speeds. Automatic stops are provided for

the feeds in all directions It will be noticed that the telescopic feed-driving shaft commonly used on American designs is not employed.

In Fig. 9 is shown a high-speed upright drill press. In this machine six different spindle speeds are obtainable; of these three are obtained by means of a gear box and these are multiplied by two by the back gears. The feed is positive, three speed changes being provided for each spindle speed. The circular work-table can be swung out of the way whenever it is required to use the base plate for large work.

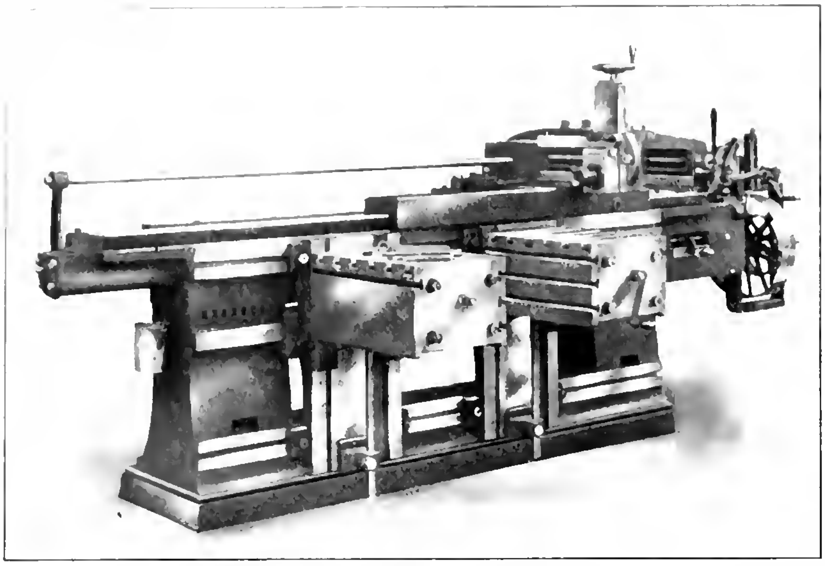

Fig. 7. Richard Type of Side Planing Machine.

The accompanying examples of Swedish machine tools indicate in a general manner the present state of the art in that country, and indicate the present development. While it is evident from the illustrations that the designs largely follow along the lines of American and German built machines, the high class of workmanship put into these machines should be emphasized. This has been one of the strong claims of the Swedish machine tools in the past and has enabled the Swedish machine tool builders to hold their own in competition with foreign-made tools.

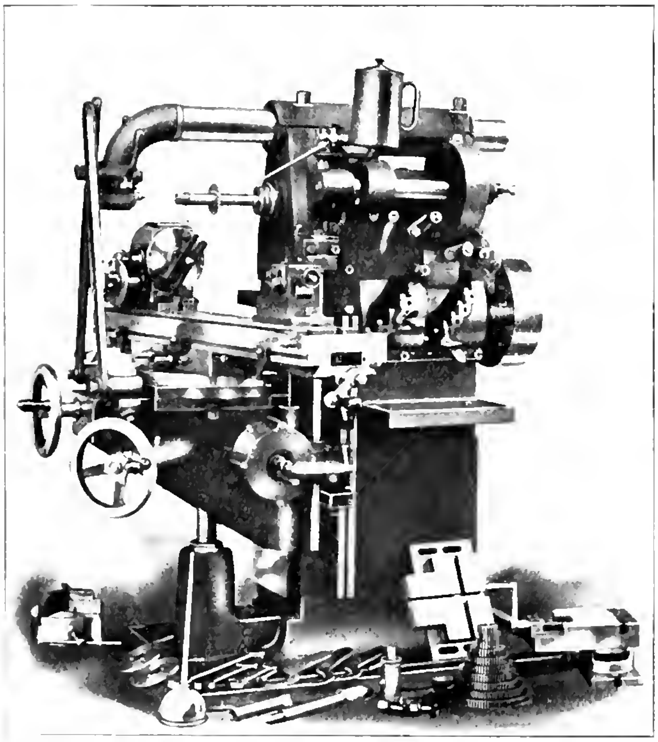

Fig. 8 Milling Machine, combining in its design American, Swedish and German Features.

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The lawyer reasons by precedent; the engineer by cause and effect.—*Common Sense.*

STEAM PIPE SIZES.*

CHARLES L. HUBBARD †

The problem of determining the size required for steam pipes under varying conditions is one which often confronts the engineer, and the difficulty of obtaining reliable data is well known. In order to facilitate work of this character, the tables given in the current Supplement have been computed. Tables I, II and III (Plates I and II) are computed from D'Arcy's formulas for flow of steam in pipes, which are given in the Supplement in connection with Table IV, which gives the value of constants used in these formulas for various diameters of pipe.

Table I gives the flow of steam in pounds per minute through pipes 100 feet in length, for initial pressures of ¼ to 5 pounds, assuming that the pressure in each case drops to zero. That is, the drop in pressure equals the initial pressure. It is seen from the table, for example, that a 2-inch pipe will discharge 2.9 pounds of steam per minute under a pressure of ¼ pound per square inch, or 14.9 pounds under a pressure of 5 pounds, the terminal pressure dropping to zero in each case. The table is sufficiently accurate for any initial pressure less than 10 pounds for the drops in pressure noted at the heads of the columns, regardless of whether the pressure falls to zero or not. For example, a 4-inch pipe, 100 feet long, will discharge approximately 18.1 pounds of steam per minute with a drop in pressure of ¼ pound, or 91.9 pounds with a drop of 5 pounds, for any initial pressure up to 10 pounds.

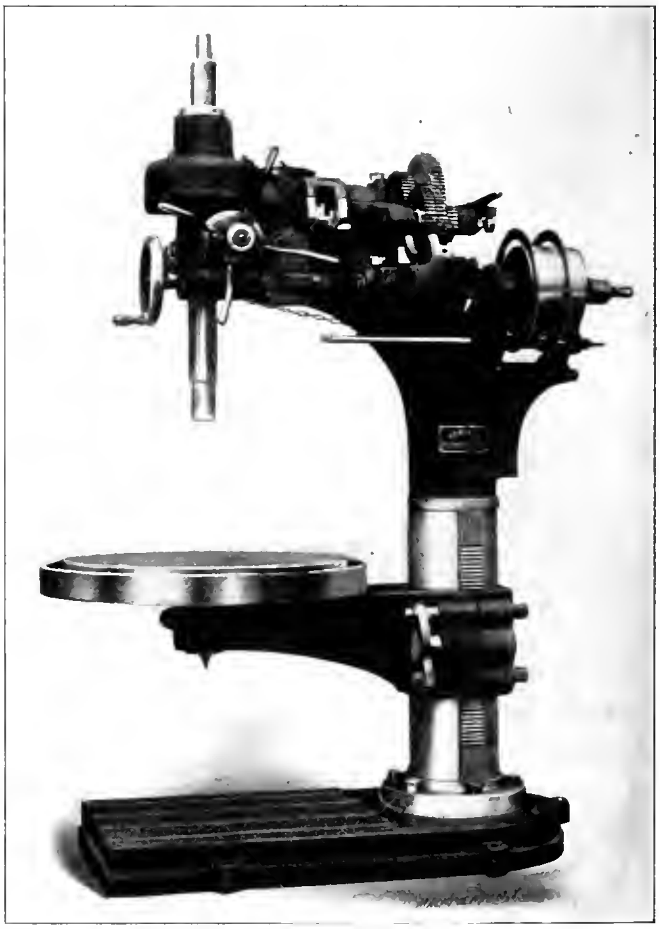

Fig. 9. Koping High-speed Upright Drill.

As the initial pressure increases, the quantity of steam discharged for a given drop in pressure becomes greater than given in Table I. Table II gives correction factors for higher initial pressures. For example: The factor for a drop of 5 pounds at an initial pressure of 80 pounds is 2.09, so that

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* With Data Sheet Supplement.
† Address: 283 Central St., Auburndale, Mass.

under these conditions a 4-inch pipe will discharge 91.9 × 2.09 = 192 pounds of steam per minute, the value 91.9 having been obtained from Table I.

The figures given in Table I are for pipe runs of 100 feet only. For different lengths, the results should be corrected by the factors given in Table III. For example: A 4-inch pipe, 100 feet in length, will discharge 91.9 pounds of steam per minute with a drop in pressure of 5 pounds at the discharge end; if the pipe is only 50 feet in length, it will discharge 91.9 × 1.41 = 129.5 pounds, or if it is 500 feet in length, it will discharge 91.9 × 0.45 = 41.4 pounds.

Examples in the Use of Tables.

What weight of steam will be discharged per minute through a 3½-inch pipe, 100 feet long, with an initial pressure of 40 pounds, and a drop of 3 pounds?

$$47.8 \times 1.70 = 81.3 \text{ pounds.}$$

What size of pipe will be required to deliver 51.3 pounds of steam a distance of 100 feet, with an initial pressure of 60 pounds, and a drop of 2 pounds?

The factor for 60 pounds initial pressure and 2 pounds drop is 2.02, and $\dfrac{51.3}{2.02} = 25.4$, which in Table I corresponds to a 3-inch pipe.

What weight of steam will be discharged per minute through a 5-inch pipe, 600 feet long, with an initial pressure of 5 pounds, and a drop of ½ pound?

$$45.7 \times 0.40 = 18.3 \text{ pounds.}$$

The tables given may be applied to either power or heating work, or to any conditions where the quantity of steam used can be reduced to pounds per minute.

Engine Connections.

Steam pipes for engine connections are commonly based on a velocity of 6,000 and 8,000 feet per minute for the steam and exhaust pipes respectively, assuming the entire cylinder to be filled with steam at each stroke. This gives approximately 0.14 square inches internal area per H. P. for the steam pipe and 0.20 square inches for the exhaust. For example, a 100 H. P. engine would require

100 × 0.14 = 14 square inches, or a 4-inch steam pipe.
100 × 0.20 = 20 square inches, or a 5-inch exhaust pipe.

Tables V, VI, and VII, finally, give the diameters of pipe required for heating purposes.

* * *

THE DISTURBING EFFECT OF CENTRIFUGAL FORCE ON HIGH-SPEED CUTTERS.

The manufacturers of wood-working machinery have found the effect of centrifugal force a very troublesome factor in high grade wood planers. It has been found practically impossible to build a planer cutter head that will stay so well balanced that it will not run out at speeds of say 4,000 revolutions per minute sufficiently to leave distinct cutter marks on the lumber planed. The slight eccentricity due to lack of perfect balance causes one knife to cut deeper than the other three. The result is irregular work that will not pass inspection where the product is employed for fine furniture. A circular issued by the S. A. Woods Machine Co. of Boston, Mass., is devoted to this matter, and describes an attachment for truing up planer cutter heads at full speed. The circular in pointing out the nature of the difficulty, states that the effect of centrifugal force is far greater than is ordinarily supposed. One pound of metal revolving at 4,000 revolutions per minute, in a circle of six inches diameter, exerts a radial force of over 1,700 pounds. On the same basis a 7-inch cutter head, which is an ounce out of balance, would have to stand a strain of 125 pounds, tending to throw a knife edge out of perfect concentricity with the others. So it follows that even if cutter heads were in perfect balance when built, they could not remain so because of slight inequalities developed by grinding and wear; hence the practical necessity for truing these knives up when running at speed and thus elminating the effect of the disturbing influence. The truing device is in the nature of a lathe turning tool, guided by a straight bar, an emery stick held in a suitable holder and traversing along the cutter head when at speed being employed to remove a small amount of metal from the blade projecting beyond the others.

APPROXIMATE FORMULAS FOR SIZES OF BEAMS AND GIRDERS.

C. R. WHITTIER*

In determining the size of a beam to carry a uniformly distributed load, it is customary to use the tables in the various steel companies hand-books as follows: The total load and span are given. The size is tentatively found by selection from the load tables; the weight of the beam thus provisionally determined is calculated and added to the load; and then a second reference is made to the tables to see that the total capacity is not exceeded.

A more rapid, and closely approximate method for determination without tables is developed below. It is founded on the well-known fact that I-beams and plate girders resemble open beams or trusses. In the ordinary truss with uniformly distributed load, the horizontal stress at the center of either chord is approximately the total weight times the span, divided by 8 times the height—all in inch pounds. Applying this to an I-beam flange, we have for 16,000 pounds fiber stress:

$$\frac{Wl}{8\,h} = 16{,}000 \times \text{area of flange.}$$

As the area of the flange is practically one-third the area of the cross-section of the beam:

$$\frac{Wl}{8} = \frac{A}{3} \times 16{,}000\,h.$$

Transforming the left-hand member of this equation to inch-pounds, we have:

$$\frac{2{,}000\,W \times 12\,l}{8} = \frac{A \times 16{,}000\,h}{3}$$

[The assumption that the area of the flange is one-third the area of the cross-section of the beam is only approximately correct. The area of the flange varies in proportion to the total area of the beam from 0.26 for the larger sizes of standard I-beams to 0.37 for the smaller sizes. It should also be remarked at the outset that the approximate formulas in the following apply only to the minimum or standard sizes of I-beams.—EDITOR.]

In I-beams it is found, closely enough for our present calculations, that $A = h - 2$.

[More accurately A varies between $h - 0.68$ and $h - 2.74$ for different sizes of I-beams.—EDITOR.]

Introducing this value of A, reducing, and solving for h, we have:

$$h = \sqrt{0.56\,W\,l + 1} + 1$$

The quantity 1 under the vinculum is so small as to be negligible.

The coefficient 0.56 needs further modification to allow for the average weight of the beam itself, which value is taken as equivalent to $3.5\,h - 10$ per foot; also a correction for using h as the distance between extreme fibers instead of the distance between the center of gravity of the flanges, and an allowance for the strength of the web. This changes the coefficient to 0.6, giving as a final formula:

$$h = \sqrt{0.6\,Wl} + 1$$

This is so simple that it can be solved mentally. Thus h may be determined without reference to the tables for all preliminary work. A trial in comparison with the tables will be convincing proof of its accuracy. It applies *only to the minimum sections*, as these are always used if possible.

Similar formulas have been deduced for minimum sections of channels, Z-bars, angles with equal legs, and tees with stem and flange equal; also for plate girders of the ordinary dimensions tabulated in Carnegie Steel Co.'s hand-book, as shown on the following page.

The formulas reduce to this simple form because the relation between weights and areas of beams, if plotted, closely approximates a straight line.

Incidentally, it may be stated that a closer approximation is given by the following formulas:

Weight per foot of I-beams, minimum section $= 0.07\,h^2 + 1.7\,h$ pounds.

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* Address: 204 West 111th St., New York City.

Area of I-beams, minimum section $= 1.1\,h - 3$ square inches.

The average weight per foot of plate girders of standard dimensions (Carnegie Steel Co.) in pounds, is

$$\text{weight} = 0.1\,h^2 + 2\,h.$$

Memorizing the formulas which are most useful to the work in hand enables one to make mental calculations without reference to tables.

Another handy approximate rule, *good for all standard weights* of I-beams, and depending on l in feet, W in tons, and w (weight of beam per foot) in pounds being known, comes from the following well-known relation: When depth of beam in inches equals span in feet, then, weight of beam per foot in pounds equals load in thousands of pounds; other loads vary inversely as their lengths.

BEAMS OF MINIMUM SECTION.

h = height in inches, l = span in feet, W = load in tons.

Shape	Maximum Fiber Stress	For Uniformly Distributed Load	For Center Load.
I-beam	16,000	$h = \sqrt{0.6\,lW + 1}$	$h = \sqrt{1.2\,lW + 1}$
Channel	16,000	$h = \sqrt{lW + 1}$	$h = \sqrt{2\,lW + 1}$
Z bar	16,000	$h = \sqrt{lW}$	$h = \sqrt{2\,lW}$
L (equal legs)	16,000	$h = \sqrt{lW + 1.3}$	$h = \sqrt{2\,lW + 1.3}$
T (equal legs)	16,000	$h = \sqrt{lW + 1}$	$h = \sqrt{2\,lW + 1}$
Plate girders	15,000	$h = \sqrt{0.5\,lW}$	$h = \sqrt{lW}$

Then, changing the load from pounds to tons, it follows that

$$\frac{w\,h}{2\,l} = W, \text{ and}$$

$$h\,w = 2\,l\,W$$

As w depends on h, a value of h must be selected by trial to balance the equation.

* * *

MECHANICAL IMITATION OF GRAVITAL FORCE.

An interesting account of experiments conducted by Prof. Arthur Korn in gravitation was recently published in the *Westminster Gazette*. Prof. Korn has constructed a machine which mechanically imitates the action of gravital force in a way visible to the eye. He apparently demonstrates that gravitation is a mode of motion, inasmuch as by rapid vibration he causes bodies to attract one another which are under the influence of the vibratory force with a force proportional to their mass.

Prof. Korn started with the assumption that gravitation is the result of the vibration of elastic bodies in an inelastic medium. All matter is in a state of eternal vibration. The vibration according to the professor, is analogous to the vibration of a violin string. The third string of a violin, for instance, rightly tuned, emits an A. In addition, however, to the ground tone A, there are the so-called over-tones in the relation of 1 to 2, 2 to 4, and so on. Of complex character are the vibrations of all particles of matter, and it is these vibrations which lead respectively not only to the attractive force of gravitation, but also to the repulsive force which, in the case of the heavenly bodies, is observed at the same time.

The machine constructed by the professor to produce this "artificial gravitation" is extremely simple. A metallic globe, fitted with a window for observation of what is going on inside it, is united by tubes with a cylinder, one end of which is closed only by a membrane. To this membrane is attached an electro-motor, which, by pushing and pulling the membrane alternately, makes rapid pulsations. The metal globe contains two air-filled india-rubber balls of different sizes. The larger one is fixed firmly to the inside wall of the globe; the smaller is free to move whither it likes. The whole apparatus is then filled with water, and the motor set to work. Each time the membrane is pressed in, the increased water pressure causes the rubber balls to contract, and each time the membrane returns to its original position the relaxed pressure of the water causes the two balls to expand. The motor is set working so quickly that these pulsations become inconceivably rapid vibrations, and the contraction and expansion of the balls is invisible to the eye. As water is practically incompressible, Prof. Korn thus obtains the conditions he needs—he has two elastic bodies vibrating in an inelastic medium. Then the phenomenon looked for occurs. When the vibrations attain a certain speed, the smaller ball, impelled by a mysterious force, begins slowly to move through the water to the larger ball, and gradually increases its speed, exactly as the apple observed by Newton increased its speed as it fell nearer and nearer to the ground.

So far, this was merely a puzzling phenomenon; but that it was gravitation, and no other force, which drew the balls together was soon proved. Measurements showed that the bigger ball attracted the smaller exactly in accordance with Newton's law, or in inverse ratio to the square of the distances between them. It became, therefore, possible to construct an exact working model of the solar system in water, in which the planets should all move in their appointed paths without any visible support or externally-applied power.

Prof. Korn's researches do not end here. He had shown why matter attracts matter, but he had to solve the problem why matter also repels matter. Why is it, for instance, that comets, after rushing directly towards the sun from the depths of infinite space, never collide with it, and invariably return whence they came? To this problem the professor again applies the musical-vibration theory. Just as there are over-tones in the violin string, so in the vibrations of matter there are over-vibrations. These over-vibrations come into play when the attracted bodies come too near, and their effect is immediately repulsive. They are counter-gravitational in their effect, and operate in this way also only in an inelastic medium like water. In an elastic medium the vibrations of matter would have no attractive or repulsive effect; hence it follows that gravitation depends entirely upon the fact that all the heavenly bodies are surrounded by inelastic ether.

* * *

NEW COOPERATIVE TRADE SCHOOL.

A cooperative plan of shop and school instruction for boys has, according to the *Iron Age*, been instituted in Chicago, along lines similar to those in operation at the University of Cincinnati, and at the high school in Fitchburg, Mass. In Chicago, the manufacturers send their apprentices to the Lewis Institute one-half of the time, one week being spent in the shop, and the next week in the school. The course extends over two years, but it is not the intention either of the manufacturers or the instructors of the Lewis Institute to turn out a skilled workman in this time. The idea is simply that the boy will be able to develop intellectually, and grasp the principles of his trade more quickly, than he otherwise could. Each manufacturer is represented in the school by units of two boys, one boy working in the shop, while the other is in the school. The employer pays a tuition fee of $50 a year for each apprentice sent to the Institute, and pays the boy $5.00 a week for each week he works in the shop. Two weeks' vacation from the school instruction is given in the summer, but twenty-six weeks are spent in the shop.

The school instruction comprises eight hours a day for five days in the week. Instruction is given in the physical sciences and the principles of mechanics, mechanical drawing, mathematics, English and history, and in shop work, supplementing the productive work done by the boys in the metal working shops. A boy who has taken this course at the Institute and in the shop will still have to continue his apprenticeship in the shop, but it is expected that it may be possible to reduce the time of the apprenticeship as a result of the better education of the boy. The Lewis Institute has equipment for the instruction of sixty boys in this course.

* * *

British Machine Tool Trade.—In a note published in the November issue on the English machine tool trade in the London district, it was mentioned that the firm of Henry Pels & Co. had enough work on hand to keep several shifts busy for several months, and that it was contemplating considerable extensions. The idea conveyed was that the company has a plant in Great Britain, which is incorrect. All the tools sold by the company in Great Britain are imported from the Continent.

MANUFACTURING AIR-COOLED CYLINDERS.

F. J. HAYNES.*

The process of manufacturing air-cooled cylinders of the type used by the H. H. Franklin Mfg. Co., Syracuse, N. Y., on the Franklin automobiles, differs radically from the operations used in manufacturing water-cooled motor cylinders. The operations are of considerable general interest from the manufacturing standpoint, and in the following article a few processes are illustrated and briefly described.

The motor cylinder of the Franklin car is made from cast iron, and cast in a separate piece. On the exterior of the cylinder are mounted phosphor-bronze rings, which increase the radiating surface. After the casting has been made, it is first inspected; the things to be noted at this time are that the casting is sound in all respects, having no blow holes or other defects; that the cores are located centrally, and the dimensions of the core holes correct and that the bosses are in proper position. Then the casting is sand blasted to remove all core sand; this saves the cutting edges of the boring tools.

The cylinder is bored on a Gisholt turret lathe. The boring bar is guided in the spindle by a bushing, and the cylinder is bored within 0.015 inch of the finished dimension. The dome head is machined simultaneously with the boring of the cylinder, and the base is faced off at right angles to the bore, the proper distance from the base to the center of the auxiliary exhaust port being made the right dimension at the same time. In machining the dome head, considerable care must be taken to avoid forcing the forming tool to one side, as this would result in throwing the dome head off center. These operations are very severe on the tools; carbon steel cutters will last only a short time, and even high-speed steel tools must be carefully watched. The boring and the facing operations are illustrated in Fig. 3.

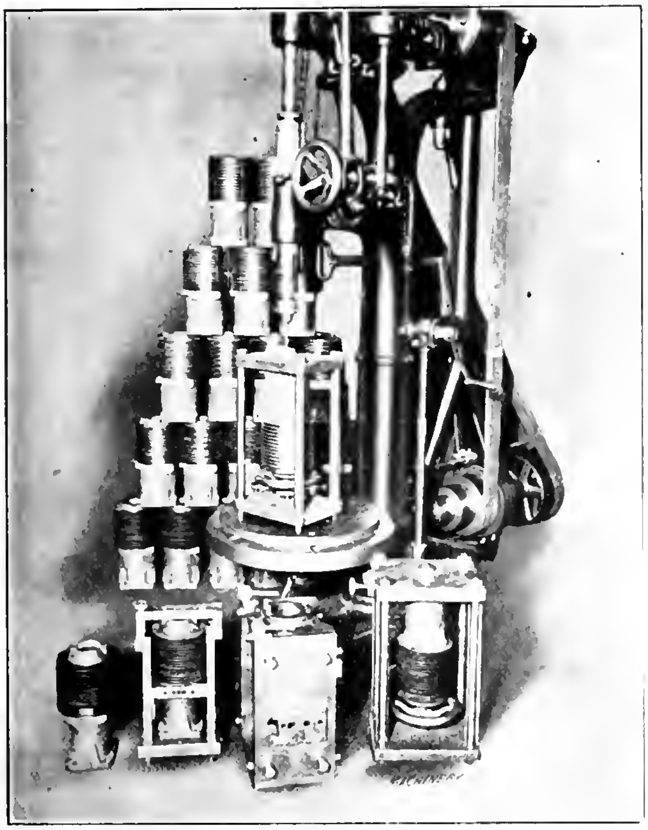
Fig. 1. Drilling the Cylinders, and Jigs for this Operation.

The cylinder is now submerged in water, and tested with compressed air of eighty pounds pressure. Any porous or unsound places will be revealed by the leakage of the air. Of course, if the cylinder shows leakage in this test, it is "scrapped" before any further operations on it are performed. If it passes the test, it goes to the next operation, consisting of rough turning and grinding. During the grinding operation, and also during the later operation of grinding the bore of the cylinder, it is flooded with water and kept at a temperature of 70 degrees F. It is necessary to keep the water at this temperature, by adding either cold or warm water, otherwise the micrometer measurements taken by the operator, and those taken by the inspector, will not agree. If the water is too cold, the dimension of the cylinder will be too large when the cylinder has acquired the temperature of the room; if the water is too hot, the cylinder will be too small when cooling down. When the cylinder has been accurately ground to the exact size outside, it is again tested by compressed air under water. If no leaks develop, it passes to the inspection room for checking of the outside diameter. When this is done, the phosphor-bronze rings are applied.

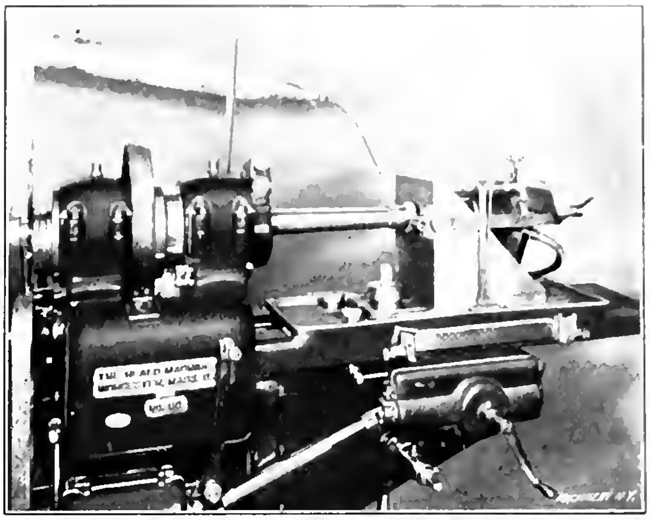
Fig. 2. Grinding the Cylinder Internally

These rings are punched in a combination die which produces a complete ring for every stroke of the press. Before being applied to the cylinder, they must be accurately bored for a shrink fit. The allowance for the shrink fit is carefully calculated, so as to be within the elastic limit of phosphor-bronze when the rings are shrunk in place. On the other hand, due consideration should be given to the fact that the rings must not work loose, due to their expansion caused by the heat of the cylinder when in use. After boring, the rings are heated in an oil bath to the exact temperature required, and are placed on the cylinder with split steel washers between the rings.

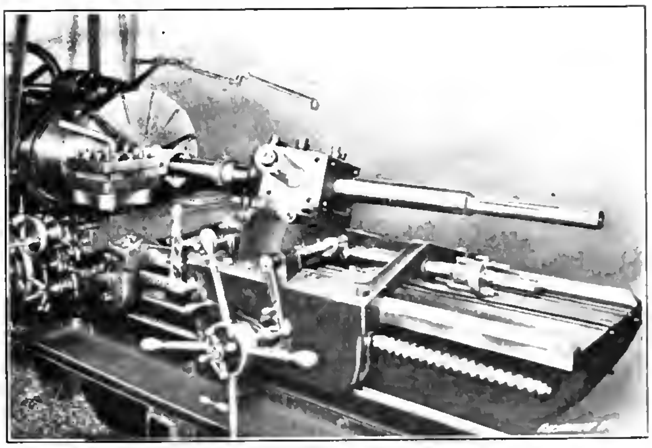
Fig. 3. Boring and Facing the Cylinder

The remaining work on the cylinder, such as facing the bosses, drilling and tapping the holes, etc., is now carried out with the exception that the concentric valve seat in the dome head is only roughed out to within a few thousandths of the correct size. The drilling and the tapping of the holes is done in jigs, as shown in Fig. 1. When these operations are performed, the cylinder is again inspected, and if found correct, it passes again into the grinding room to have the bore ground. The cylinder is placed in a cylinder grinder, by fastening it to a large angle plate provided with a hole of the same size as the bore. The grinding wheel enters

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* Address: Superintendent, H. H. Franklin Mfg. Co., Syracuse N. Y.

through this hole, as shown in Fig. 2. The grinding machine is of the type where the grinding wheel has a planetary motion, besides its regular revolving motion, so that the work itself does not revolve. The finish grinding of the bore is performed last, in order that the pressure due to the shrinking on of the phosphor-bronze rings may have no effect on the final dimension of the bore.

When the grinding operation is completed, the cylinder passes to a large heavy lathe, fitted with a special face-plate and compound rest, as shown in Fig. 4, which is used only for finishing the concentric valve seat. As a roughing cut has already been taken on the valve seat the finishing cut merely insures that the angle of the valve seat is correct, and the surface round and true. The valve seat is tested for its accuracy with a hardened taper plug, ground to the exact shape and size of the finished seat, and smeared with Prussian blue. When this operation is finished, the cylinder passes through the final inspection, and is then delivered to the stock-room for finished work.

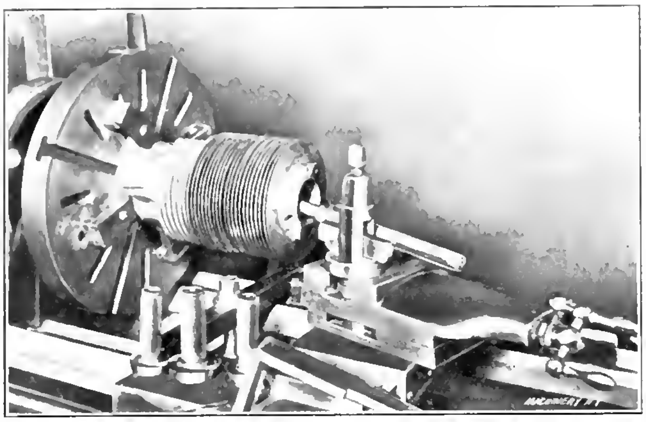


Fig. 4. Finishing Valve Seat Hole in Top of Cylinder.

The cylinder, some stages of the finishing of which are shown in the accompanying illustrations, is of 4½-inch bore, and is 11 9/32 inches long over all, and weighs 16 3/4 pounds when fitted with the phosphor-bronze rings. The wall of the finished cylinder is 3/16 inch thick. All of the inner surface and one-half of the outside surface is machined; thus there are no uneven thicknesses of metal, and the design enables a very light cylinder to be produced. It is interesting to note that, in all, the cylinder passes through thirty-two operations before completion.

* * *

Mr. Bethel, foreman of the manufacturing department of the Taft-Peirce Co., Woonsocket, R. I., has a blueprinted placard tacked on the shipper rod of each of his lathes. This placard reads as follows:

LATHEMEN—ATTENTION.

Be sure
That lathe is well oiled.
That lathe and work are kept orderly.
That live center runs true.
That tail center is smooth.
That tail center is hard.
That both centers are 60 degrees.
That center holes in work are clean.
That center holes in arbor are clean.
That arbor runs true.
That arbor is smooth and does not rough hole in work.
That wrenches are kept with lathe.
That you take your work to be inspected every two hours.
That you work to figures.
That at least one hour before your job is completed you notify your foreman.

This list of instructions, which somewhat resembles in positive form the "don'ts" we published some time ago, combines a number of points which are commonly understood, but are as commonly neglected. By placing this list where it is before the men constantly, and holding them responsible for following it, a noticeable improvement in the quality of the work was effected.

* * *

With an engineering education you know the relation of knowledge with its use.—*Common Sense.*

MACHINE SHOP PRACTICE.*

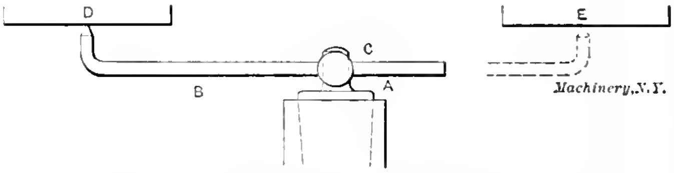
MACHINING A THREE-THROW BUILT-UP CRANK-SHAFT.

W. BURNS.[†]

As the machining and building-up operations on a crank-shaft of the built-up type, are usually done by the same men in the shop, one may be employed for considerable time without having the opportunity of obtaining experience on work of this class; and should one chance to be called upon to do such work when starting in a new shop, he might be quite at a loss to know how to proceed. A short description, therefore, covering some of the salient points in connection with this work, may be of interest.

The largest sizes of the three-throw shafts are usually made up of three separate cranks, each machined and built up separately, and then all connected in their relative positions to one another by means of solid forged couplings on each shaft. There are, however, a very large number of three-throw crank-shafts shrunk together into one solid shaft and then turned after the building-up operation. As it is a much easier proposition to machine a single crank and then connect it to other cranks by means of coupling bolts, than to machine, shrink together, and then turn a three-throw shaft, a brief description of the work involved in the latter will be given. Illustrations showing the construction of a built-up shaft will be found on the Shop Operation Sheet accompanying this issue.

The forgings for the different parts of the shaft and the crank-pins, should first be roughed out to within 3/16 or 1/4 inch of the finished size. It is not necessary to face the ends to the correct length and center anew, as it is not essential that the centers be left in the finished work, in this case, as is desirable for some shafts. When the different parts of the shaft are being roughed out, they should all be turned to the same diameter, as this uniformity makes it much easier for the erector to produce a true shaft when shrinking the parts together. This, however, does not apply to the crank-pins, as they are finished to fit the holes in the webs and turned to finish size on the body before being shrunk in place. When turning the coupling end, the inside face and the fillet should be roughed out first, as the forging is sometimes defective in this part, and should it chance to be condemned because of any defect, little machine work will be lost. Occasionally, a flaw in the metal may be discovered near the center of the shaft when facing the outside of the coupling. If such a defect appears, it should be examined carefully to determine, if possible, the distance it penetrates into the shaft.



Tool for Setting Lines Concentric with, or Surfaces at Right Angles to, the Axis of a Horizontal Boring Mill Spindle.

Before any of the cylindrical parts are machined, however, the webs are first finished as the crank-pins and the ends of the shaft proper are turned to a shrink fit for the holes in the web. These webs are usually forged solid, which means that a large amount of metal has to be removed in boring the shaft and crank-pin holes. Sometimes, however, small holes are punched for the crank-pins and shaft so as to reduce the time required for the boring operation. When machining the webs, the thickness and the distance between the shaft and crank-pin holes are the most important dimensions. It is also essential that the holes be bored out very true to the face of the webs, that is, at right angles, as no machining is done on them after the crank is shrunk together. The method of setting the angle-plates, described on the Shop Operation Sheet, will, as will be understood by referring to the Supplement, bring the faces of the angle-plates in line with the cross travel of the table. In a well-built machine this cross travel will be at right angles with the axis of the spindle, and, in that case,

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* With Shop Operation Sheet Supplement.
[†] Address: 16 Golfview Terrace, Paisley Road West, Glasgow, Scotland.

the angle-plates will be correctly set. By the use of a special tool, such as the one here illustrated, the setting of the plates may be tested directly from the spindle, which is a desirable thing to do, as then any error in the machine table will not be reproduced in the work. This tool consists of a shank *A* which fits in the spindle, and has passing through its outer end a gage wire *B* which is adjusted in and out and held in position by a knurled thumb-screw *C*. The faces of the two angle-plates *D* and *E* may be tested by bringing this gage point into contact with one, and then revolving the spindle one-half of a revolution. This moves the gage to the position indicated by the dotted lines in the illustration, and obviously, if the plane in which the two faces of *D* and *E* lie, is at right angles with the axis of the spindle, the point of the gage will just touch the face of each plate. By the insertion of a wire *B* having a sharpened point, circles scribed on the work may also be accurately set concentric with the spindle, by revolving the spindle and gage and adjusting the work until the pointer follows the line on it.

The outside edges of the webs are machined after the sides have been planed and the holes bored. These edges are occasionally painted when in place on the engine, and, in that case, often they are only rough machined. When all cylindrical parts are turned to fit the webs, the shaft is ready to be shrunk together. This might seem like a rather complicated job, especially when doing it for the first time, but if one keeps cool (which is not an easy thing to do when two big bunsen burners are playing on the web) no trouble will be experienced. When the shaft is shrunk together it is placed in the lathe for the final turning operation and all the parts of the shaft proper, or the journals, are finished as described on Shop Operation Sheet No. 93, thus bringing them into alignment. Considerable care has to be exercised when performing this last operation to obtain a shaft which is round and not sprung to any appreciable extent. It is hardly practicable, however, to finish a large three-throw crank-shaft which will not show slightly out of true when being bedded in place in the bushings in the sole-plate.

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TESTS ON CRANK SHAPERS.

Some interesting tests on crank shapers were recently undertaken by the Queen City Machine Tool Co., Cincinnati, Ohio, with the purpose of ascertaining the horse-power required for taking ordinary cuts on motor-driven crank shapers. The tests were made on the 16-inch and the 24-inch back-geared crank shapers manufactured by the company. A 5-horse-power constant-speed motor was used for driving the smaller machine, and a 20-horse-power motor for the 24-inch shaper; 220-volt current was used. A regular cone pulley drive was employed, the counter-shaft being driven by the motor. The required revolutions per minute of the counter-shaft were obtained by reduction through pulleys, so that the counter-shaft for the 16-inch shaper was running at 300 revolutions per minute, and the 24-inch shaper counter-shaft at 330 revolutions. The length of the stroke in the tests on both machines was 16 inches, which is the rated capacity of the smaller shaper. All the cuts were made with the back-gears thrown in, the 16-inch shaper being run to obtain an average cutting speed of 24 feet per minute, and the 24-inch to obtain a speed of 22 feet per minute.

TESTS ON 16-INCH CRANK SHAPER.

Depth of cut, ½-inch.

Feed.	Net Amperes.	Net Horse-power.	Feed.	Net Amperes.	Net Horse-power.
0 0125	2.5	0.75	0.075	14.	4.1
0.025	4.5	1.33	0.0875	16.5	4.87
0.0375	6.5	1.93	0.100	17.5	5.16
0.050	8.5	2.5	0.125	21.5	6.33
0.0625	11.5	3.4	......	....	....

The motor and counter-shaft were first run idle, and the power required for this was carefully noted. Then the machine belt was thrown in, and it was found that when running the machine idle, there was practically no increase in the power required for the 16-inch shaper, except at the point of reversal, when there was a rise of about one-half ampere. On the 24-inch shaper, one-half ampere or about one-seventh horse-power was required to run the ram on the forward stroke, and nearly two amperes at the moment of reversal. Readings were taken at the highest point reached by the needle of the meter on each stroke. In the accompanying tables, the results of the tests are given for cuts one-half inch deep made in cast iron. The net amperes and net horse-power given in the tables give the figures actually required for taking the cut. In the case of the 21-inch crank shaper, one-half ampere should be added to the net amperes to obtain the maximum amperes required for running the machine on the forward stroke.

It is rather surprising that so high a horse-power is required for driving the coarse-feed cuts, but considering the reciprocating motion of the machine, a somewhat smaller motor can be used than what would be indicated by the net horse-power, because first-class standard motors provide for a momentary over-load of 100 per cent. Besides, it is doubtful if many shops would attempt to take cuts with as coarse feed as that indicated by the last items in each table, although the shapers being tested are guaranteed to withstand cuts with this feed indefinitely, if properly cared for.

TESTS ON 24-INCH CRANK SHAPER.

Depth of cut, ½-inch.

Feed.	Net Amperes.	Net Horse-power.	Feed.	Net Amperes.	Net Horse-power.
0.025	5.5	1.6	0.150	22.5	6.6
0.050	8.5	2.5	0.175	25.0	7.4
0.075	11.5	3.4	0.200	26.5	7.8
0.100	15.0	4.4	0.250	31.0	9.1
0.125	20.0	6.0	...	....	...

Some of the interesting things noted from the two tables given are that the horse-power for any given cut is about the same on the two sizes of machines, and that the horse-power advances in nearly direct ratio to the feed. The first fact is interesting as indicating that shapers of different sizes, when properly built, will work with about the same efficiency within their respective capacities, and the latter fact is of interest because it indicates that there is little additional loss from binding action and friction, even on the heavy cuts, in shapers properly designed and rigidly built for the work for which they are intended. This is all the more remarkable, as the shaper is particularly subjected to severe twisting stresses, due to the great amount of over-hang inherent in its construction

* * *

MACHINERY SWINDLER IN THE SOUTH.

The swindler, "Eddie Ward," whose operations in the West were mentioned in the August, 1908, issue of MACHINERY, is now working in the South. He still represents himself as agent for J. J. McCabe, 30 Church Street, New York, and was last reported at West Point, Miss., and Talladega, Ala. At West Point he collected from Mr. F. A. Bentley of the West Point Machine Co., a deposit on a trade he proposed, which seemed very profitable to the concern. The Talladega Foundry & Machine Co. gave Ward a deposit on the purchase of a Hendey lathe, which was represented as belonging to McCabe, and as being ready for shipment from some point in Mississippi. Mr. McCabe informs us that he has no traveling men whatsoever at present in the South or West, as he is represented in these sections by prominent machinery dealers.

* * *

The last reports of the exports of machine tools from Great Britain indicate a healthy increase in trade. The exports during the month of December last year were the highest for any month during the year. The value of the exports of machine tools for this month amounted to about $575,-000, and the value of the imports during the same period, to about $40,000.

FORMULAS FOR MACHINE SCREW BUTTON OR SPLIT DIES.

THOMAS J. NORTON[*] AND DOUGLAS T. HAMILTON

Upon the adoption by the American Society of Mechanical Engineers of new standards for machine screws, it occurred to the authors to investigate a means of standardizing the proportions of button dies, so as to admit of a uniformity of manufacture and to eliminate all trial and error methods in the laying out of these dies. The method described has as its basis the maximum root diameter and outside diameter of the basic screw to be threaded. These are the only fixed quantities; all proportions of the die are derived from these two fundamental dimensions.

The dies are made with three cutting edges or teeth set slightly ahead or in advance of the center. The ratio of land to space has been taken as one to two. This relation has been found to work most satisfactorily in practice, especially in the present case for machine screw dies of small size. The advance ahead of the center, necessarily a small dimension to lay off, is taken care of by the general method employed.

Let D = outside diameter of basic screw,

d = maximum root diameter of basic screw,

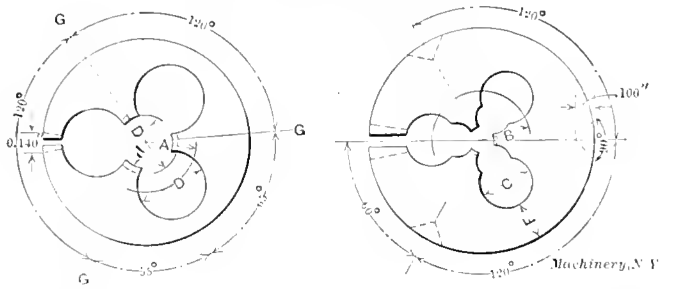
A = distance of first clearance hole of diameter D from center of die blank.

Take any three axes G on the die blank at 120 degrees to one another. Lay off the center lines of the clearance holes to make angles of 55 degrees with these axes. The distance A of the centers of the clearance holes from the center of the die blank along these 55-degree lines is given by the formula

$$A = \frac{d}{2}\cos 40\text{ deg.} + \sqrt{\left(\frac{D}{2}\right)^2 - \left(\frac{d}{2}\sin 40\text{ deg.}\right)^2}$$

From these centers, by drawing circles of diameters equal to the outside diameters of the basic screw, the correct relation of land to space is immediately obtained, and the necessary advance ahead of the center assured. For the larger size dies with a single clearance hole, the die blank is now ready for drilling and tapping.

PROPORTIONS FOR A. S. M. E. STANDARD SCREW THREAD BUTTON DIES, STANDARD SIZES.



Outside Diameter of Basic Screw and Threads per inch D, inches.	Max. Root Diameter of Basic Screw d, inches.	A inches.	Outside Diameter of Die Blank, inches.	B inches.	C inches	Thickness of Die Blank, inches.	F inches.
0.060–80	0.0438	0.0432	$\frac{13}{16}$	0.1853	0.2543	0.2187	$\frac{3}{32}$
0.073–72	0.0550	0.0529	$\frac{13}{16}$	0.1918	0.2414	0 2187	$\frac{3}{32}$
0.086–64	0.0657	0.0626	$\frac{13}{16}$	0.1983	0.2284	0.2187	$\frac{3}{32}$
0 099–56	0.0758	0.0721	$\frac{13}{16}$	0.2046	0.2157	0.2187	$\frac{3}{32}$
0.112–48	0.0849	0.0814	$\frac{13}{16}$	0.2109	0.2051	0.2187	$\frac{3}{32}$
0.125-44	0.0955	0.0910	$\frac{13}{16}$	0.2174	0.1902	0.2187	$\frac{3}{32}$
0.138–40	0.1055	0.1005	$\frac{13}{16}$	0.2237	0.1775	0.2187	$\frac{3}{32}$
0 151–36	0.1149	0.1098	$\frac{13}{16}$	0.2301	0.1649	0.2187	$\frac{3}{32}$
0.164–36	0.1279	0.1199	1.000	0.1898	0.2453	0.2500	$\frac{3}{32}$
0.177–32	0.1364	0.1291	1.000	0.1961	0.2328	0.2500	$\frac{3}{32}$
0.190–30	0.1467	0.1386	1.000	0.2024	0.2201	0.2500	$\frac{3}{32}$
0.216–28	0 1696	0.1582	1.000	0.2155	0.1940	0.2500	$\frac{3}{32}$
0.212–24	0.1879	0.1767	1.000	0.3217	0.1690	0.2500	$\frac{3}{32}$
0 268–22	0.2090	0.1961	1.000	0.3347	0.1431	0.2500	$\frac{3}{32}$
0.294–20	0.2290	0.2150	1.000	0.3474	0.1177	0.2500	$\frac{3}{32}$
0.320–20	0.2550	0.2351	1.000	....	....	0 2500	......
0 346–18	0 2738	0.2538	1.250	0.4308	0.2009	0.3125	$\frac{3}{32}$
0 372–16	0.2908	0.2722	1.250	0.4482	0.1660	0.3125	$\frac{3}{32}$
0.398–16	0.3168	0.2832	1.250	0.4570	0.1485	0.3125	$\frac{3}{32}$
0.424–14	0.3312	0.2902	1.250	0.4637	0.1350	0.3125	$\frac{3}{32}$
0 450–14	0.3572	0.2938	1.250	0.4686	0.1249	0.3125	$\frac{3}{32}$

In the case of the smaller dies, where two clearance holes are necessary some difficulty was experienced in obtaining a general method, inasmuch as the outside diameter of the die blank is constant for several sizes. This must be so on account of the die holder.

The diameter C of the second clearance hole is given by the formula

$$C = \frac{H}{2} - \left\{A + \frac{D}{4} + F\right\}$$

where H = outside diameter of die blank,

F = width of metal between outside of die blank and edge of clearance hole.

The thickness F of the outer skin of the die may be taken to suit different practice; in the present case it was taken as 3-32 inch.

PROPORTIONS FOR A. S. M. E. SPECIAL SCREW THREAD BUTTON DIES, SPECIAL SIZES.

Outside Diameter of Basic Screw and Threads per inch D, inches	Max. Root Diameter of Basic Screw d, inches.	A inches.	Outside Diameter of Die Blank, inches.	B inches.	C inches.	Thickness of Die Blank, inches.	F inches.
0.073–64	0.0527	0.0525	$\frac{13}{16}$	0.1917	0.2417	0.2187	$\frac{3}{32}$
0.086–56	0.0628	0.0620	$\frac{13}{16}$	0.1980	0.2290	0.2187	$\frac{3}{32}$
0.099–18	0.0719	0.0713	$\frac{13}{16}$	0.2043	0.2165	0.2187	$\frac{3}{32}$
0.112–40	0.0795	0.0803	$\frac{13}{16}$	0.2104	0.2042	0.2187	$\frac{3}{32}$
36	0.0759	0.0794	$\frac{13}{16}$	0.2100	0.2051	0.2187	$\frac{3}{32}$
0.125-40	0.0925	0.0903	$\frac{13}{16}$	0.2170	0.1910	0.2187	$\frac{3}{32}$
36	0.0889	0.0896	$\frac{13}{16}$	0.2167	0.1917	0.2187	$\frac{3}{32}$
0.138–36	0.1019	0.0997	$\frac{13}{16}$	0.2234	0.1783	0.2187	$\frac{3}{32}$
32	0.0974	0.0987	$\frac{13}{16}$	0.2229	0.1793	0.2187	$\frac{3}{32}$
0.151–32	0.1104	0.1089	$\frac{13}{16}$	0.2296	0.1659	0.2187	$\frac{3}{32}$
30	0.1077	0.1083	1.000	0.2761	0.2602	0.250	$\frac{3}{32}$
0.164–32	0.1234	0.1190	1.000	0.2831	0.2462	0.250	$\frac{3}{32}$
30	0.1207	0.1184	1.000	0.2828	0.2468	0.250	$\frac{3}{32}$
0.177–30	0.1337	0.1285	1.000	0.2895	0.2335	0.250	$\frac{3}{32}$
24	0.1229	0.1262	1.000	0.2863	0.2358	0.250	$\frac{3}{32}$
0.190–32	0.1494	0.1391	1.000	0.2964	0.2196	0.250	$\frac{3}{32}$
24	0.1359	0.1364	1.000	0.2951	0.2223	0.250	$\frac{3}{32}$
0.216 24	0.1619	0.1565	1.000	0.3084	0.1957	0.250	$\frac{3}{32}$
0.242–20	0.1770	0.1745	1.000	0.3206	0.1712	0.250	$\frac{3}{32}$
0.268–20	0 2030	0.1947	1.000	0.3340	0.1445	0.250	$\frac{3}{32}$
0.294–18	0.2218	0.2134	1.000	0.3466	0.1193	0.250	$\frac{3}{32}$
0.320–18	0.2478	0.2337	1.000	0.3600	0.0925	0.250	$\frac{3}{32}$
0.346–16	0.2648	0.2519	1.250	0.4348	0.1928	0.3125	$\frac{3}{32}$
0.372–18	0.2998	0.2740	1.250	0.4491	0.1642	0.3125	$\frac{3}{32}$
0 398–14	0.3052	0.2903	1.250	0.4605	0.1414	0.3125	$\frac{3}{32}$
0.424–16	0.3428	0.2916	1.250	0.4649	0.1336	0.3125	$\frac{3}{32}$
0.450–16	0.3688	0.2942	1.250	0.4690	0.1245	0.3125	$\frac{3}{32}$

The distance B of the second clearance hole from the center of the die blank is given by the formula

$$B = \frac{H}{2} - \left\{\frac{C}{2} + F\right\}$$

It will be seen from the accompanying tables of proportions that B and C are given in nearly all cases. In many of these it is impossible to drill C without a jig, in which case the second clearance hole may be filed. These tables give all the proportions derived from the foregoing method for laying out button dies for the A. S. M. E. standard and special machine screws.

Universal Application of Formulas.

The formulas may be applied to any case whatsoever, regardless of the number of flutes and relation of land to space. For example, they may be used for dies with say six lands.

Let n = number of lands,

α = land ratio,

β = space ratio,

then the formula in its general application will be

$$A = \frac{d}{2}\cos x + \sqrt{\left(\frac{D}{2}\right)^2 - \left(\frac{d}{2}\sin x\right)^2}$$

$$\text{where } x = \frac{360}{n \times (\alpha + \beta)} \times \frac{\beta}{2} \text{ degrees}$$

For a case of four lands with a ratio of land to space of 2 to 3

$$x = \frac{360}{4(2+3)} \times \frac{3}{2} = 27 \text{ degrees.}$$

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[*] Address: Northern Electric & Mfg. Co., Ltd., 814 Notre Dame St., West Montreal, Canada.

The angle that the clearance hole makes with the axis of the teeth would be x — 5 or 22 degrees. This gives the necessary advance ahead of the center. For a second clearance hole the method is the same as outlined above.

In order to insure a good cutting edge on the die, the first clearance hole is lapped after hardening. This proves very satisfactory.

* * *

HOB GRINDING ATTACHMENT FOR THE PLANER.

To avoid the necessity for the constant attendance of an operator in sharpening hobs, an automatic arrangement for this work has been rigged up by Mr. H. C. Gilman, shop superintendent of the Philadelphia Gear Works, Philadelphia, Pa. This attachment is mounted on an old 16-inch planer and employs a very simple arrangement of mechanism for the necessary movements, automatically indexing the hob and feeding the wheel. Fig. 1 shows the attachment at work, and Fig. 2 is a diagram showing the arrangement of the mechanism.

Special index centers are provided. Indexing spindle *A* carries two dials. One of these, *B*, has ratchet teeth for indexing the spindle, while the larger one, *C*, is provided with notches for locking the spindle after the indexing. A "tip-up" dog *D* with a taper face is mounted on a bracket *E* fastened to the rear side of the bed. This dog engages the rounded end of a bar *F*, which slides in guides in the front face of the head-stock casting *G*. As the table starts on the forward stroke, the rounded end of *F* runs up the inclined face of the dog *D* pushing *F* to the right. The locking bolt *H*, clamped to *F* by the support shown, is thus released from the notch in locking dial *C;* and a counter-weighted pawl *J*, also pivoted to *F*, indexes the spindle by its action on dial *B*. When the end of *F* drops over the face of the dog *D*, the bolt *H* flies into place in the locking disk, holding the spindle in position for the next stroke of the wheel, while pawl *J* is brought back into engagement with the next tooth of ratchet *B*. This retraction of bar *F* is effected by spring *K*. On the backward stroke, as shown at the right of Fig. 2, dog *D* tips up to the position indicated by the dotted lines, allowing *F* to pass in this direction without interference.

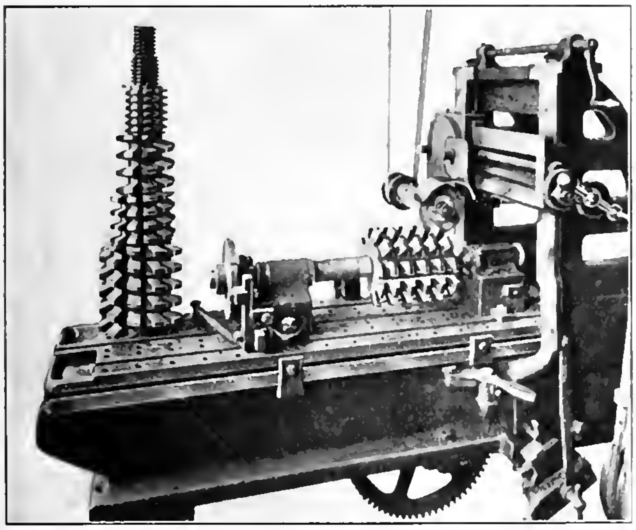

Fig. 1. Simple Planer Attachment for Sharpening Hobs.

The automatic feed arrangement is almost ridiculously simple. The feed-screw has an end movement of about 1/64 of an inch between its thrust collars. This end movement is taken up toward the right by a spring suitably placed at the left hand end. In setting up the machine for a grinding operation, the wheel is fed up against the face of the teeth until this slack is all taken up. When the machine is once started, it will continue to cut until 1/64 of an inch has been removed. On the first few cuts the end teeth are rounded, of course, but as the work progresses, the face is finished straight across. This machine has proved to be of such value that it is left permanently rigged as shown, and is constantly in demand.

CHECK SYSTEM FOR TOOL-ROOMS.

GEO. D. HADEN.

In order to determine the best system for keeping track of the tools lent to the workmen from the tool store-room, three methods, as outlined in the following, were tried in a well-known shop employing about five hundred hands.

With the first method, each man had a number of checks in his own keeping, and one of these was deposited with the store-keeper for each tool borrowed. This check was hung near the space previously occupied by the tool lent, in the usual manner.

As the foregoing method was somewhat unsatisfactory all checks were collected from the workmen, and kept on a board in charge of the store-keeper, from which they were removed and hung, as in the first case, when tools were borrowed.

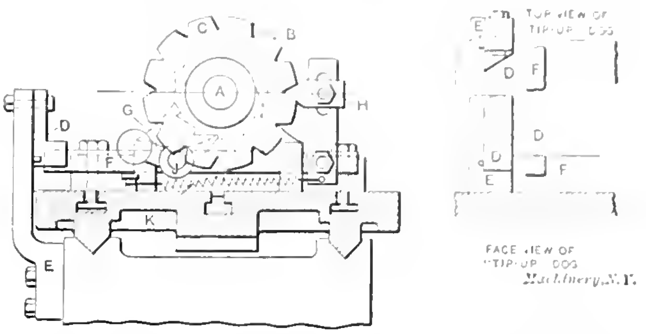

Fig. 2. Diagrammatical Sketch of the Mechanism shown in Fig. 1.

The second method also proved unsatisfactory and was abandoned. Loose printed slips of paper were then distributed in suitable boxes about the works, and each man was obliged to write on a slip his pay roll check number, what tool he required, the date, and his signature. This slip was then handed to the store-keeper in receipt for the tool borrowed, and the slips filed away in card cases, in numerical order, back of guide cards arranged to suit the various classes of tools, such as taps, reamers, cutters, etc. When the tool was returned, the slip was handed back to the man to be destroyed.

The first two methods are the ones commonly used where there is a tool store-room, some firms preferring one, and some the other. The first method was abandoned by the shop in question after a twelve months' trial, because the men could not, or would not, take care of their checks, and if one of these were lost, there was nothing to prevent its being used by another man, if he found it, for it was impossible for the store-boys to know whether every man handed in the proper check or not. Again, checks would occasionally get misplaced, causing considerable trouble. Various means were taken to prevent these troubles, but without success, and finally the second method was adopted. This was also given a twelve months' trial, and, if anything, proved rather worse than the first, as the store-boys misplaced the checks, omitted to replace them on the board when tools were returned, or, if there was more than one check on the hook, sometimes took off the wrong check. I do not think, however, that these boys were any worse than the average. No doubt some of the men contributed to the trouble by losing or mislaying a tool, and then claiming that it had been returned and that the boy had forgotten to replace the check on the board. The third method has now been in use about three months, and, so far, it has proved more successful than either of the other two. Of course, it takes longer to write out the slips, and there is a slight expense for paper, printing, etc., but this expenditure is more than offset by the satisfactory way in which the system works.

Perhaps some who read this may be inclined to say that the first system is the best, and greater firmness should have been exercised in order to keep it going. Possibly if I had not tried all three methods I should be inclined to say the same, but all will agree that with the same men, and under similar conditions, the system which causes the least trouble is the system to adopt, and this was done. Have any of your other readers had a similar experience?

VALVE GRINDING MACHINE.

J. F. MIRRIELEES *

A machine for grinding gas engine valves, designed to grind the particular style of valve shown in Fig. 1, is illustrated in Fig. 2. Previous to designing this machine, the best practice in valve grinding, in general, as applied to this style of valve, in particular, was thoroughly investigated; and from a series of experiments the following facts were established: The grinding speed should not be less than 50 feet per minute, nor more than 75 feet per minute; the valve must be rotated alternately in both directions, and one and a fractional part of a revolution each way is sufficient and even better than two or more revolutions; the valve must be raised clear of the seat and allowed to rotate freely; carborundum is the best abrasive for cutting, and emery flour the best for finishing.

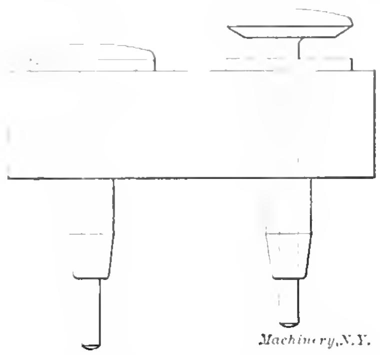

Fig. 1. Type of Valves for which the Machine shown in Fig. 2 was designed.

The necessity for reversing the motion and lifting the valve is much more pronounced when carborundum is used than when emery. The particles of the former seem to have a greater tendency to imbed themselves in the metal, and if this tendency is encouraged by rotating continuously in one direction, the particles become permanently imbedded, and grooves in the seat are the result. If the valves are not raised occasionally to allow the abrasive to distribute itself, the grinding will be ununiform. The machine here illustrated covers these points. When valves are to be ground with it, the seats, the style of which is shown in Fig. 1, are placed on the table of the machine. They are not secured, however, but allowed to center themselves at all times. The forks or drivers *A* grip the valves by means of suitable holes in the latter, and the valve stems extend through the table and directly above the lifter levers *C*. The variation in the length of the stems of the different size valves is regulated by means of parallel strips of thickness sufficient to make all stems extend through the table the same distance. Power is transmitted to the machine by means of a 2-inch belt on an 8-inch pulley which runs about 150 revolutions per minute. The power is then transmitted through a train of gears, which connects with the segment *M* plainly shown in the end elevation, thus giving a reversing motion to the shaft *D*. From this shaft through bevel pinions and gears, the spindles *E* are driven. The latter are held in quills *F* which, in turn, are held in heads *G* which are adjustable horizontally along the cross-rail *H*. The vertical adjustment of the spindles is automatic. Each spindle is splined in its quill, and the adjustment for different heights of work is made by spiral springs located above the spindles. The grinding pressure exerted is likewise regulated automatically. The larger seats, with larger valves and longer stems, must be raised from the table on strips so that the stems extend through just enough to clear the lifting levers *C*; consequently the spiral springs in the quills are compressed and press harder on the valves. Under the lifting levers *C* runs the shaft *I* upon which are located the cams *J* employed to actuate the lifting levers, which, in turn, lift the valves from their seats. The cams are placed quartering around the shaft so that but one valve raises at a time. The shape of the cams causes the valves to raise quickly, which, after revolving free momentarily, drop hard to their seats. The cam shaft is driven by means of sprockets and chains from the hub of the driving pulley. As will be seen by referring to the illustration, the lifting levers *C* may be operated by hand when desired. In order that work on any of the spindles may be stopped without interfering with the others, the little chains *K* are attached to the quills, and suitable button-head screws *L* inserted in the spindles, which, when raised, may be caught and held up by the chains.

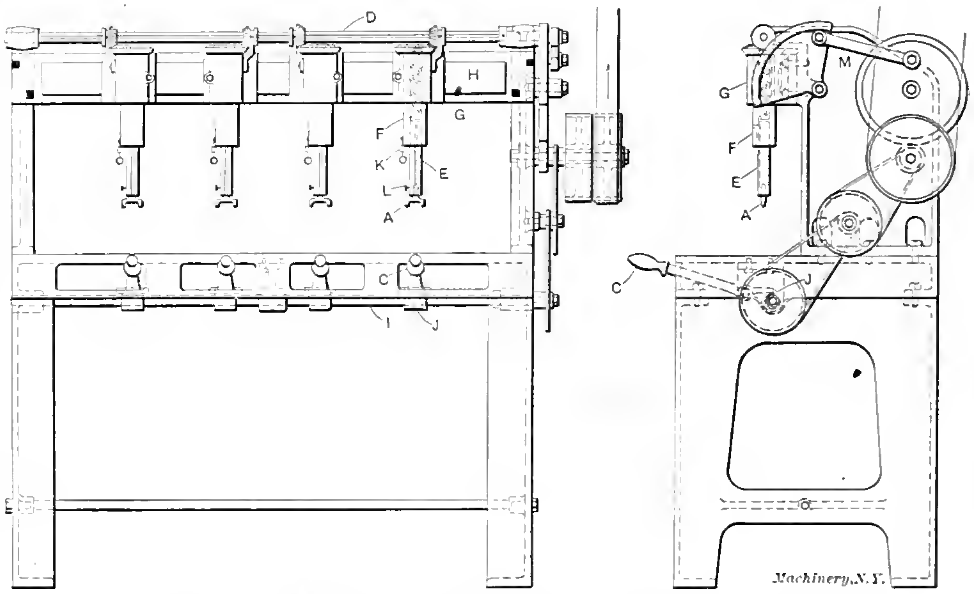

Fig. 2. Valve Grinding Machine which automatically Reverses the Movement of the Valves, and occasionally lifts them from their Seats.

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* Address: 3765 Rosedale Ave., Cincinnati, Ohio.

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The Maxim silencer or muffler for guns which has been referred to in recent numbers of MACHINERY was given a public test in New York, February 8. The silencer was applied to a variety of guns, from the 0.22 caliber to the high power Springfield 0.30 army rifle, and in all cases the efficiency of the device was conclusively demonstrated. The sound of the report was almost entirely eliminated, except in the case of the automatic rifles of the "blow-back" type. With these guns, the escape of gases at the breech made a perceptible report. With the other types of rifles the sound was confined to the whistle made by the bullet in its passage through the air, and its impact on the target. The silencer consists of a thin steel tube about 1½ inch in diameter, and 9 inches long, which is screwed onto the muzzle of the piece. The weight for the heaviest guns is about 11 ounces, and for the lighter ones about 8 ounces. The interior of the tube contains ten or twelve disks, perforated above center with a hole slightly larger than the caliber of the gun. The disks are rolled over into a shape somewhat like the vanes of a turbine water-wheel and cool and dissipate the gases at a low pressure because of the effect of the rotary and centrifugal action. The action is somewhat similar to that of water escaping from a wash basin. When the plug is pulled and the water allowed to flow, it acquires a circular action which may become so rapid that the water goes slowly through the hole and a clear space exists in the center through which air is drawn. The flow of the water is impeded by its rotary motion and the more rapidly it rotates the slower it escapes. Thus it is in the silencer; the gases are expanded and permitted to escape to the atmosphere only when the low pressure is attained. Perhaps the most useful purpose that the device will be applied to will not be as a silencer of guns but rather as a muffler for that useful worker, the gas engine.

* * *

You can tell a salesman by the way he sells his own services.—*Common Sense.*

STOVE BOLT TAPS.

S.

In the various articles that have appeared in MACHINERY from time to time regarding taps, nothing has been said about stove bolt taps, and as these taps, and likewise the bolts and screws, are provided with a form of thread which is an interesting example of a mongrel United States standard form of thread, perhaps some of the readers of MACHINERY would be interested in a description of them.

The thread has an angle of 60 degrees, with flat top and bottom which are equal in width. The width of the flats is wider than for the U. S. standard thread, being in some cases nearly one-quarter the pitch. The widths of flats being so wide as compared with the pitch, makes the thread shallow in comparison with other screw thread systems.

Below are given the widths of tools for the various sizes, and though the tools given are a little narrow in some cases, for reasons explained later, it will be shown that they are near enough for all practical purposes. However, if one wishes and has the proper instruments for measuring the widths of flats, the tools can be ground to the widths given. Where there has been any choice in the selection of the nearest U. S. standard threading tool, the one that is narrower than the width of the flat has been chosen, so that the flat on top of the tap would be wider than in the bottom, that it might be certain to take out enough material from the nut or tapped hole, to insure the bolt or screw turning easily. Should one, however, be making a hob tap to make a die for making stove bolts, it would be well to follow the dimensions given.

STOVE BOLT HAND TAPS.

Nominal Size.	Actual Diameter, Inches.	Root Diameter.	No. of Threads per Inch.	Total Length.	Length of Thread.	Length of Shank.	Size of Square.	Length of Square.	Approximate Machine Screw Tap Size.
5/32	0.167	0.134	28	2 1/8	13/16	1 5/16	1/8	7/32	8
3/16	0.200	0.157	24	2 1/4	7/8	1 3/8	5/32	1/4	10½
7/32	0.227	0.180	22	2 3/8	15/16	1 7/16	11/64	9/32	12½
1/4	0.260	0.203	18	2 1/2	1	1 1/2	3/16	5/16	15
5/16	0.317	0.2585	18	2 11/16	1 1/8	1 9/16	15/64	11/32	19½
3/8	0.352	0.287	16	2 15/16	1 1/4	1 11/16	1/4	3/8	22

Stove bolt taps are made 0.004 to 0.005 inch larger than the screw, so that the nuts may be a loose fit, a fit that would not be tolerated on any of the standard screw-thread systems for bolts and nuts. For this reason, the few ten-thousandths inch the threading tools are narrower than the table calls for would make but little difference in the fit of the nut.

NUMBER OF THREADS, WIDTH OF FLAT, AND THREADING TOOLS FOR STOVE BOLT TAPS.

Nominal Size of Tap.	Pitch.	Width of Flat.	Nearest U. S. Standard Threading Tool to Cut Thread.
5/32	28	0.0083	16 threads U. S. which is 0.0078 inch wide.
3/16	24	0.0084	
7/32	22	0.0092	14 threads which is 0.0089 inch wide
1/4	18	0.0113	11 threads which is 0.0114 inch wide
5/16	18	0.0109	12 threads which is 0.0104 inch wide
3/8	16	0.0125	10 threads which is 0.0125 inch wide

As mentioned, the taps are made oversize, and the nominal sizes are smaller than the actual sizes except in one case, the three-eighths, where the actual size is nearly one-thirty-second inch smaller than the nominal size.

It is obvious that special screws or bolts might become oversize before the days of micrometer calipers and screw-thread micrometer calipers, for unless the working gages are looked after carefully, and there is a master gage to which to refer these working gages occasionally, they will become worn, and so allow the screws to become larger than they were originally intended to be. This is probably what happened to stove bolts years ago.

Another example of this same idea is the so-called 41/64-inch shanks for twist drills, used principally by blacksmiths at the present time. These shanks instead of being 0.6406 inch, the decimal size of 41/64 inch, are 0.647 inch, which is about 0.006 inch oversize.

It is customary to make stove bolt hand taps with shanks the same diameter as the actual size of the tap, and the accompanying table has been figured to that end.

* * *

NEW HIGH-SPEED STEEL.

In an address delivered before the Royal Institution, Prof Arnold of Sheffield University said that within a year there would be on the market a British steel with quadruple the cutting power of any now known. What Prof. Arnold referred to was a product of the Continental Steel Works (Jonas & Colver, Ltd.) at Sheffield, just discovered and named "Novo Superior." Mr. B. W. Winder, the manager of the works, in an interview said the discovery was the outcome of litigation instituted by the Bethlehem Steel Company, which claims the patent rights on air-hardened high-speed steel. Experiments with a view to rendering themselves independent of the American claims, conducted by the Continental works, resulted in the discovery. A tool made of the old high-speed steel working on hard material at Sheffield had to be ground five times a day. A similar tool of the new process steel worked with one grinding for a day and a half, and was still sharp. The American agents for Jonas & Colver, Ltd., are Hermann Boker & Co., New York.

A later report states that the new steel can be readily annealed and that no other high-speed steel has any advantage over it in the matters of annealing, forging or nonsusceptibility to overheating. The makers recently tried a severe experiment. A tool made of the new steel was hardened seventeen times in cold water without showing a sign of a crack. It can be hardened also in oil, paraffin, or air blast. Prof. Arnold stated that it is an absolutely new departure in metallurgy to have obtained a water-hardened steel which will work for a long time with a keen edge at a low red heat when cutting hard steel. He added that in all probability every high-speed steel manufacturer in the country soon would be making the same steel, as the secret could not be long retained. From this statement it might be inferred that the process of manufacture is essentially simple.

* * *

TAYLOR-WHITE HIGH-SPEED PATENTS INVALID.

The United States Circuit Court of the District of New Jersey recently handed down a decision in the suit brought by the Bethlehem Steel Co. two years ago against the Niles-Bement-Pond Co. for infringement under the Taylor-White high-speed steel patents, deciding that the nineteen claims of the plaintiff were invalid. The testimony covered about 5,000 typewritten sheets and reviewed much of the history of steel making from the time cast steel was first made down to the discovery of the Taylor-White process. It evidently was shown to the satisfaction of the court that the process was not essentially a new one and that the testimony of important witnesses was biased. The case was reopened last November and then it was shown from certain copy books or other records of the Bethlehem Steel Co. that the principal inventor had received a valuable concession in consideration of testimony favorable to the Bethlehem Steel Co., to which the patent had been assigned. The court severely scored the witnesses and declared that all the claims made by the Bethlehem Steel Co. were invalid.

* * *

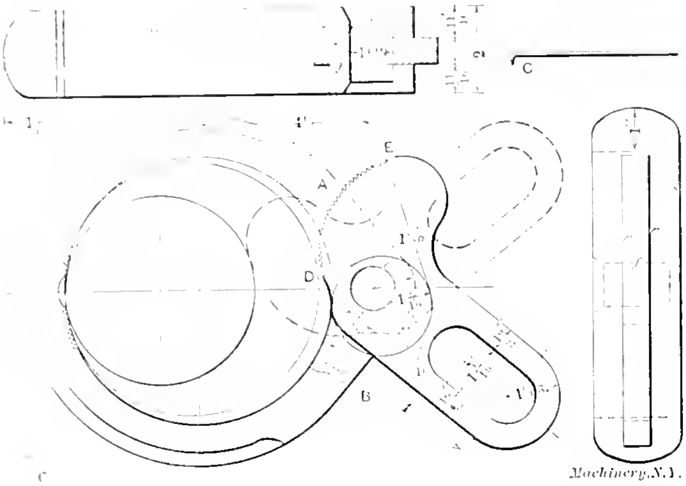
In its famous decision on eighty-cent gas legislation, the Supreme Court of the United States made an important ruling in regard to the value of good will. It is to the effect that good will is not a concrete thing that can be capitalized in a city where a public utility corporation has monopoly of its particular business. The decision virtually limits the value of the franchise to the allowable capitalization at the time the franchise was granted. The growth of a city and the increased earning power of the monopoly cannot be employed as excuses to increase the capitalization. A city's inhabitants are entitled to the same service for less cost when it can be shown that the increase of population enables the public utility corporations to produce much cheaper than before.

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

LATHE DRIVER FOR ROUND STOCK.

The accompanying engraving shows an excellent style of dog or driver which has been found by use to remedy the difficulties that often occur when driving large, round work in the lathe, which requires heavy cuts and high speed. The reader can readily see without a lengthy explanation, that it would be impossible for this dog to release its grip, for the larger the cut the more the teeth will bite. It is made of a low grade of tool steel, and the teeth are given a chisel temper, so that they will not bend or break when the strain comes. To generate the curve of the toothed surface *A*, secure a cylindrical piece having a diameter equal to that of the generating circle *B*, and locate it concentric with the generating circle. Obtain a piece of small wire, and bend and sharpen one end for a scriber, as shown at *C*. Wind the wire around the cylindrical piece, and, beginning at *D*, scribe the curve to a point *E*, as the wire is unwound. Those who have experienced difficulties in this line will be well repaid by giving this driver a trial.



Dog adapted to Driving Large Cylindrical Work in the Lathe

R. F. S.

GAGES FOR ACCURATELY SIZING BEVEL GEAR BLANKS.

In the manufacture of our sensitive high speed universal milling attachment, we use quite a number of small bevel gears, and as the gears sometimes run at a high speed, it is necessary that they should be accurately planed. To facilitate the sizing of the blanks, the writer designed the gages illustrated in Figs. 2 and 3, which were made to gage the blanks for the miter gears shown in Fig. 1. As these are miter gears, the face angles are, of course, the same, but it will be noticed that one has a longer hub than the other, which necessitates making two gages. The parts of the attachment in which these gears run are very accurately machined with reference to the distance from the hub of one gear to the center of the other, so that if the blanks are correctly sized and cut, they will go in place and run properly without fitting.

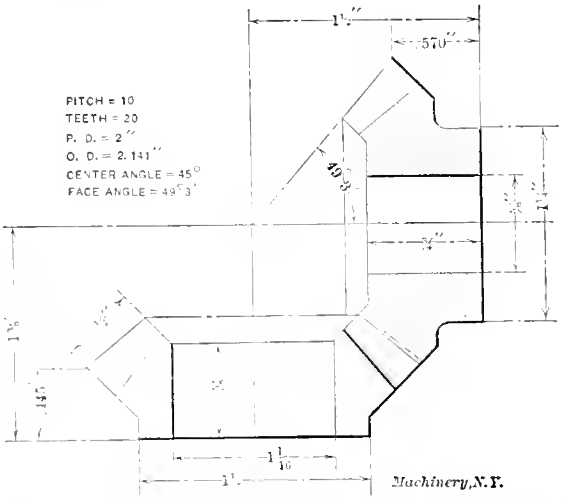


Fig. 1. Miter Gears for which Gages in Figs. 2 and 3 were made.

The following method was used to obtain the gage dimensions. We will take the gage shown in Fig. 2, which is used for sizing the gear with the long hub.

The distance from the hub of this gear to the center of the other shaft is 1½ inch, and the face angle is 49 degrees 3 minutes. The triangular opening in the gage should correspond exactly to these dimensions. To obtain this result the size of a circular plug gage which would just pass through the triangular opening, was determined as follows.

It is evident from Fig. 2 that as the triangle *A G B* is an isosceles triangle, if a circle be inscribed in it, the center of the circle must be somewhere on the line *C D* which bisects the angle *A G B* and the line *A B*. It must also be somewhere on the line *A E* which bisects the angle *G A B;* therefore it must be at the point where these two lines intersect. $GF = 1.5$ inch; angle $AGF = 49$ degrees 3 minutes; therefore $AF = 1.5 \times \tan$ 49 degrees 3 minutes $= 1.5 \times 1.1524 = 1.7286$. One-half of the angle $GAF = 20$ degrees 28½ minutes; $OF = AF \times \tan$ 20 degrees 28½ minutes $= 1.7286 \times 0.37339 = 0.6454$ inch, which is the radius of the inscribed circle; $2 \times 0.6454 = 1.2908$ inch, diameter of inscribed circle or plug gage. The same process was, of course, used to obtain the size of the gage shown in Fig. 3. The gages were made from ¼-inch cold rolled sheet steel; larger ones may be made from thicker material. The outside of the gages was worked out with a hacksaw and smoothed up with a file. The inside was drilled out, leaving about 1/16 inch on each side to be finished with a universal milling attachment. The gages were strapped to the face-plate of a Brown & Sharpe 60 to 1 index head while being milled out, the head being set at 90 degrees; the gage rested on three parallels to allow the end mill to get into the work without danger of milling into the head, and also to assist in using the plug gage. The job was set so as to bring the side *A G* in line with the table travel, and that side was finished down to the line with a small end mill; we now turn the head 98 degrees 6 minutes, which with a 60 head and 60 hole plate, is 16 turns and 21 holes for the index pin (one turn equals 6 degrees, and with the 60 hole plate 1 degree or 60 minutes equals 10 holes, and therefore 1 hole equals one-tenth of 60 minutes or 6 minutes.

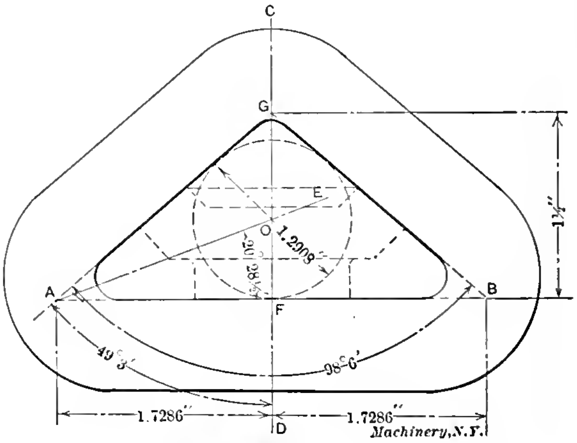


Fig. 2. Gage for Miter Gear with Long Hub in Fig. 1.

This brings the side *G B* in line to be milled. After it has been finished down to the line we turn the index pin 6 turns and 49½ holes farther, which brings the side *A B* in line to be milled, and this side is worked out until it is a good fit on the plug gage.

The ½ hole in the last indexing was guessed at, and this proved to be accurate enough, for when a blank had a good smooth finish on the face and was sized so that it would just pass through the gage without binding we could not see light through anywhere between the blank and the gage.

The indexing, of course, was just the same for the gage shown in Fig. 3, as the only difference in the two gages is the size of the opening.

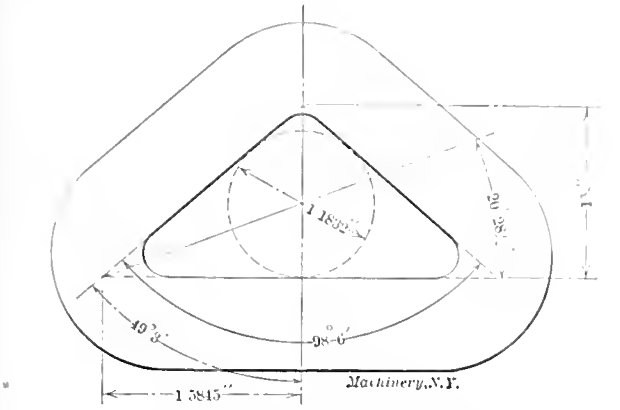


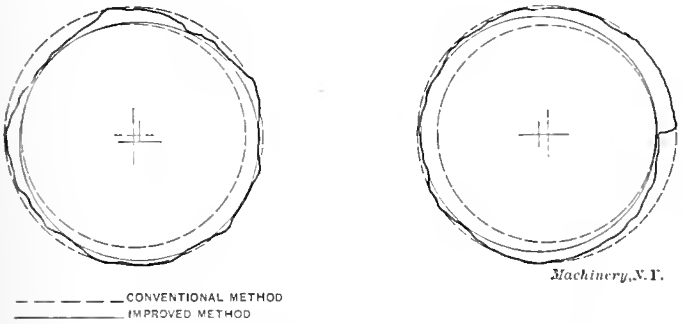
Fig. 3. Gage for Miter Gear with Short Hub.

We have made up quite a number of these gages and they have given excellent satisfaction, and it would seem that this same scheme might be used to advantage in a good many instances and in various ways.

Syracuse, N. Y. GEORGE. D. PORTER,
The Porter-Cable Machine Co.

TRUING ROUGH WORK.

There is a fundamental error in the conventional method of truing rough work, such as forgings or castings, especially large ones, in the lathe. There are two requisites, either of which may determine whether the piece is true enough. First, it is desirable that the point of the tool should get beneath the scale on the first cut, and if the piece runs out too much, the point of the tool will not reach the low spots. This dulls the tool and it will probably be necessary to run the lathe at a slower speed. In the second place, the casting or forging may be barely large enough to finish to the desired size, and therefore requires to be trued accurately. The usual method is to hold a piece of chalk close enough to the work, as it revolves, to touch the high places. The work is then adjusted or re-centered, and tried repeatedly until the chalk will touch opposite points, and, perhaps, additional points between these. The result is that the highest points are running true, and when they are turned off it is the low spots that run out and cause the trouble.



Diagrams showing why Work should be trued by the Low rather than by the High Spots.

What is needed is a method that will true the work by the low spots, instead of by the high ones. To do this, place a tool in tool-post, parallel to the ways and say an inch from the work. Then turn the work a little at a time and measure from it to the tool until the spot farthest from the tool is found. This is, of course, the low spot, and we shall assume, for example, that it is 7/16 of an inch farther from the tool than the opposite side. Hold a scale against this low place and adjust the work until it has moved one-half of the distance it is out which, in this case would be 7/32 of an inch. Repeat this operation until the low spots all measure practically the same. The piece is then trued so that it will clean up to the best advantage. If the work is long, it is better to test both ends and the middle. When the lowest spot or depression is found, it is well to mark the place and then when the piece is ready to be turned, set the tool by this low spot and note the position of the feed handle. Then when setting the tool for the first cut, it may be adjusted so that it just cleans the entire surface of the work. On a long forging that is sprung, such as a crank shaft, this method will show whether it can be turned to size without straightening.

Wonalancet, N. H. CHARLES E. BURNS.

ATTACHMENT FOR MILLING HALF CIRCLES IN DROP-FORGE DIES.

In the engraving, Fig. 1, is shown an attachment for the milling machine, which is used for milling out circular recesses in dies used in drop forging. It consists of a frame *A* (see Fig. 2), which supports an arbor *B* upon which is mounted a spur gear *C*, which is in mesh with and drives the milling cutter *D*. This cutter is supported between two adjustable spindles *E* the ends of which fit into recesses in its sides as shown in the detail Fig. 3. When it is desired to remove the cutter, the spindles may be withdrawn by the screws shown. The spur gear shown on the arbor in Fig. 1, will drive cutters for milling any circle from 1¼ to 4 inches in diameter. The gear and cutter seen on the die are for milling circles smaller than 1¼ inch in diameter. Different size cutters may be placed in mesh with the driving gear by loosening the bolts which hold the slides *F* in place and adjusting the latter to the vertical position required. This driving gear is driven by a key and is made of machinery steel and case-hardened. The cutter is shaped somewhat like a spur gear, except that the cutting faces of the teeth are flat and part of the addenda or tops of the teeth are removed to make them stronger. The outside diameter may be altered, within reasonable limits, to suit the required diameter of the recess. The cutters should have 10 diametral pitch if larger than 0.9 inch pitch diameter, and 14

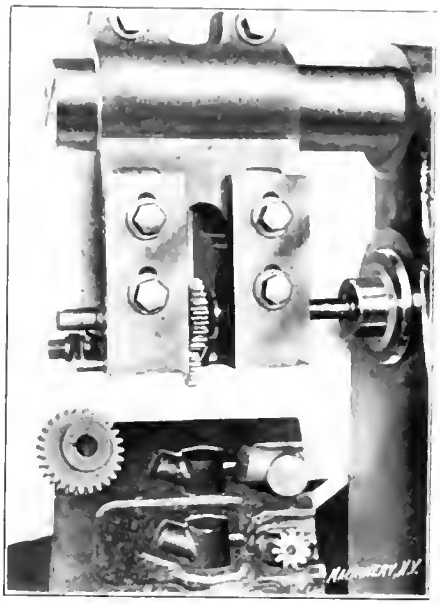


Fig. 1. Attachment for Milling Drop-forge Dies and Example of the Work.

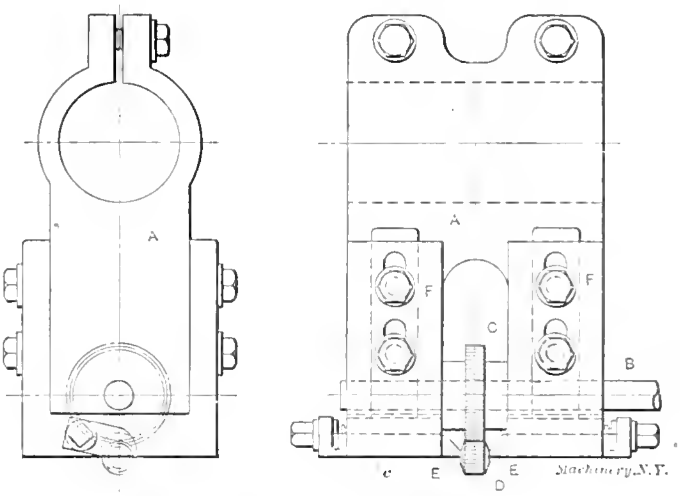


Fig 2. Elevations of the Die Milling Attachment.

diametral pitch if smaller. The centers of the circular ends of the spindles *E* are 1/32 inch below the bottom face *c* of the frame so that the center of a circular recess may be milled flush with or slightly below the surface of the die. The die shown in Fig. 1, which is used for forging brackets

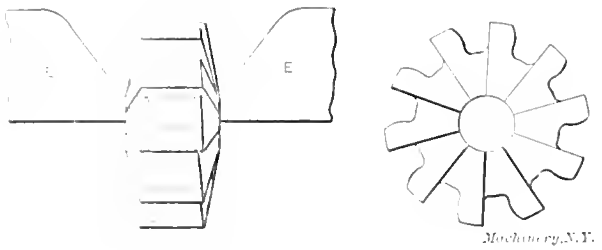


Fig. 3. Enlarged View showing Cutter and Ends of Spindles upon which it revolves.

for bicycle frames, is an example of the work done with this attachment. We have been milling dies in this way for some time and the method certainly "knocks the spots" out of chipping and filing. **Fred Terry.**

West Toronto, Canada.

BINDER FOR PRESERVING ARTICLES OF SPECIAL INTEREST.

The illustrations, Figs. 1 and 2, show a binder or holder which will be found convenient for preserving the various articles on special tools, processes, etc., published in Machinery, which I think will be appreciated by many mechanics wishing to keep these articles ready for reference. Fig. 1 shows a view of the closed holder, which is simply an old ledger book with all the leaves cut out to within about one inch of the binding. Pages from Machinery containing articles of special interest are fastened into the holder by pasting them to these short leaves, as indicated in Fig. 2. If the back of the page contains nothing of particular interest, short articles or interesting notes can be pasted upon it, as shown to the left, in Fig. 2. If possible, it is better to obtain a cover which exceeds the size of the page by about one-half inch. The writer was fortunate enough to secure a new invoice book with gummed leaves, which is admirably adapted to this purpose.

Fig. 1. View of the Closed Binder.

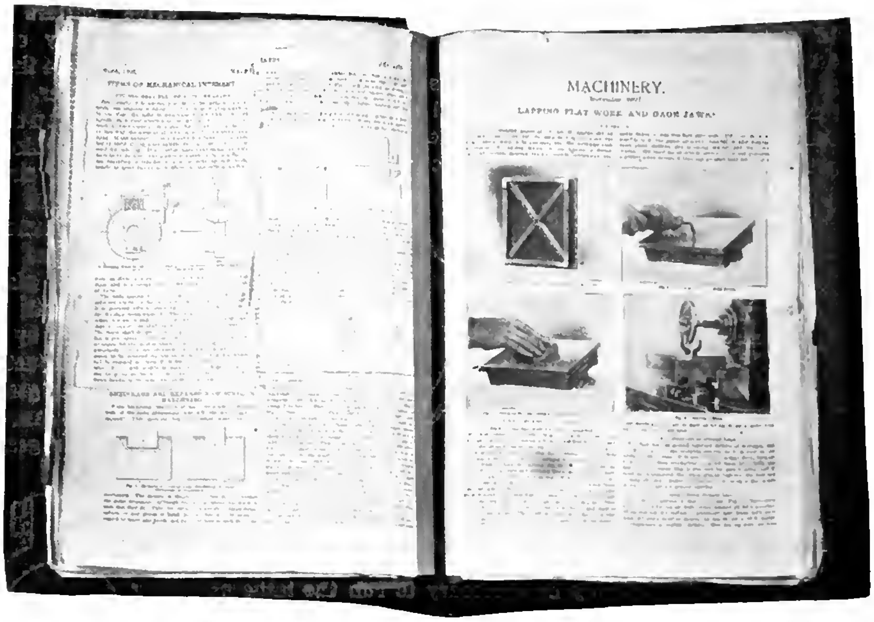


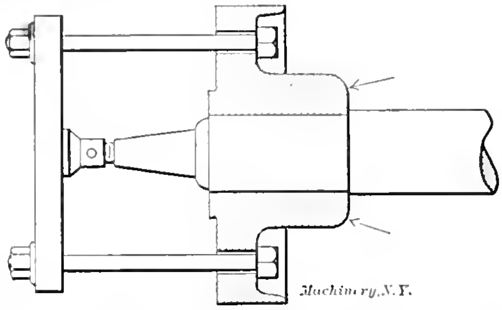
Fig. 2. View of the Opened Binder, showing the Method of Attaching the Leaves.

By the use of such a binder, a very valuable book may be made up in a comparatively short time, which will go well with Machinery's Data Sheets, and Shop Operation Sheets, and in this way a large amount of material, valuable for reference purposes, may be kept in a small compass, thus enabling the mechanic to keep track of various modern appliances and ways of doing work. **J. A. Caless.**

Providence, R. I.

REMOVING A FLANGE COUPLING FROM A SHAFT.

No doubt many of the readers of Machinery have had experience in removing flange couplings from shafts, and have found that it is not always an easy job. This is especially true if the shaft is of considerable size and has run in a damp pit for several years and consequently has become corroded. Such was the condition of a coupling on an 8-inch shaft in a tube mill in which the writer was employed. This coupling had to be removed, and, of course, it was a Sunday job. The honor (?) fell to another machinist and myself, with the assistance of a couple of husky laborers. The shaft was first jacked up in a convenient working position, and the coupling and shaft well soaked with kerosene.



Removing a Flange Coupling by the Application of Blows in conjunction with Pressure.

Sledging was then tried, but to no avail, so a fire was kindled under the coupling with the idea of expanding it and, of course, removing it with ease. To facilitate the heating process, a gas pipe was run from one of the nearby heating furnaces. After the coupling was thoroughly heated, sledging was again resorted to, but it seemed as solid on the shaft as ever and refused to move. It was then decided to subject the coupling to a pressure while it was being struck with the sledge. To accomplish this, a couple of 1¼-inch bolts, a heavy cross-piece, and a jack screw were procured and arranged as shown in the engraving. The jack was tightened as tight as one man could pull it, and then, while two men did the sledging at the points shown by the arrows, one man pulled on the lever of the jack-screw. In this way the coupling was moved an appreciable amount with each blow of the sledge. It was removed slowly, of course, but with comparative ease.

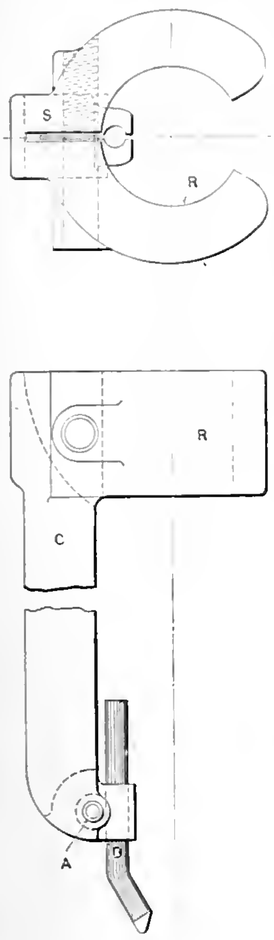
This "kink" may be familiar to some, and probably there are those who know of a better way of doing the job, but to any who have work of this nature to do and do not happen to have a better way, I can conscientiously recommend the above method, as it proved in actual practice to be effective. **T. W. H.**

[The method of removing the flange coupling, as described in the foregoing, by the application of blows from a sledge in conjunction with pressure from a jack, can often be advantageously applied in connection with work of this kind. Tight locomotive frame bolts can often be started by applying pressure from beneath with a jack, and then striking the frame, near the bolt head, a sharp blow with a sledge. The work of forcing crank-pins, locomotive driving-box brasses, etc., in place, when power presses are not available, can also be greatly facilitated by the application of this method.—Editor.]

DRILL STOP.

The appliance shown in the accompanying engraving is intended to act as a stop for the drill press when drilling holes required to be of a certain depth, using the hand feed. The feature of the device is that the stop pin *D* acts directly against the top surface of the work to be drilled, so that the depth of the hole to be drilled will always be gaged in relation to this surface. The appliance was introduced for the purpose of drilling a number of ⅝-inch holes exactly ¾ inch deep. The casting *C* is provided with an open ring *R* at the top, which is finished on the inside to fit the sleeve of the drill press. A ⅛-inch slot is sawed into the casting *C* at *S*, and a collar-head screw tightens the finished ring on the drill press sleeve. The pin *D*, at the lower end of the casting *C*, is made of ⅜-inch drill rod; the point of this pin is slightly rounded, so that it will always find its way through the chips down to the solid surface of the work. The point is adjustable up and down and is held in place by a screw at *A*. When the pin *D* is once adjusted so as to allow the drill to enter into the stock the required depth, no more attention need be given it. The point of the pin is bent so as to bring it near the drilled hole. The fixture is very cheap and simple to make, but it answers the purpose for which it is intended very nicely.

R. B. Lovejoy.



A Stop for Drilling Holes of Uniform Depth.

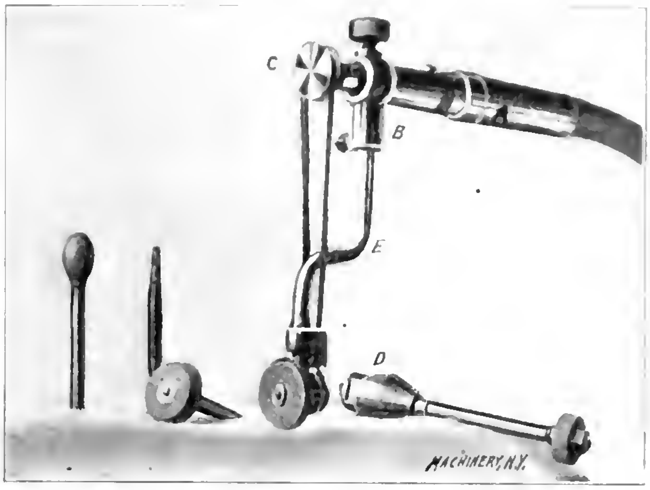
[It will be noted that this stop for the drill press differs in some important respects from such stops as may be provided right on the spindle in the form of collars, nuts, etc. When once set in relation to the drill employed, it will always prevent the drill from entering into a piece of work more than a fixed amount, inasmuch as the pin *D* stops against the top surface of the work itself. In the case of a collar or nut applied directly to the spindle, if the table be lowered or raised, the depth to which the drill will enter into the work will vary accordingly; hence the advantage of a drill stop such as illustrated.—Editor.]

ATTACHMENTS FOR FLEXIBLE SHAFT GRINDER.

The accompanying engraving shows the attachments that we use in connection with a flexible grinder, all of which will be found most convenient in any shop where steel of irregular shapes has to be worked or ground. *A* is the stationary part of the flexible shaft to which is fitted clamp *B* which holds the emery wheel extension equipped with a small pulley, as shown. On this extension and near to the emery wheel is soldered a piece of sheet metal which serves to increase the belt contact, thus preventing slipping. Slackness in the belt is taken up by adjusting the rod *E* in clamp *B*. Pulley *C* is the driver and is screwed direct to the revolving member of the flexible shaft. The belt is in one piece cut from the rawhide with a sharp knife, thus avoiding any joint.

This attachment is used principally on drop-forging dies, and with it concave surfaces can be reached and ground, that would otherwise be inaccessible. The attachment and pulley *C* can be removed and replaced by small chuck *D*, which holds the tools shown in the engraving. The two emery wheels are most convenient for grinding hardened punches and dies, or the rougher class of drill bushings that just need the high sides eased off. The burrs to the left, which are cut similar to a file, also fit chuck *D* and are used for drop forging dies. This flexible shaft is held in the hand, resembling an overgrown dentist's engine. It should run at about 3,000 R.P.M., and will save lots of hard scraping, lapping or polishing, according to the nature of the job.

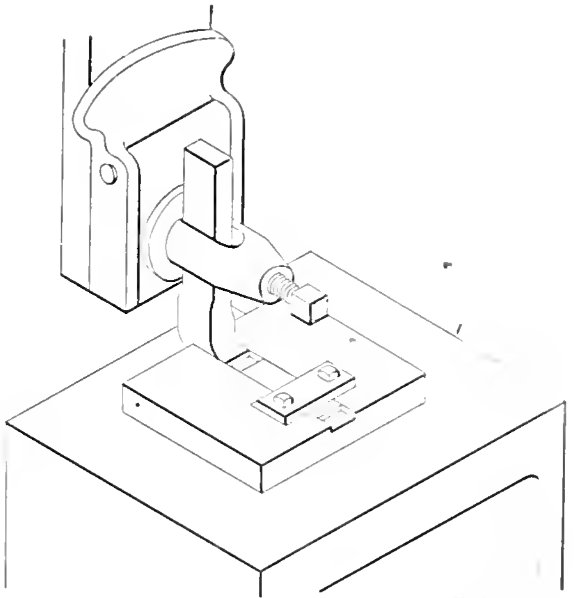
West Toronto, Canada. W. J. Thompson.



Attachments and Tools for Flexible Shaft Grinder

OLD SHAPER CONVERTED INTO A SHAVER.

An old, worn-out shaper was once put to work reducing the stock on printers' slugs, but not in the usual manner. These slugs were both of steel and of brass, some 0.083 inch and some 0.166 inch thick. The stock, as it came from the mills, was from 0.001 to 0.003 inch too large, and as these slugs were put through in lots of several thousand at a time it was no small task to bring them down to exact size. After experimenting in different ways that all proved too slow, an old shaper was converted into a "shaver," as shown in the line engraving. The block on the table was grooved 0.83 inch deep, and across one end of the groove was bolted a hardened strip of flat steel for a cutter. This strip was slightly raised



Shaving Printers' Slugs to the Proper Thickness in the Shaper

at the [illegible] end to give the slug clearance as it was passing through. The slugs were shaved as fast as they could be fed in by the succeeding pieces pushing out the previous ones so that the tool did not have to run far under the cutter and could therefore be made with a short and stiff end. Directly beneath the cutter was inserted a hardened plug furnished with means of adjustment after being ground. An occasional drop of oil on the cutting edge was necessary to prevent "lating."

When the thicker slugs were shaved the cutter was raised by putting under it steel blocks 0.083 inch thick, leaving a space 0.166 inch high. It will be noticed that one edge of the cutter is ground square and the other with a bevel face. For work on the brass slugs the cutter was reversed and the edge with no rake brought into service. **Donald A. Hampson.**

Middletown, N. Y.

[A device in which identically the same principle was made use of was illustrated in the March, 1900, issue of Machinery, and was contributed by Mr. W. A. Bright. Here drop-forged keys, which were too wide, were shaved off from 0.010 to 0.012 inch on the side.—Editor.]

MACHINE FOR GRADUATING INDEX WASHERS.

A hand-operated machine for graduating the index washers used on the screws of lathe saddles and milling machines, is shown in Fig. 1. This machine automatically indexes the work and varies the length, in this case, of every fifth and tenth graduation line as illustrated in Fig. 2. The cutting tool *A*, which is adjusted by the knurled screw *B* for dials of different diameters, is mounted on a slide *C* which is reciprocated back and forth by the handle *D*. The work is mounted on an arbor having a taper shank which is inserted in the spindle of the machine. Attached to the end of the spindle is a worm-wheel meshing with a worm on the shaft of which ratchet *E* is mounted. As will be seen in the engraving, the pawl which meshes with this ratchet is operated by tappets on the rod *F*, which is attached to the slide *C*. In this way the work is indexed for each stroke of the tool, the movement taking place on the back stroke. The lengths of the graduations are regulated by the adjustable screw *G*, which strikes against the top of the pivoted tool *A*, thus lifting it out of its cut. As the tool leaves the cut the marks are tapered to a point, and this finish gives them a very neat appearance. The lever *H* to which the stop-screw *G* is attached, is pivoted in the center, as shown. The end of this lever is pressed against a cam, by means of a flat spring, which is located just back of the ratchet wheel *J*. As the cam is rotated by means of the ratchet and pawl which connects with the rod *F*, it presents to the end of the lever *H* which presses against it, slight indentations at each half revolution, into which the end of the lever is pressed, thus varying the position of the screw *G* and changing the length of the graduation mark. This cam is rotated in such a ratio to the work, that the end of the lever sinks into a depression at every fifth and tenth stroke, and, as one depression is slightly deeper than the other, each tenth stroke of the tool is made longer, as illustrated in Fig. 2. The particular machine shown is geared to graduate the work into 250 divisions, but, obviously, different numbers of graduations could be provided for.

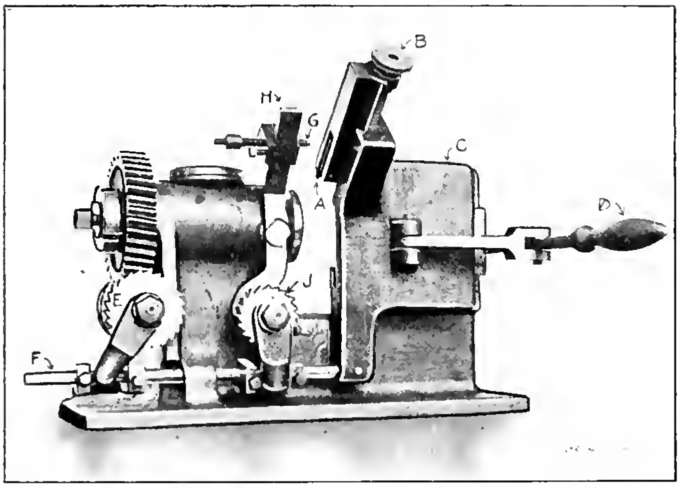
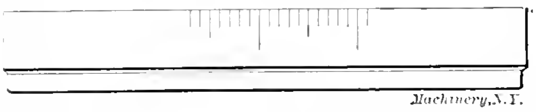


Fig. 1. Machine for Graduating Cylindrical Work.



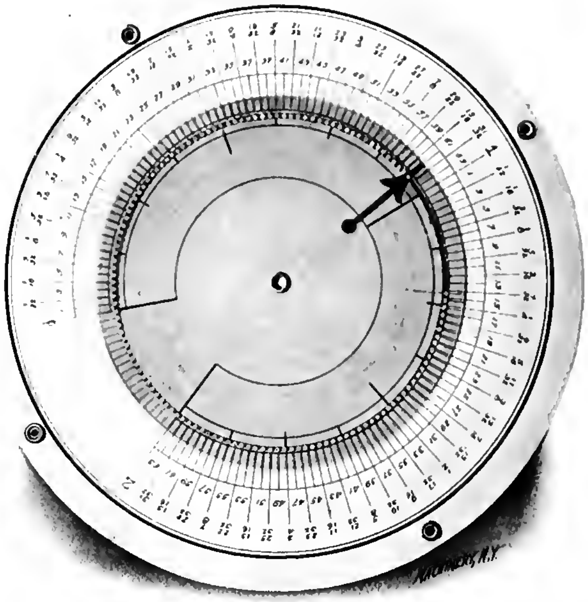
Machinery,N.Y.

Fig 2. The Lengths of the Graduating Marks are Varied, as shown, Automatically.

Keighley, England. **C. H. Caton.**

CIRCULAR "SLIDE-RULE" FOR ADDITION AND SUBTRACTION OF FRACTIONS.

The accompanying halftone shows a very useful device for use in any engineering office and for the aid of any shop man having considerable work to do in the way of checking drawings. The purpose of the device is to assist in quickly and correctly adding common fractions, and a little practice with the device will fully demonstrate its usefulness. It is made from two celluloid disks, one larger in diameter than the other, and pivoted together in such a manner that the upper or smaller disk can be moved around the center relative to the larger or bottom disk. The manner in which the larger disk is graduated is plainly shown in the illustration. Each of the small divisions represents one-sixty-fourth of an inch.



Device for Adding and Subtracting Fractions.

To illustrate its use, suppose we desire to work the following example: 5/64 + 5/16 + 1/2 + 1/16. The process would be as follows: Place the chart at your left hand with the ends of the fingers resting lightly upon the lower disk, and with the pencil in the right hand, place the point in the small hole at the arrow and move the disk around by this means until the arrow point is opposite and in line with the graduation 5/64, then hold the disk with the finger of the left hand and set the pencil in the small hole opposite zero; now again move the disk without removing the pencil from the hole until the line coinciding with this hole on the upper disk is opposite 5/16; again, hold the upper disk with the left hand and set the pencil back to zero without moving the disk; again, place it in the new hole opposite zero and move the disk around until the line coincides with 1/2; repeat the operation setting the pencil point back to zero and rotating the disk to 1/16; finally read opposite the arrow point 61/64, or the sum of the several fractions.

Any number of fractions can be added, if after the arrow has passed the point marked 1, the pencil is set in the hole opposite this point and the disk moved back to zero, which in reality deducts one whole unit from the sum of the fractions, and this point carried to the column of units, which are

added. The purpose of this device is for adding fractions only, the whole numbers being added mentally or otherwise. A fraction may be as readily subtracted as added if the operation is reversed. A column of fractions may be added and one subtracted from it without taking any note of any of the readings except the final answer. F. N. WHITESELL.

Three Rivers, Mich.

TOOLS FOR BENDING PIPES.

The articles describing pipe bending devices in the September and December issues, have been very interesting to me because they represent the very latest practice in fixtures of this kind. Especially is this true of Mr. Little's article in the December number, in which he takes pains to explain a few of the important details, the neglect of which is likely to cause trouble for a novice in this line. All of Mr. Little's suggestions are of a very practical nature, and my experience has been such as to give endorsement to them all with the slight exception of the one in which reference was made to the shape of the "business end" of the horn or mandrel. Where the wall of the tube is comparatively heavy and the radius of the bend large, it is possible to bend the pipe with a mandrel that is simply rounded on the end by a cut-and-try method, but the conditions are quite different when the material to be bent is thin brass tubing, say about 26 B. &. S. gage (0.015 inch thick). I will state my problem, describe the fixture for bending the tube, and also the method of obtaining the correct shape for the end of the mandrel.

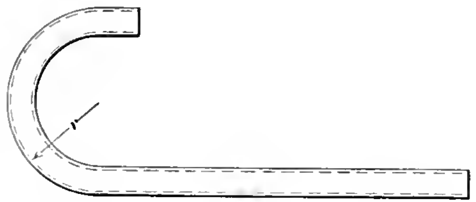


Fig. 1. Shape of the Bend produced by the Tools shown in Figs. 2 and 4.

The tube to be bent is shown in its finished shape in Fig. 1. It is used in the manufacture of a cheap inverted incandescent burner, and the output was required to be at least 2,000 per day. Subsequent polishing made it imperative that the bend should be clean, uniform, and free from any sign of buckling. The fixture shown in Fig. 2 is almost identical in construction with that shown in the December issue, and it is therefore unnecessary to describe it in detail. I was able to omit the backing block, and a slight variation in the size of the tubing made it inadvisable to continue the radius R of the swivel block beyond the center of the pipe. Inasmuch as the bend is a complete return, the pipe can be slipped off the mandrel without removing the cam-lever *D* and block *F*. In operating the fixture the tubing, having been cut to length, is slightly moistened with oil on one end and this end is slipped over the mandrel *A* to the stop collar *B*. Then, by grasping the long handle *C* and the cam-lever *D* at the same time, the tube is clamped and the bend quickly started. The bend is finished by bringing the handle *C* up to the adjustable stop *E*. While the long handle *C* remains in this position, the cam-lever *D* is opened and the bent tube is pushed off with the aid of any straight piece applied to the end which remains on the mandrel. The long handle is then brought around in position to make another bend. The method of shaping the end of the mandrel is illustrated in Fig. 3. The body of the mandrel is first finished so as to be a sliding fit in the inside of the tube. It is then centered in the chuck and formed by means of a radius tool *T*, having a radius *t* equal to the radius of the mandrel, and a compound rest set to the proper radius *r* (see Figs. 1 and 3.) As the cutting tool is swiveled about the end of the mandrel, which is held stationary, the latter is given the correct shape.

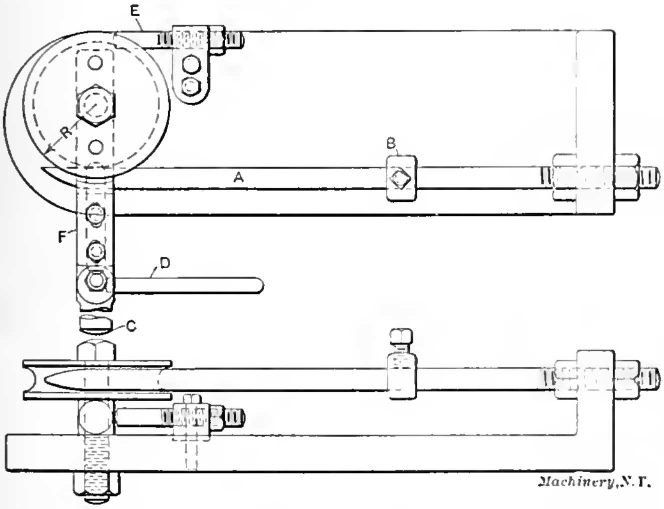


Fig. 2. Hand-operated Tool which bends Thin Tubing without Buckling.

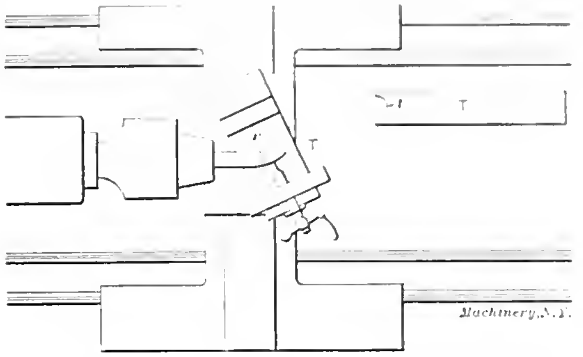


Fig. 3. Method of forming the End of Mandrel A in Fig. 2

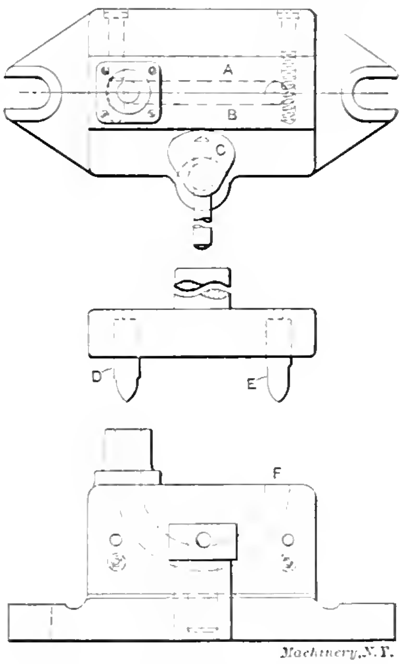


Fig. 4 Punch and Die for Forming the Bend shown in Fig 1

In connection with pipe bending devices, I wish to add a few words in corroboration of your very able editorial on Toolmaking and Manufacturing," published in the December number. There exists today among tool-makers and those having charge of laying out processes of manufacture, a very regrettable lack of knowledge and appreciation of the financial side of every proposition which comes up for consideration. To illustrate my meaning, I wish to call attention to the punch and die, illustrated in Fig. 4, for accomplishing the same results as the hand-operated fixture shown in Fig. 2. When the question of how this work was to be done came up for discussion, the foreman of the tool department (a first-class mechanic but a sad failure as a business man) was very positive about the meritorious features of the die, and the general manager and I, not having had sufficient experience in this particular line, could not, as a matter of course, offer any serious or well-based arguments against its construction. The die was made as shown, and consists essentially of two steel blocks held together by a cam *C*. A semi-circular groove of the radius of the bend was milled in the face of each block. The punch *D*, descending, pushes the straight piece of tube through the opening between the two blocks. When the operation has been almost completed, one end of the tube, slightly out of round, appears through the opening *F* in the die, and the punch *E* performs the function of giving the hole in this end its original round shape. The cam

is then released, two springs force the blocks apart and the completed article is withdrawn.

Mechanically, the die was a brilliant success and the operation itself was very interesting—so much so, in fact, that it was one of the things which was always called to the attention of visiting stockholders; but commercially it was a difficult matter to make it show a profit. You see it required that a specially-made, slow-speed, long-stroke press should be kept tied up, thus at the outset putting a big handicap on our capacity for some long-drawn brass shells, the weekly output of which was one of the main sources of the factory's income. Naturally, it was impossible to draw shells by hand, and after our good die had withstood a few days' competition with the bending machine, it was only to be expected that it would be put on the shelf, where it has been ever since. Even when the matter is figured down to a plain business basis, the balance is all in favor of the hand-operated fixture. The interest of the money invested in the press and die, the large amount of floor space occupied, the cost of power, maintenance and depreciation, were all heavy charges against the die as compared with the corresponding charges against the fixture; and above all, the accident liability, which is such a troublesome feature in all factories, was practically eliminated on this particular operation. Therefore it must not be taken for granted that everything that is new, novel, and different, will pay a good return on the money invested. HENRY J. BACHMANN.

New York City.

TURNING SOFT RUBBER.

An inquiry appeared in the December issue of MACHINERY in regard to the best method of turning soft rubber. In my opinion, there is nothing which beats grinding. If a knife must be used, it should be kept flooded with water, for as two freshly cut rubber surfaces (rubber being a homogeneous mass, i. e., when properly vulcanized) will adhere considerably if allowed to come together, a great deal of heat is also generated in parting the particles. After seven years experience in a rubber works, where a part of my duties were to weigh the various compounds, I would venture to state that the correspondent who advocates using no lubricant, has never had the pleasure of dissecting a hand of the pure upriver fine Para. He may, however, be correct in his theory about using no lubricant, when we take into consideration the article that perhaps he has been led to believe is soft rubber. The question naturally arises as to what soft rubber is. About the only pure soft rubber that I know of is found in the common rubber band. I do not say that pure, soft rubber cannot be bought, but years ago rubber manufacturers found that it was not the best to use, except for a few special purposes, such for example as linings for sulphuric acid tanks, rubber gloves for laboratory use, etc. If the rubber was white, and it is impossible to make pure white rubber, the correspondent referred to was probably cutting a compound having less than 10 per cent of a less than 90 per cent pure crude rubber, the balance consisting of the various white minerals, such as zinc, barytes, whiting, Paris white, etc., whose sulphites are white.

As one writer has suggested, it would be well to send a sample of the rubber to some reputable manufacturer of abrasive wheels, and abide by his judgment. It is not necessary, however, to buy a new wheel to grind one roll unless it is very large, as any wheel will do the work. Grind dry, but be careful that you do not have a fire—never mind a little smoke and the unpleasant odor. In the inquiry referred to, no specific information was given as to the form of the work, which is, of course, important. If, for example, rubber jar rings are to be parted, a knife is probably by far the most economical, since there is no waste; but for small rolls such as wringer rolls, for instance, for one or two, or even thousands for that matter, where a slight error in size is of no material account, sandpaper applied by hand to the roll, which should revolve at a high speed, is as economical as any. Of course, we are always governed, more or less, by our surroundings. If the piece is not too heavy to stand a high surface velocity, and where only a few slight ridges are to be taken out, with nothing but a lathe without a grinding attachment to do the work with, I would probably rough out the worst places with a file and then use a coarse garnet paper to make the roll approximately true, finishing with a fine grade of sandpaper. If a fine finish is required, it may be obtained on black rubber by the use of cocoanut butter, palm oil, linseed oil, cottonseed oil, or other vegetable oils. The oil is rubbed over the work by hand, until it is well spread, and the result is a nice-looking job, but the use of the oil is somewhat detrimental, as it has the effect of softening and destroying the rubber, more or less. For finishing white rubber, speed up the lathe and rub the work thoroughly with a little soapstone, Paris white or whiting; these latter are perfectly harmless. A. NEWTON HAMMOND.

Erie, Pa.

THE CASTING PUZZLE.

The casting shown on page 369 January number, engineering edition, was probably made by black-leading the bore of the ratchet and casting the bushing therein. Casting the ratchet about the bushing would probably split the former. I made "false-back" hose-couplings on this principle about 1874; they were subsequently patented by Allen. I illustrated them at the time in the *Journal of the Franklin Institute*. ROBERT GRIMSHAW.

Dresden, Germany.

I would like to submit an answer to the casting puzzle mentioned in the January issue of MACHINERY.

A bushing should be first cast from a separate pattern and a pattern made to represent the pawl with the bushing in place; then mold this pattern and let the flanges of the bushing serve as core prints to hold it in position. Next place the bushing in the mold in the same manner as a core or chill and pour the metal around it to make the pawl. This metal will shrink away from the bushing, allowing a little clearance and at the same time chilling the surface about the hole.

Pittsburg, Pa. WM. PFOUTS.

Referring to the casting puzzle in the January issue of MACHINERY, I should, if called upon to make a casting like the one there illustrated, make the pawl first and then machine the hole to size, taking care to make it perfectly smooth. I would then have the bushing cast in it. The pawl will act as a chill, and the iron bushing will shrink in cooling so that it will draw away from the pawl on the inside. To prevent the collars from shrinking fast to the pawl, I would insert some combustible material between the collar or flange and the pawl. The hot iron will burn this material, and after the casting is cool it can be worked out by revolving the bushing.

Windom, Kans. O. A. ANDERSON.

In the January number of MACHINERY, there is illustrated a casting puzzle in the shape of a cast iron pawl which is mounted on a solid bushing, having flanges on either end, on which it is free to rotate. As to the probable method of making this casting, I do not believe, from the foundry-man's point of view, that it would make much difference which piece was cast first—the pawl or the bushing; but, from the pattern-maker's point of view, it would be easier and more practical in making the patterns to have the pawl cast first. Then a coat of some suitable preparation could be applied to the parts of the pawl which come in contact with the bushing. Doubtless a thick coat of glue and very fine sand, supplemented by a coat of "black wash" such as molders use, would accomplish the purpose. In this way sufficient play would be obtained between the pawl and bushing, provided the casting were small, but for larger ones where the shrinkage is considerable, other methods would have to be adopted. A thin false flange of some suitable material could be used under the flanges of the bushing, while the shrinkage of the body would give sufficient clearance. H. V. B.

* * *

Calculated on the basis of present consumption, it is estimated that the available coal supply in Great Britain will last from 500 to 800 years.

SHOP KINKS.

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A HANDY PENCIL POINTER.

The illustration, herewith presented, shows a very handy instrument for a draftsman to have near his board. It is very easily turned, and ought to be of some hard wood, such as cherry. The slots *A* are gashed into the sides by a thin saw, and small wooden wedges hold emery paper in them. By making two gashes instead of one, two grades of emery paper, coarse and fine, may be used. A small eye is screwed into the handle to hang the instrument up with. The advantage of this kind of sharpener over the flat file, or flat emery paper, is the fact that the points are rubbed up on a rounded surface, which gives a point as shown in Fig. 3. This point is parallel for a short distance, which means that the point is the same for a longer period of use. Fig. 1 shows a point rubbed up on a flat surface, and it is easily seen that every stroke of the pencil makes the point thicker. F. C. DOUGLAS WILKES.

Scranton, Pa.


Fig. 1

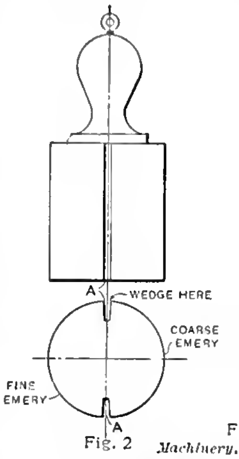


Fig. 2

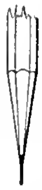


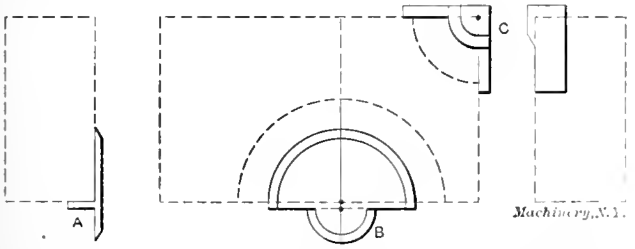
Fig. 3

Machinery, N.Y.

CENTERS FOR SCRIBING SEMI-CIRCLES FROM THE EDGE OF A BLOCK.

When it is necessary to draw a half circle on a block of metal or wood, the center of which comes on the edge of the block, the tool shown in the illustration will be found very useful, as it makes it possible always to have the center in the tool box. This tool is made of thin steel or brass and has centers which may be aligned with the edge of the block upon which the semi-circle is to be drawn. It will be noticed that there are two centers; one on each side of the perpendicular locating piece *A*. The side *B* is made smaller so that the tool can be reversed and used for drawing circles of smaller radii. The other tool shown at *C*, which is made on the same principle, is used on corners. F. A. ROSS.

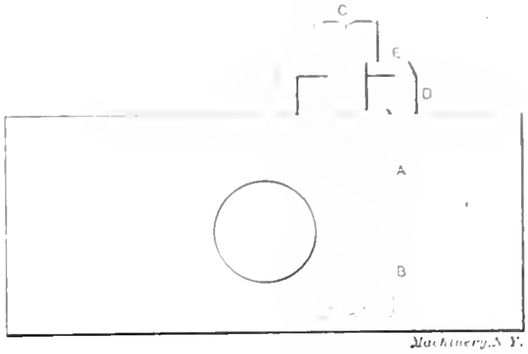
Beloit, Wis.



Machinery, N.Y.

REMOVING BUSHINGS FROM TURRETS.

In the accompanying sketch, a common form of turret tool binder is shown, which consists of two bushings *A* and *B*, located about one-eighth inch apart, and cut out to the same radius as the hole for the tool. Tightening the screw which passes through the tool bushings, draws them together, as *B* is tapped and *A* is a sliding fit on the screw. In this way the tool is gripped tightly. After considerable use, it will usually be found that the two bushings have become so worn on their working faces that they come together and do not grip the tool. Upon trying to remove them so as to file the ends, difficulty will often be met with, as the ends are usually pressed out so that they are a tight fit in the holes, and the bushings are so located that they cannot be driven out. The illustration shows a very effective way of doing this work. A screw *C* is made longer than the regular one, and in addition, three or four collars *D* and one washer *E*. It is obvious, by referring to the sketch, that tightening down on the screw *C* will draw the bushings up. When *A* comes into contact with the washer *E*, the screw *C* can be removed, a thicker collar *D* put on, and the operation repeated until the bushings are out of the hole. In case there is only one bushing, as *A*, the binding screw working right in the solid metal as in some of the older types of machines, tap in the bushing *A*, and proceed to draw it out as described. PAUL W. ABBOTT.

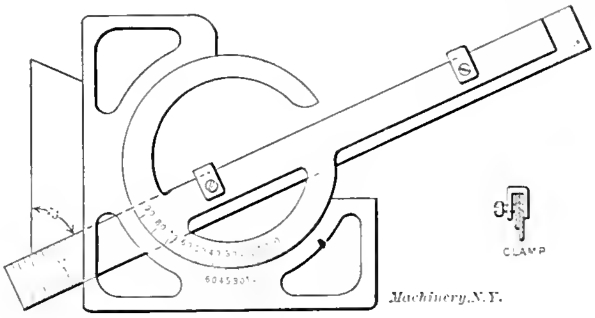


Machinery, N.Y.

Wilkes-Barre, Pa.

EXTENSION FOR DRAFTSMAN'S PROTRACTOR.

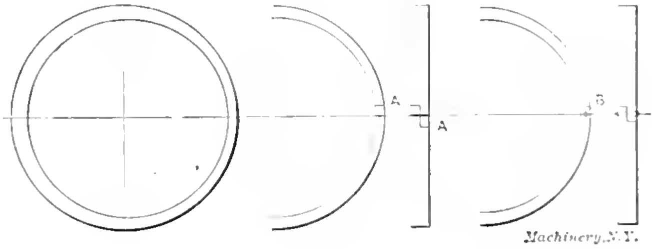
While the well-known draftsman's protractor, shown in the engraving, was no doubt designed to be used solely for drawing, it also has another use quite as helpful. If a scale is clamped to the blade as shown, it is adapted nicely for measuring or laying out angular pieces, which the draftsman often has to do. Although the scale can be used in many cases, a straight-edge, beveled at the end, could be used, perhaps, to better advantage, as it would permit getting into recesses where the scale could not be placed. As the vernier is graduated to read to 5 minutes, very accurate measurements can be made when necessary. C. E. J.



Machinery, N.Y.

METHOD OF MAKING PISTON RINGS.

The following is a brief description of a method of making piston rings, which may interest the readers of MACHINERY. First, the ring is roughed out and bored slightly eccentric, as shown in the illustration. The lap joint is then milled, as shown, the portions *A A* being removed on the thin side, after which the ring is clamped together and held with a small pin *B*, made of drill rod. The ring is next bored to the exact size desired, and then put on an expanding arbor and finished outside, care being taken to preserve the eccentricity. With this method, a ring can be made that is almost perfect, and one which is well adapted to gas engines. W. E. MOREY.



Machinery, N.Y.

Chicago, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

[illegible] and name and address. The latter are for our own convenience and will not be published.

The following questions are referred to the readers.

L. S.—I wish to cast a 1/16-inch wall of rubber around a piece of sheet metal 1/32 x 3/4 x 3 inches long. What process is used to make rubber flow into narrow cavities?

L. B. D.—Please publish a table giving the proper proportions of steam whistles in all commercial sizes; also the same data for steam sirens.

K. A. T.—What is the practice followed in regard to shape of tools and grade of steel for grooving chilled cast iron rolls used in flour mills? What is the common cutting speed, and how are the rolls prepared for the grooving operation?

J. W. F.—Can you give me information regarding the bending and forming of fiber sheets 3/16 to 1/4 inch thick? We have been experimenting considerably, but cannot obtain satisfactory results. We soften the fiber by steam, but if we make it soft enough to form a square corner it splits up; and if it is not softened so that it splits, it breaks in making the desired bend.

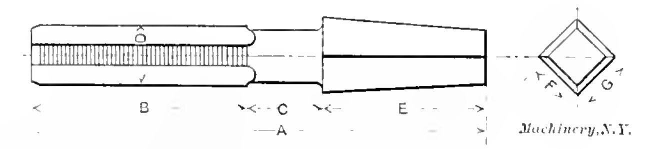
C. L. L.—Can you give me a good formula for a bluing compound, like that used by gun manufacturers for bluing the steel parts of revolvers, etc.? I have a formula which calls for 2 parts crystal chloride of iron, 2 parts solid chloride of antimony, 1 part gallic acid and 4 or 5 parts water. An expert chemist declined to fill it, saying it was not a practical formula, *i. e.*, the ingredients would not properly mix.

DIMENSIONS OF BIT-BRACE TAPS.

S. C.—What are the dimensions commonly used for bit-brace taps? Are the shanks of all bit-brace taps made the same, and what is the commonly used size of the taper square shank?

A.—Below will be found a table giving the dimensions generally employed by tap manufacturers in making bit-brace taps. Two sizes of shanks are generally used, the smaller size being employed for taps up to ½-inch diameter, and the larger size for taps ½-inch in diameter and larger. While some tap manufacturers list these taps up to ¾-inch size, they are not commonly used larger than ½-inch diameter, and it is evident that to tap a ¾-inch hole with a bit brace would be rather a laborious job. The taps are usually provided with four flutes. The shanks may be milled to size, in which case no further finish is required. In most cases, however, tap manufacturers forge the shanks to size and then simply grind or file off the fins or burrs. These taps are not made in sets of taper, plug and bottoming taps, the same as hand taps, but the chamfer on the end of the taps is made similar to a plug tap chamfer.

TABLE OF BIT-BRACE TAPS.

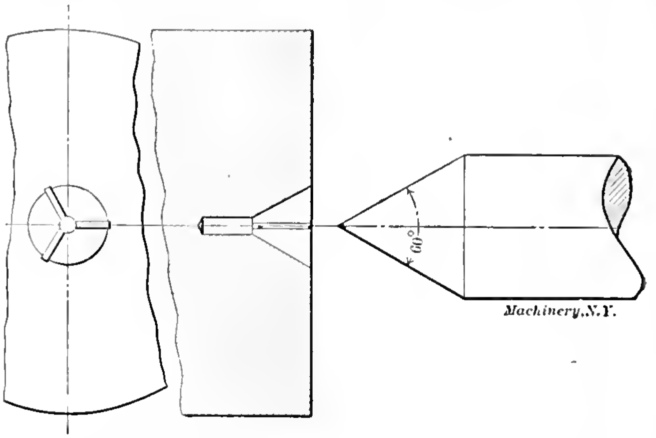


Diameter of Tap.	Total Length.	Length of Thread.	Length of Neck.	Length of Shank.	Size of Square, Small End.	Size of Square, Large End.
D	A	B	C	E	F	G
3/16	3 1/4	1	1	1 1/4	7/32	11/32
1/4	3 3/8	1 1/16	1 1/16	1 1/4	7/32	11/32
5/16	3 1/2	1 1/8	1 1/8	1 1/4	7/32	11/32
3/8	3 5/8	1 3/16	1 3/16	1 1/4	7/32	11/32
7/16	3 3/4	1 1/4	1 1/4	1 1/4	7/32	11/32
1/2	3 7/8	1 3/8	1 1/4	1 1/4	1/4	7/16
9/16	4	1 1/2	1 1/4	1 1/4	1/4	7/16
5/8	4 1/8	1 5/8	1 1/4	1 1/4	1/4	7/16
11/16	4 1/4	1 3/4	1 1/4	1 1/4	1/4	7/16
3/4	4 3/8	1 7/8	1 1/4	1 1/4	1/4	7/16

LUBRICATING GROOVES IN CENTERS OF HEAVY LATHE WORK.

W. U.—Having a cast iron cylinder weighing about 600 or 700 pounds to turn in a lathe I filed three grooves in the centers with a small square file, as shown in the accompanying illustration. These grooves were filed for lubricating the centers, and is a practice that I have followed very successfully, never having any trouble with centers cutting or squealing. A shopmate says he would not follow the practice as a cylinder turned with grooves cut in the centers, as shown, will be slightly out of round at points corresponding to the location of the grooves in the centers. Is his contention sound?

A.—Undoubtedly the narrow grooves cut in the centers do have a slight influence on the roundness of the work turned, but if the grooves are cut narrow, the influence would be so slight as to be practically negligible except, perhaps, for calendering rolls or other work requiring a highly accurate surface. No doubt the practice saves much trouble when turning long, heavy shafts, as thorough and constant lubrication is possible. The objection to cutting grooves in the work can be met by grooving the lathe tail-stock center, one groove being placed in a position midway between the horizontal and vertical planes so as to permit the oil to run into the bearing and still avoid the slight reaming action that might follow placing the groove at the top. Cutting spiral grooves in the work centers might overcome all objections.



Lubricating Grooves in Centers of Heavy Lathe Work.

* * *

The different spirit in Europe and America in regard to peaceful achievements and destructive policies of warfare is hardly ever better exhibited than by the manner in which advances in science and industry are commented upon in the old and the new world. Whenever some epoch-making invention has been made in Europe the European press, both the daily and the engineering, first of all consider what influence this invention may have on military developments; and it seems as if the whole purpose of existence, in the opinion of a large majority of editorial writers abroad, is merely to excel in military achievements. In America, on the other hand, the first consideration is what influence the new invention will have on the peaceful industries of the country. Perhaps it is laregly due to this fact that the industrial progress of the United States has made such rapid strides. Of late, the tendency has been, more than before, to introduce the European military idea in the United States also; but it is to be hoped that any such tendency will be ephemeral, and that in this country industrial progress will never be considered merely as an incident in the perfection of military armaments.

* * *

The latest record to be broken by Wilbur Wright and his aeroplane was that for distance. On December 31st, 1908, he made a continuous flight of 76.5 miles, in 2 hours, 9 minutes and 33 seconds, giving a speed of about 35 miles an hour. This flight was made for the Michelin prize of $4,000 cash, and a $2,500 trophy.

* * *

Maple is recommended by the *Practical Engineer* as the best material for wood pulleys. A pulley made of maple, forty-six inches in diameter by sixteen inches face, was successfully run at a speed of 2,400 revolutions per minute, which is equivalent to a peripheral speed of 5½ miles per minute.

THE PASSING OF THE SHARP V-THREAD.*

Nearly forty-five years ago the Franklin Institute of Philadelphia recommended the Sellers screw thread system for general adoption in the United States, as the United States standard thread. Over forty years ago this system was authorized for the naval service by the Secretary of the Navy, and soon afterwards the system was adopted by the Master Mechanics' Association and the Master Car Builders Association. Nevertheless, the engineering profession has been slow to adopt universally the U. S. thread, and in spite of its shortcomings, the sharp V-thread has been, and still is, used to a considerable extent. It is evident that for the purpose of standardization, the use of two systems of threads where one would be sufficient, is undesirable; and in the case of the sharp V-thread its use is all the more objectionable because a "standard" sharp V-thread does not exist. The shortcomings of the sharp V-thread have been referred to several times in MACHINERY; and the fact that various tap manufacturers have each a different "standard" for V-threads was pointed out, in particular, in an editorial in the engineering edition, October, 1906, entitled "The Flat on the Top of Sharp V-Threads," and also in an article on "Screw Thread Systems" in the February, 1908, issue. The subject has also been referred to in other publications, and a thorough treatment is given in "Hand-Book of Small Tools," by Erik Oberg, pages 8 to 14, inclusive.

For a number of years the tap and die manufacturers in the United States have been considering the advisability of discontinuing the regular manufacture of taps and dies with sharp V-thread. An agreement has now been reached to this effect. The causes which have been active in bringing about this decision may be best set forth by quoting from our editorial in the October, 1906, issue of the engineering edition:

"While theoretically the sharp V-thread is not flatted on the top of the thread, it has, on account of practical reasons, become necessary to provide this kind of thread with a slightly flatted portion. In the first place, it is very difficult to produce a perfectly sharp edge on the top of the thread, and, in the case of a tap, the sharp edge would be very likely to be impaired in hardening, leaving the top of the thread less perfect than if provided with a slight, uniform flat. In the second place, the sharp edge would wear away very rapidly both in the case of a tap and a screw, and as the wear could not be expected to be uniform, the ultimate result would be far less desirable than the one obtained by slightly flatting the top of the screw from the beginning.

"For the reasons mentioned it has always been the practice of tap manufacturers to provide the top of the thread on V-thread taps with a slight flat; but as a standard outside diameter always had to be maintained, the diameter in the angle of the thread had to be increased. This has caused difficulties, inasmuch as there has been no established standard as to *how much* of a flat the thread ought to be provided with; the various manufacturers have each had their own practice in this particular. The result has been that the gages from one firm have not corresponded to the taps manufactured by another, and many customers, not familiar with the reasons for this confusion, have questioned the correct sizes of gages as well as taps. The question has been still more confusing on account of the fact that many manufacturers did not have even a certain standard for all taps manufactured by them, but working to their old-established gages, they often produced large taps with smaller flats on the top of the thread, proportionally, than the flats on smaller taps.

"In order to overcome the difficulties arising from the facts mentioned, we understand that the tap manufacturers are endeavoring to establish a standard flat for the top of sharp V-threads. While, as far as we know, nothing has been definitely agreed upon as yet, there seems to be opinions favoring a flat equal to one-fifteenth of the pitch. This is a greater flat than has hitherto been employed by some leading tap makers. Some have used the same flat for the V-thread as is used for the Brigg's standard pipe tap thread, which, although theoretically rounded at top and bottom, is, in this country at least, made with a small flat on the top of the thread. The width of this flat is selected so as to give exactly the same angle diameter as is obtained when rounding the top of the thread in accordance with Briggs's original proposition. This flat is equal to about one-twenty-fifth of the pitch."

Apparently the various tap and die manufacturers failed to agree upon a definite standard for the flat on the top of the V-thread so as to establish what would have been an exact *standard*, and therefore the discontinuing of the manufacture of taps and dies with this thread has been agreed upon.

As an example showing how the gages for V-threads of different manufacturers vary, the following figures giving the pitch diameter of a $\frac{3}{4}$-inch tap, 10 threads per inch, as made by ten manufacturers, may be cited. The following are the ten pitch or angle diameters: 0.6702, 0.673, 0.671, 0.6731, 0.6715, 0.671, 0.6711, 0.6715, 0.677 and 0.671. The theoretical pitch diameter is 0.6634.

For a 2-inch gage, with $4\frac{1}{2}$ threads per inch, the pitch diameters of eight manufacturers are as follows: 1.8219, 1.818, 1.833, 1.8176, 1.8187, 1.8197, 1.828, and 1.831. The theoretical pitch diameter in this case is 1.807. It will be seen that in this case a difference of approximately 1/64 inch exists between the gages of two of the manufacturers.

In view of this condition it is clear that it would be advantageous for the manufacturers and the users alike to discontinue the use of the sharp V-thread. It is also clear that the discontinuing of the use of the V-thread is a better solution of the difficulty than the standardization of the thread; because the latter would involve a change in the present practice of all the manufacturers, and during the transition period the standardization would create quite as many serious difficulties as the adoption of a practically new standard. In fact, it seems that it is easier to abandon the sharp V-thread entirely than to try to force a somewhat different standard of the same thread on the trade. As the U. S. standard form of thread fills the requirements of a desirable screw thread so much better than the sharp V-thread, it is to be expected that the majority of the present users of the latter will cheerfully accept the change, and aid the tap manufacturers in their commendable effort of establishing *one* standard. A rapid acceptance of the U. S. standard in place of the V-thread is all the more likely to take place, because the manufacturers propose to charge special prices for V-thread taps and dies, as well as for tools with the old machine screw thread, the place of which latter will be taken by the A. S. M. E. standard for machine screws.

A fact that will be useful to know in making the change is that the pitch diameter of the U. S. standard thread is somewhat larger than the pitch diameter of the sharp V-thread, so that a V-threaded hole can be re-tapped by a U. S. standard thread tap.

* * *

TREND OF AUTOMOBILE DESIGN.

An analysis of the cars of the exhibit at the last Madison Square Garden Automobile Show, made by the *New York Times*, is of interest, giving as it does the general trend of design and use of motor cars. There were on display 117 complete gasoline cars, 28 gasoline chassis, 19 motor business wagons, 5 motor business chassis, 3 taxicabs, 6 steam cars, 1 steam chassis, 37 electric carriages, and 5 electric chassis. A great majority of the gas engines had water-cooled cylinders, there being 138 water-cooled, and 7 air-cooled. The four-cycle type of engine was in the majority; there were 140 of the four-cycle type and only 5 of the two-cycle type. In cylinder construction there was considerable variety, there being 25 six-cylinder models, 116 four-cylinder, 3 three-cylinder, and 1 single cylinder. Of these, 96 were in pairs, 41 were cast separately, and 6 *en bloc*. The jump spark ignition was used on 125 cars and 20 cars had the make-and-break system; 48 of the cars used the double-jump spark system, 56 the dual, and 21 the single system. In clutches the cone and multiple-disk were equal, each type being used on 56 cars. On the remaining cars, 22 used the expanding clutch and 10 the contracting type. The selective gear was the most popular in transmission devices, 121 using the selective and only one using the planetary system.

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* The following articles relating to screw-thread systems have been previously published in MACHINERY: Whitworth *vs.* Sellers Thread, May, 1899; Screw Pitches in Foreign Countries, February, 1900; Screws, September, 1903; Proposed Standards for Machine Screws, June, 1906; British Standard Fine Screw Thread, October, 1906; The Flat on the Top of Sharp V-Threads, October, 1906, engineering edition; Automobile Fine Screw Threads, November, 1906, engineering edition; Standard Proportions for Machine Screws, December, 1907, engineering edition; Screw Thread Systems, February, 1908. See also MACHINERY'S Reference Series, No. 31, Screw-Thread Tools and Gages, page 3; Screw-Thread Systems.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

BICKFORD & WASHBURN TAP THREAD MILLING MACHINE.

In the article on The Manufacture of Taps in the January, 1909, issue of Machinery, was shown an engraving (Fig. 6) illustrating the method of threading and relieving tapered taps by milling. This method of cutting taps has been used for many years, special machines having been built by tap manufacturers for the purpose. The firm of Bickford & Washburn, Greenfield, Mass., has now for the first time placed a machine of this type on the market for general use in tap manufacturing. It is the design of Mr. O. S. Bickford, who has had many years experience in tap manufacturing. It has been his aim to incorporate in this machine such improvements and adjustments as will fit it for a wide range of work in general use.

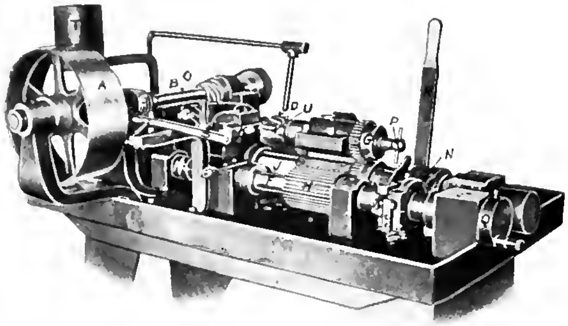


Fig. 1. Mechanism of the Bickford & Washburn Tap Machine.

Briefly, the operation of the machine is as follows: The milling cutter *D* is cut with circular (not helical) grooves of the cross section of the desired tap. This cutter is fluted helically to give a smoother cutting action than would be possible with straight flutes. This cutter revolves continuously. The tap *U* is mounted in front of it, parallel with it if a straight thread is being cut, and at a suitable angle in the case of a taper thread. The tap revolves slowly at a feed suitable for the cut being taken. It is moved forward as it is revolved by a lead-screw geared to the pitch of the thread. The blank is fluted previous to this threading operation, to permit the machine to be arranged for relieving as well. For relieving, mechanism is provided which moves the tap in as the cutting action approaches the heel of the land, and brings it out again to the full diameter when the hob starts in again on the next cutting edge. The arrangement of mechanism provided for giving these movements, will be understood by reference to the accompanying engravings and the following description.

The driving pulley is shown at *A*. This is connected to the driving shaft *B* by a clutch which is automatically disconnected at the completion of the work. This clutch may be operated by hand lever *S*. Coarse pitch spiral gears, one of bronze and the other of steel, connect this driving shaft with the cutter spindle *C*, on which the hob *D* is mounted. This spindle has a taper front bearing with a large collar for end thrust. The rear bearing is of the tapered and split bushing type, adjusted by threaded collars at each end. The cutter or hob, as is shown more plainly in Fig. 2, is carried on a short stiff arbor supported at its outer end. This rigid mounting permits the taking of very heavy cuts without vibration. The whole of this hob driving and carrying mechanism is mounted on a slide which may be adjusted in or out to suit the diameter of the work, though a fine adjustment for accurate sizing is provided in addition to this, as will be explained later.

The rotary feeding movement of the blank is obtained from the driving shaft through worm gearing *E*. The vertical worm-wheel shaft in turn drives (through a second set of worm-gearing) a short shaft which is connected by change gears (not visible in either illustration) with the camshaft *F*. The gears provided at this point give five changes of feed. One of the principal functions of shaft *F* is to revolve the work and feed it forward to agree with the pitch of the thread being cut. To permit this movement, the work *U* is driven from its squared end by work spindle *G*, which is in turn connected by the gears shown with driving gear *H* on camshaft *F*. Spindle *G* is mounted in an adjustable head clamped to bar *J*, which forms the real carriage of the machine. The outer end of the blank is supported by a center in slide *K*, also held in a second head on bar *J*. The axial movement is given this bar and the work which it supports by a short lead-screw at *N*, which, through the split nut at *L*, controls a yoke on shaft *J*. It will thus be seen that as camshaft *F* slowly revolves, the work is revolved in unison and fed forward at the same time by lead-screw *N*, which is made of the same pitch as the work.

Besides having this axial movement, bar *J* and the work holding members may be rocked about the bearings of the bar to bring the work closer to the hob or further from it. This movement is controlled by a series of cams *M*, any one of which may be brought beneath the point of adjusting screw *O*. These cams have four lobes for four fluted hobs, three lobes for three fluted hobs, etc. The point of screw *O*, which is seated in the tail center head, bears on the cam surface, and rocks the work in and out from the cutter to give the desired relief. Screw *O* is also used for the fine adjustment for the diameter, being provided with a graduated dial for that purpose. Weight *T* keeps the point of *O* in contact with the cam.

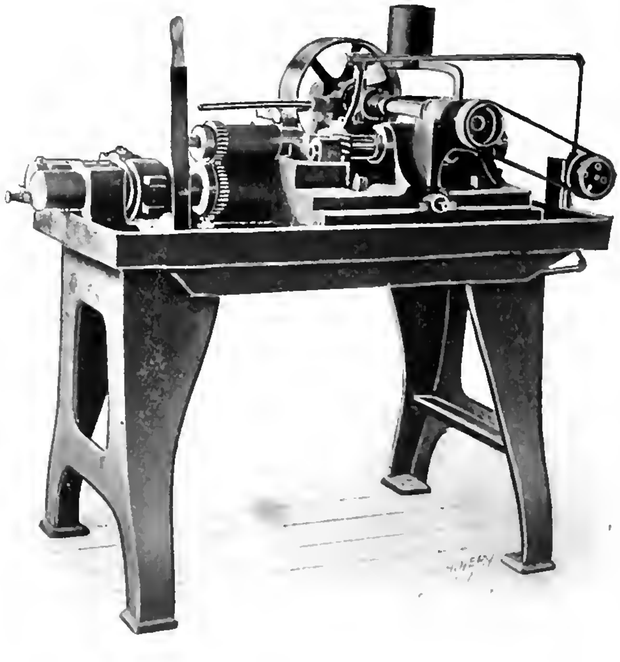


Fig. 2. A Machine for Threading Taps with a Hob.

The tap being cut is driven by a dog in the front end of work spindle *G*. Provision for cutting taper taps is made by adjusting tail center *K* crosswise, a fine screw movement being provided for this purpose. The other center is the point of screw *P*, which forms part of the work spindle and is readily tightened. The lead-screw *N* is so attached as to be readily removed for changing from one pitch to another.

In the operation of the machine, the split nuts *L* are first opened allowing bar *J* to be drawn back by lever *R*. The nuts are then closed, the finished tap is removed, the new blank is inserted, and the clutch lever *S* is thrown over, starting the machine again, which completes the new tap and stops itself ready for another blank. The operation in the case of ¾-inch pipe tap requires about three minutes.

The machine is also arranged for threading the hobs *D* which it uses as cutting tools. For this work an ordinary V-milling cutter is used, of the proper shape for the thread. One groove at a time is cut in the hob blank. At each revolution the machine stops and the operator indexes the work ahead by hand to the next groove. The lead screw is free from the influence of the feeding mechanism, and is operated by the knurled index pin in disk *Q*, which seats in a taper hole in the bed.

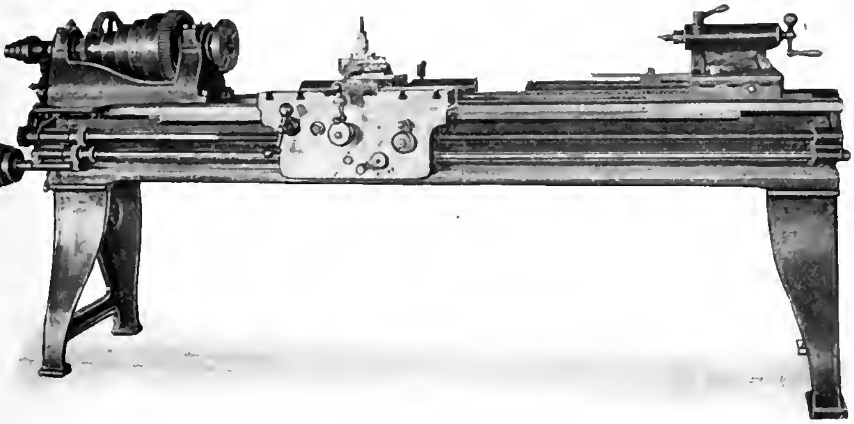
The regular equipment of the machine, so far as the movable parts are concerned, consists of a full set of extra lead screws and nuts, and the dogs necessary for driving the sizes of taps as required by the range of the customers' work; depending on whether right- or left-hand taps are to be cut, and whether Briggs standard or Whitworth shapes and sizes are to be used.

The first machine of this type has been in use for some time and is giving, so the builders state, complete satisfaction to the purchaser. It is threading 2-inch pipe taps at the rate of one hundred per day.

MIAMI VALLEY 15-INCH STANDARD ENGINE LATHE.

The Miami Valley Machine Tool Co., of Dayton, O., has added to its line the 15-inch standard engine lathe shown herewith. Particular attention has been paid in this lathe to giving a strong rigid construction, which will permit heavy cuts without chattering or vibration. The head-stock is massive and has long spindle bearings, bushed with phosphor bronze. The spindle is of high-grade crucible steel, bored with a 1⅜-inch hole. The cone pulley has five steps for a 2¼-inch belt, and the back gear ratio is 9.6 to 1.

Among the conveniences of the carriage is the provision made for reversing the feed in the apron, as well as in the head-stock. The feeds are so arranged that it is impossible to throw in the screw and feed rod motions at the same time. A positive geared feed is provided, obtainable from a connection of the feed rod with the lead-screw. This is in addition to the four belt feeds, which range from 50 to 150 turns per inch. A chasing dial is provided to permit threading without stopping or reversing the lathe.



Miami Valley 15-inch Standard Engine Lathe.

The price includes follow and steady rests, change gears, large and small face-plates, double friction counter-shaft and wrenches. The lathe is equipped with a compound rest, but a plain rest will be substituted if ordered. The lathe has an actual swing over the bed of 16½ inches. It will weigh approximately 1,600 pounds with a 6-foot bed.

ACME GAS-ENGINE AIR COMPRESSOR.

The gas-engine-driven air compressor shown herewith is an unusual example of neatness and compactness in design, made possible by combining two separate units in one machine. This apparatus comprises a 5-inch by 5-inch 4 H.P. gas engine and a 5-inch by 5-inch air compressor cylinder, mounted in one frame, and with all parts conveniently arranged for inspection and repair. It is built by the Acme Mfg. Co., Bradford, Pa.

The two cylinders form one solid casting with the valve chambers and the upper half of the crank case. This casting is made of fine gray iron, and has an ample water jacket cast integrally with it, serving for both the gas engine and air compression cylinders. The pistons are duplicates, of the usual gas engine type; they are very light and extra long, and the rings are placed well to the top. Oil grooves on the lower face of the piston ensure even distribution of the oil thrown against it when exposed at the lower end of the stroke. A flywheel is mounted on each end of the gas engine shaft. They are carefully balanced and of ample weight. The crank-shafts are duplicates except in the matter of length, and are made of a tough, mild open-hearth steel, forged in one piece from the solid billet. The connecting-rods and other parts are also duplicates.

A Gas-engine-driven Air Compressor of Simple Design.

One of the features that allows simplification of the mechanism, is the gearing of the engine crankshaft with that of the compressor in the ratio of two to one. This allows the two members to work at suitable speeds for each, and at the same time permits the use of the compressor crankshaft as a lay shaft for operating the valves of the gas engine. The gears are cut from forged steel blocks and are designed with a factor of safety of ten. They run in a bath of oil, so that the loss of power is negligible. The valves and stems are of special nickel steel drop forgings formed in one piece and carefully turned. They operate vertically, and their stems are guided in long bushings, giving great durability of alignment. The inlet valve area of the compressor cylinder is 35 per cent of the piston area.

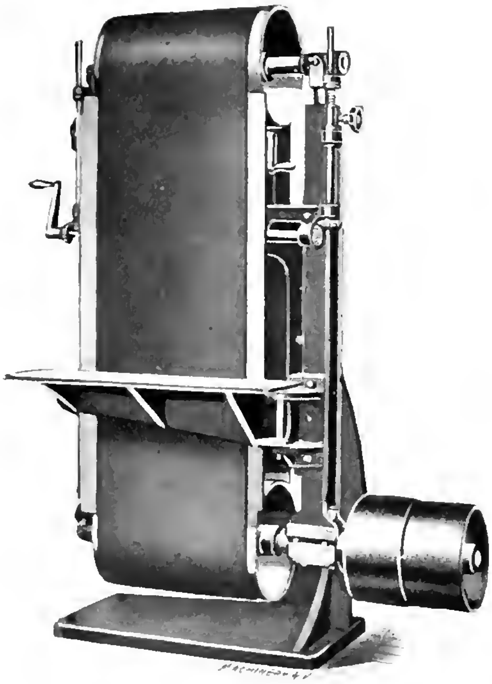
The advantages of this arrangement may be summed up as follows: compactness of design; simplicity and consequent low first cost; thorough lubrication of all working parts from the oil bath in the crank case; vertical mechanically operated valves; rigid cylinder castings and frame; removable long bronze bushings for the shafts, with ring oiling bearings; easy access to the valves; quietness of operation; availability for use under any conditions, with natural, producer or illuminating gases, gasoline or denatured alcohol as a fuel. In

order [illegible] purchaser should state the fuel it is proposed to use.

An [illegible] device, adjustable for different pressures, will be provided if it is desired to maintain a given pressure in the receiver. This allows the engine to be operated continuously. High efficiency is assured by the careful design, the high compression obtained, and the large and freely moving valves. The machine has a capacity of 17 cubic feet of air per minute at a pressure of 250 pounds. It weighs 600 pounds completed.

GILMER IMPROVED VERTICAL BELT SANDER AND POLISHER.

The L. H. Gilmer Co., 501 Arch St., Philadelphia, Pa., is well known as the maker of the Gilmer endless belt, which was first described in the New Tools department of the October, 1905, issue of MACHINERY. The use of these belts for polishing and similar purposes has resulted in the design by this firm of the vertical belt sander and polisher shown herewith. This is so constituted as to run successfully at a belt speed of 4,000 feet per minute, without heating the bearings or causing appreciable vibration. The work is supported by a swinging table, which may be adjusted to any convenient level to suit the work in hand. This supports the weight of the part being polished, so that the operator is free to guide the work with as much care as may be required.



Endless Belt Sander and Polisher for Wood and Metal Work.

By means of double screws and bevel gears the tension of the belt is adjusted from one side by a single crank. This adjustment keeps the shafts always in line, so that the belt is in no danger of being thrown off. Various special appliances for special work may be used. One of the most useful of these is the provision made for fastening felt or other backing to the machine plate, thus giving a cushion which is very effective for some kinds of work. The working surface is 18 by 24 inches. The bearings are dust-proof and of solid construction. While the machine runs regularly at 4,000 feet a minute, it is tested thoroughly at a speed of 5,500 feet. It may be used as a sand belt for wood-working or (with proper abrasives) for metal finishing.

WEISS REVOLVING WRENCH.

The instrument illustrated in Figs. 1 and 2 should perhaps be called a parallel jaw plier rather than a wrench, if strict definitions are to be followed, but the revolvable feature included in the construction fits it so well for use as a wrench on all parts of work and in all sorts of places, that the title "revolving wrench" is decidedly appropriate. The tool is the invention of Mr. Karl Weiss, 118 Cherry St., Waterbury, Conn.

Fig. 1 is reproduced from a photograph of the tool, and Fig. 2 shows details of its construction. Jaws *A* are guided in suitable slots in the body bushing *B*. In this latter member is mounted a pivot *C*, which carries two gear segments *D*, whose teeth mesh with rack teeth cut on the inner edge of jaws *A*. The longitudinal movement of a thrust bushing *E* presses it against the ends of segments *D*, and rotates them about pivot *C*, thereby closing the jaws together. This longitudinal movement of *E* in the direction of the axis of the tool is effected by gripping the handles *F*, which are thereby rotated about their fulcrums *G*, causing their inner ends to press against *E*. When the grips *F* are released, the coiled springs shown attached to segments *D* open the jaws and the handles again.

Body bushing *B* and the jaws *A* which are mounted in it may be revolved with relation to the handles. The fulcrums *G*, which are cast solid with the handles, bear against the inner end of a sleeve *H*, threaded to *B*. When jaws *A* and bushings *B* and *H* with their contained parts are rotated in relation to the handles, the latter remain stationary along with bushing *J* which supports *E*. When the handles are tightly gripped and the jaws close on the work, the parts are locked against revolving owing to the heavy thrust of pivots *G* against *H*. This makes of the tool an automatic wrench for turning in either direction. In screwing in a nut, for instance, it is tightly gripped between the jaws. This gripping locks the tool, so that the twisting of the wrists turns the nut. A slight release of the pressure loosens the contact between *G* and *H*, and allows the wrists to be twisted back again for a fresh grip. The tightening again locks the tool, so that another turn may be given the nut—all of which is done without removing the jaws from their contact with the work.

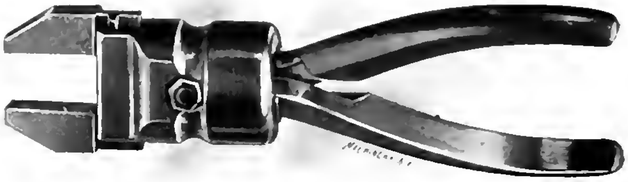


Fig. 1. The Weiss Combined Parallel Pliers and Revolving Wrench.

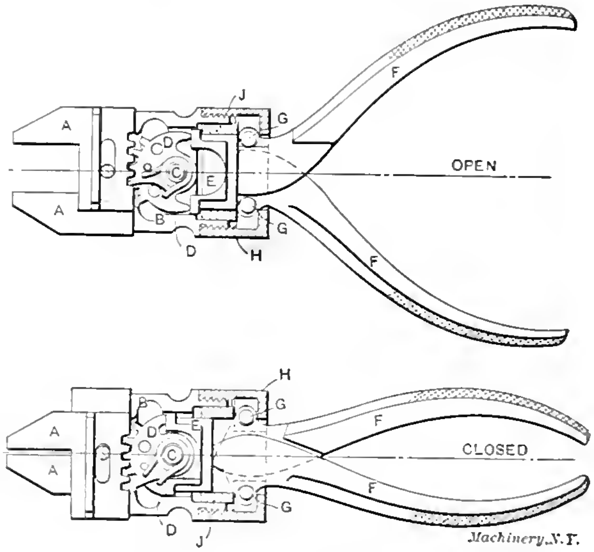


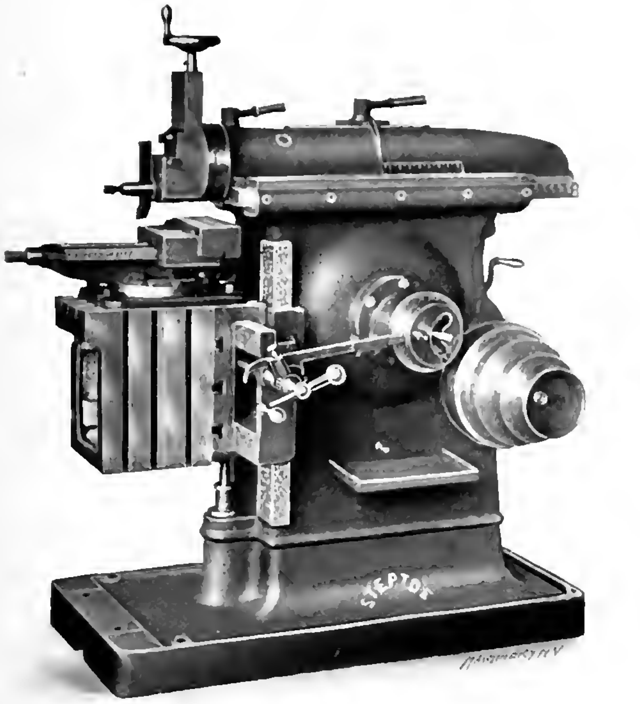
Fig. 2. Details of the Construction of the Tool.

An ordinary ratchet wrench will not reach in every hole or corner where there is a nut or screw to be tightened. This tool will reach and stay on, giving the operator a chance to rotate the part by the very smallest amount required in a corner, or by the full swing of the hand where that is possible. It does not require a new grip for each one-quarter turn, as with the common parallel pliers. It follows the quickest motion of the workman's hand without loosening the grip on the work or requiring a change of hands.

STEPTOE 16-INCH CRANK SHAPER.

The illustration shows a newly designed back-geared crank shaper made by the John Steptoe Shaper Co., of Cincinnati, O. This design incorporates a number of improvements, among them being a stiffened form of base, a clamping arrangement for the tool-head, and convenient and durable feed mechanism.

The base of the machine on the operating side is strengthened by a basin-shaped brace of thick section. The whole of the base casting is made very heavy to avoid vibration, and consequent unsteadiness of cutting action. The shaft bearings are provided with press-fitted, cast iron, ring oiling bushes. The rings are made of wide strips of brass, giving a much more liberal supply of oil than when wire rings are used. The back gears are operated by a lever at the back of the column within easy reach of the operator. The driving gears are of a high grade of phosphor bronze.



An Improved Design of the Steptoe Crank Shaper.

The ram is strongly ribbed and heavily braced. The head can be instantly loosened and swiveled to any angle by pushing the lever seen at the back of the head. Pulling the lever forward again clamps the parts together. No wrenches need to be used for this adjustment, thus saving time and annoyance. The change in the length of stroke is controlled by a lever projecting through the feed plate, which can be operated when the machine is in motion. The adjustment in the bull gear is self-locked, being held firmly in position as soon as the adjustment lever is taken off the shaft.

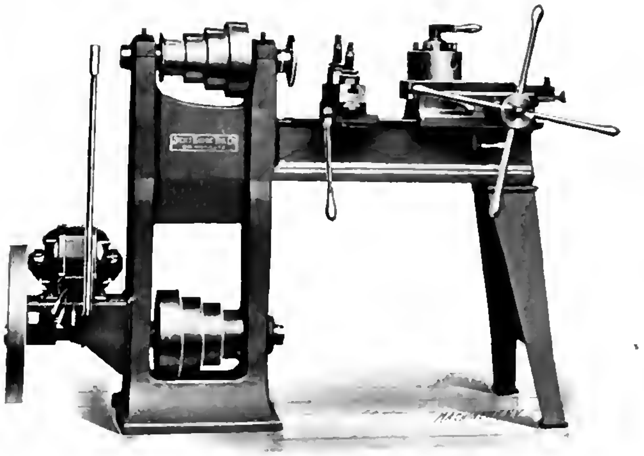
The feed motion is obtained from a variable throw eccentric on the bull wheel shaft. The eccentric is pivoted so that it can be swiveled in either direction, and locked at the desired adjustment by a tapered pin entering reamed holes in the plate. The holes are drilled and numbered to agree with the number of teeth in the feed ratchet, for convenience in changing the feed. The eccentric strap is split and fitted with a fiber washer, so that adjustment for wear may be easily effected by filing this washer as much as may be required. The elevating screw fõr the table is entirely enclosed, and is of telescopic construction. This prevents oil and chips from getting in under the base, and obviates the necessity for a hole in the floor as well. The base of the vise is graduated for its angular setting on a beveled surface, so that the setting can be easily seen by the operator. Another vital improvement in its construction is offered by the bolts provided for drawing the sliding jaw down onto the base, after it has been set up against the work. As is well known, when fastening work in a vise the outer jaw has a tendency to tilt under the pressure. These clamping screws avoid the possibility of this tipping and thus assist in securing accurate work.

The builders also manufacture a single geared crank shaper of similar design, with the gear ratio of $6\frac{3}{4}$ to 1. The back-geared crank shaper herewith illustrated has a single geared ratio of $6\frac{3}{4}$ to 1, and a back-geared ratio of about 20 to 1.

DRESES MOTOR-DRIVEN TURRET LATHE WITH SELF-CONTAINED COUNTERSHAFT.

A striking arrangement of self-contained motor drive for a brass turret lathe is shown herewith. It was designed and built by the Dreses Machine Tool Co., Cincinnati, Ohio. The motor is of the constant speed type, all the changes being made by shifting the belt, as with the usual countershaft arrangement; in fact, the substance of the design consists in placing the countershaft in the cabinet leg beneath the head-stock, instead of mounting it on the ceiling above the machine. The constant speed type of motor was used in preference to the variable speed form, because the high rate of rotation of the spindle in brass work makes a geared speed changing device practically out of the question. Variable speed motors are also open to the objection that they are most conveniently mounted on the head-stock, where their large size gives an unsightly appearance to the machine, and sets up disturbing vibrations as well. The motor shown in this particular installation has $1\frac{1}{2}$ H.P. capacity, and is of the alternating current, high speed type.

The motor is mounted on a bracket at the left side of the cabinet leg. A rawhide pinion on the armature shaft meshes with the large gear on the cone pulley shaft journaled in the leg. To start and stop the spindle more quickly than is possible by the motor controlling switch, a friction clutch is furnished, operated by the long lever shown at the left, which thus serves to connect and disconnect the lower cone pulley and the driving shaft. It will be noticed that this pulley is placed as near the floor as possible to give a long belt and avoid vibration. The bed and cabinet leg are constructed to avoid interference with the shifting belt in any position.



Motor-driven Brass Finishing Lathe with Countershaft mounted in Cabinet Leg.

LANGELIER SWAGING MACHINE FOR FINISHING VALVE STEMS.

The Langelier Mfg. Co., of Providence, R. I., has equipped its regular swaging machine with tools and attachments which adapt it to the finishing and sizing of gas-engine valve stems. The advantages of doing this by swaging, rather than by grinding as usual, are two: first, the operation is much more rapid and less expensive; and second, the quality of the metal is materially improved by the compression to which it is subjected in the swaging process.

Fig. 1 shows the machine equipped for this work. Fig. 2 shows the valve in three conditions: the rough forging; after turning the head, and after swaging. The forging (see *A*) is first clamped by the shank in a lathe, the head is turned

end finished all over, and the tapered swell of the shank into the head is machined. The forging is shown in this condition at *B* in Fig. 2. The holder for the swaging operation is shown in Fig. 3. The work is grasped by the finished head in a spring chuck *D*, of ordinary construction, tightened by the coarse-studded screw *E* and nut *F*. To make the operation of this nut and screw by handle *G* as nearly frictionless as possible, a ball thrust bearing is used, as shown. The holder is mounted on a slide *H*, which is actuated by hand lever *I* to force the work back and forth between the dies. The whole attachment is supported by bracket *K*, clamped to the face of the machine.

The finished work is shown at *C* in Fig. 2. It will be noted that a reduction of 1/32-inch has been made in the stem with a corresponding increase of length, which of course is allowed for in making the blank. As the valve stem is held by the chuck on its outside diameter and the angular face *x* of the head, this insures the finishing of the stem true with the valve seat. After the swaging operation, the valve is chucked by the swaged surfaces of the stem, and surface *x* trued up by grinding, thus insuring the truth of the important surfaces. Where great accuracy is required, the makers advise doing the swaging in two operations. The first operation roughs the stem down to within five or six thousandths of the required dimension; the second operation sizes it and gives it the desired finish. The roughing can be done very rapidly as the finish is not of great importance. The second operation must be done more slowly. In the examples shown, the time required for swaging was six per minute for the first operation, and three per minute for the second. This included the time for putting the work into the machine and taking it out again.

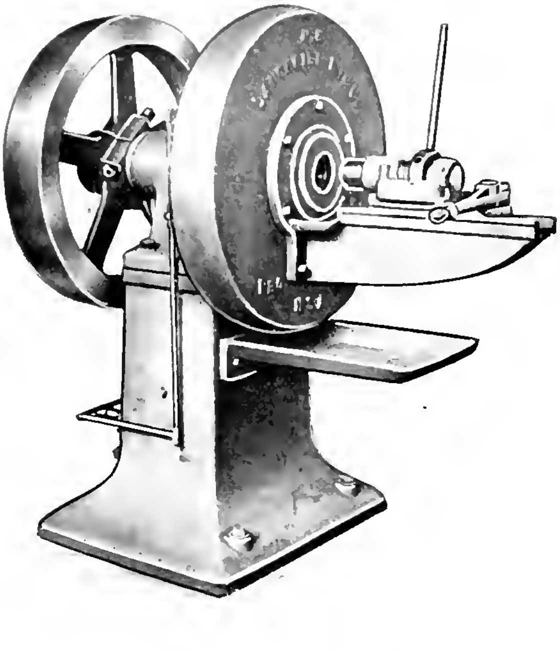


Fig. 1. The Langelier Reducing Machine, fitted with Attachments for Finishing Automobile Engine Valve Stems.

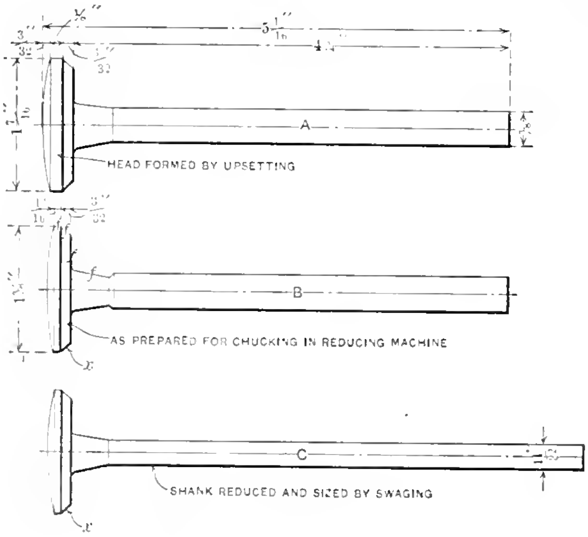


Fig. 2. Three Stages in the Making of a Gas Engine Valve.

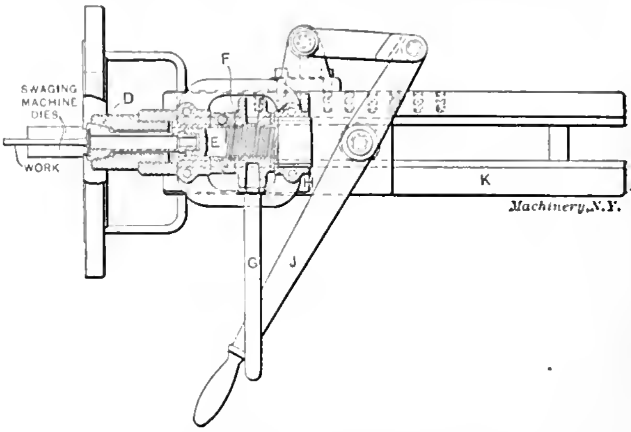
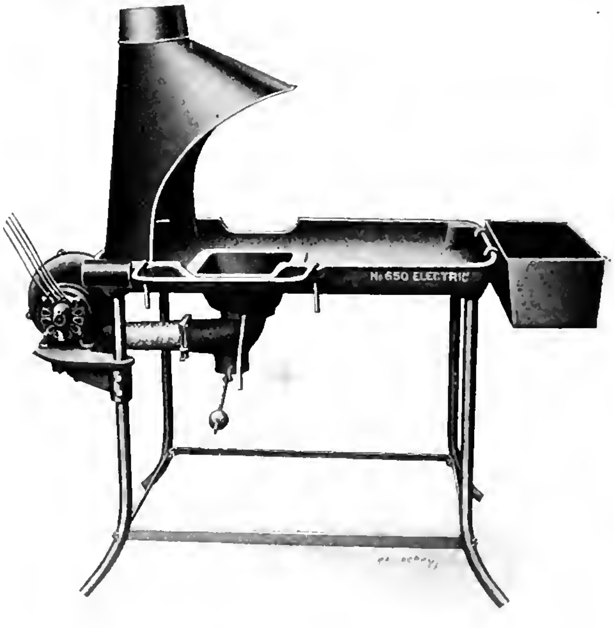


Fig. 3. Plan of the Attachment for Holding the Work and Presenting it to the Machine.

BUFFALO FORGE WITH MOTOR-DRIVEN BLOWER.

The forge shown herewith is built by the Buffalo Forge Co., of Buffalo, N. Y. It is a new design embracing, among other improvements, an all steel fan directly connected to an electric motor, running 1,700 revolutions per minute. The motor and fan case are securely mounted on a bracket fastened to one of the rear legs. Being mounted on the same base, they are kept permanently in alignment. The only wiring necessary is a plug connection to a lamp socket or, if the forge is permanently located, suitable wiring connections may be made in the usual manner. While the regular motor furnished is intended for a 110 volt circuit, suitable windings will be furnished for any desired circuit.



Forge with Direct-connected Motor-driven Blower.

The forge itself is well constructed, having a large, heavy cast iron fire pan, with a sheet steel hood for an 8-inch smokepipe, and a detachable sheet steel tank with an extension or tong support. This gives the operator every convenience for a wide range of the work. The tuyere is of the deep fire, anti-clinker type, provided with a controlling ball having three openings, which allow the blast to be directed to any part of the fire bed, and also give a blast distribution which results in quick, even heat penetration with great economy of fuel. The blower gives an adequate air supply through a short, straight blast delivery pipe, in which all joints are eliminated with the exception of the connection between the blower and the tuyere.

CUTLER-HAMMER SELF-STARTING SWITCHES FOR ALTERNATING CURRENT MOTORS.

The Cutler-Hammer Mfg. Co., of Milwaukee, Wis., has developed a line of alternating current motor controlling apparatus, conveniently mounted on slate panels for immediate installation. Different equipments of apparatus are used for various types of alternating motors. The entire line includes apparatus for use with the slip ring type of motor or the squirrel cage motor, and for single, two- or three-phase currents. They may be furnished adapted to the purposes of both manual and automatic operation.

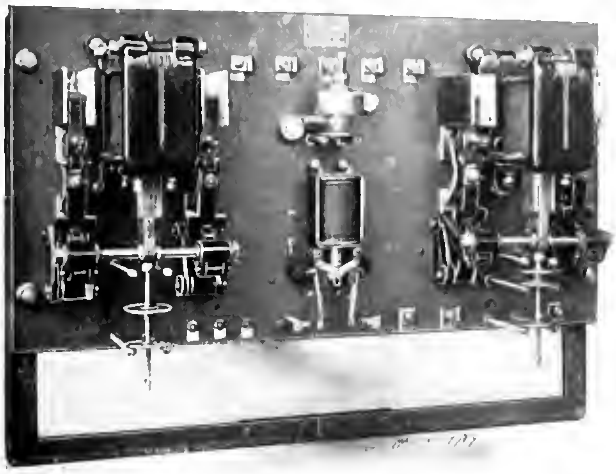


Fig. 1. Self Starter for Squirrel Cage Type of Alternating Motor.

Two examples of this line are shown herewith: Fig. 1 illustrates a self-starter for use with a squirrel cage motor, in such work as driving centrifugal pumps, or similar machines, where the starting torque necessary is materially less than the normal full load torque of the motor, and where the motor will accelerate promptly with a voltage not exceeding 60 per cent of the line voltage. This self-starter is of the multiple solenoid type, and is entirely self-contained. It consists of a slate panel carrying the solenoid switches and relays, which is mounted on a supporting frame with the starting resistance. The primary circuit to the motor for either two-phase or three-phase motors is controlled by a double pole switch in the smaller sizes. The primary switch and starting switch are of open construction, operated by single-phase solenoids. The current carrying contacts are laminated copper brushes pressed against stationary copper contacts by a toggle joint mechanism, insuring a perfect contact. The circuit is always opened and closed at the arcing contacts, which are of carbon and copper and are readily renewable. The starting resistance is non-inductive, and has ample capacity for starting the motor intermittently under light load conditions.

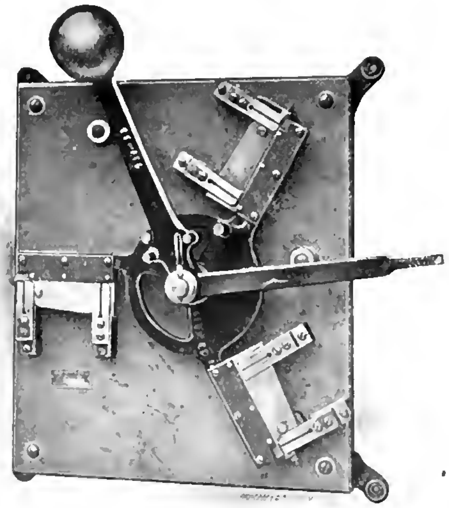


Fig. 2. Automatic Float Switch for Alternating Current Motor.

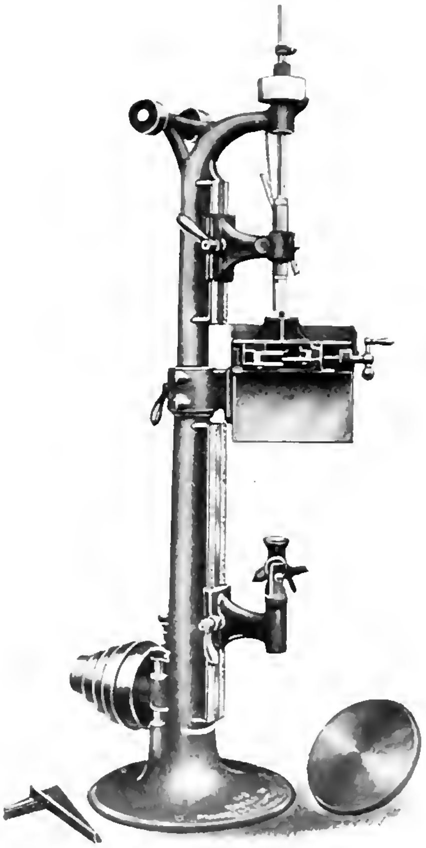
For automatic operation such as is required for electrically driven pumps, which have to be controlled by the water level in a tank, the three pole float switch shown in Fig. 2 may be used, controlling the main line circuit to the motor. It is intended for use only with self starting, single-phase motors, or squirrel cage type two- or three-phase induction motors, which may be thrown directly across the line to start. No self-starter is required when this method is permissible. As will be seen from the illustration, the float switch consists of a plain slate base with supporting feet carrying the switch parts, weight lever and operating lever. The operating lever is to be connected by a chain or other suitable means to the float in the tank, so that it will be moved up and down the proper distance as the water level in the tank falls and rises. When the operating lever moves the weight lever just past the center, the weight falls the rest of the way and opens or closes the switch with a snap.

ROCKFORD MACHINE & SHUTTLE CO.'S IMPROVED SENSITIVE DRILL.

The Rockford Machine & Shuttle Co., of Rockford, Ill., has improved the design of the sensitive drill shown in the department of New Machinery and Tools in the June issue of Machinery. This improvement relates particularly to the drive, the general arrangement of the machine being unchanged.

The driving cone, as shown in the accompanying engraving, is placed near the base of the column, and mounted on a slide which is vertically movable by means of an adjusting screw, to vary the tension on the driving belts. It affects both the countershaft belt and the quarter-turn belt which drives the spindle. This movement gives 3 inches of adjustment, which is sufficient to take care of the stretch for a long time without requiring the belt itself to be shortened.

The general features of the machine will be understood by reference to the illustration, where the table is shown tilted vertically and carrying a centering vise. Round stock, resting in the cup centers at the base of the column and held in this vise, is in proper position for centering, making the drill practically a special machine for that work. For regular work, the round table may be substituted for the combined cup, V and solid centers shown. The spindle boxes are adjustable for taking up wear.



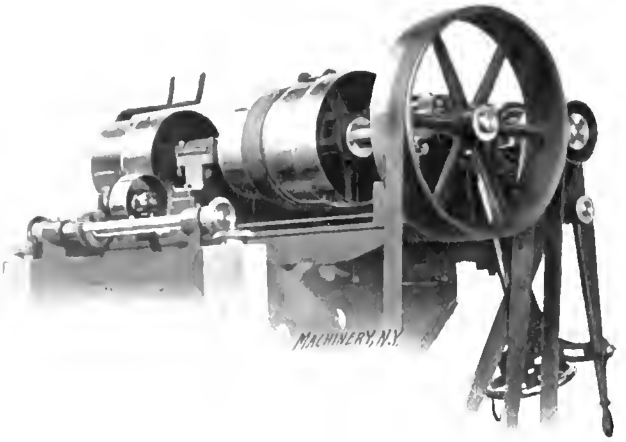
Sensitive Drill with Improved Drive.

GRAY VARIABLE SPEED PLANER DRIVE FOR BELT-OPERATED MACHINES.

In the department of New Machinery and Tools in the December, 1908, issue of Machinery, we illustrated and described a self-contained variable speed drive which the G. A. Gray Co., of Cincinnati, O., has developed for use on motor-driven planers. This drive has been adapted to belt-driven

machines as well, and we herewith illustrate the driving mechanism of a small planer thus equipped.

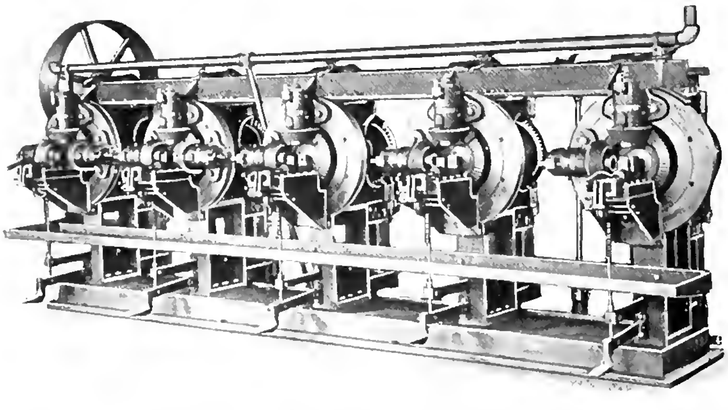
This countershaft, as on the larger motor-driven machines, gives four changes of speed, any one of which may be obtained without shutting off the power or stopping the planer; so no time is wasted in making changes. The return speed is constant, being obtained from the primary driving shaft, which is driven directly from the line-shaft by a belt on the tight and loose pulleys shown. The loose pulley is the smaller of the two, so that the belt pull is lessened when the machine is not working. The usual beveled shoulder between the pulleys facilitates shifting. The belt shifting fingers for the tight and loose pulleys are universal, and can be set to work properly when the planer stands in front of, or behind, or directly underneath the line-shaft. The handle for controlling this shifting is located at the front of the machine.



Application of the Gray Variable Speed Counter-shaft to a Belt-driven Planer.

POTTSTOWN MACHINE CO.'S AUTOMATIC TAPPING MACHINE.

The Pottstown Machine Co., of Pottstown, Pa., is building an automatic machine for tapping T's, 45-degree L's and similar fittings. The mechanism of the machine is such that its movements are automatic, there being nothing for the operator to do except place the work in the machine and remove it when completed.



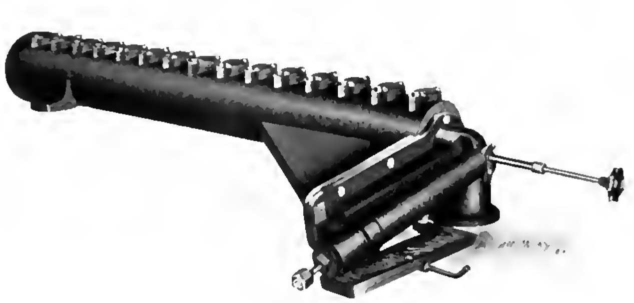
A Gang of Automatic Tapping Machines for T's, Elbows, etc.

From two to six machines may be mounted on a single base as shown. Any one of these may be started, stopped or adjusted without interfering with the other. The work is held in a vise having jaws of suitable form to center the work with the tapping spindles. These are carried in heads which are adjustable about a circular face, as shown, to any position on the quarters, or on the intermediate 45-degree angles. From one to three heads for each piece may be employed as required. The tapping spindles are arranged to make a definite number of revolutions, adjusted to agree with the length of thread to be cut. This adjustment may be made by even quarters of a revolution while the machine is in motion. It is stated that the reversing motion is so positive that the tapping depth is accurate within 1/16 of a revolution. This insures a high degree of uniformity in fit in the finished threaded joints.

The driving mechanism, when the depth has been reached, stops and returns the spindle automatically, when it again stops, waiting for the operator to remove the work. There is thus no danger of injury in the way of getting the fingers caught in the mechanism. When the new work has been clamped in place, the machine is started by a foot lever after the operator has left the working position.

GLOBE MACHINE & STAMPING CO.'S KEROSENE OIL BURNER.

The Globe Machine and Stamping Co., 974 Hamilton Ave., Cleveland, O., is manufacturing a kerosene oil burner under patents of John A. Mathes, a California inventor. It is designed to fill a wide field of industrial uses, where the installation is not so large as to warrant putting in an independent gas plant. For most industrial work the artificial gas is too expensive, and coal or coke is not convenient or efficient, and requires constant attention. The new burner, using kerosene oil is thus adapted to the heating of drying ovens, heat-treating furnaces for steels, enameling ovens, water heating apparatus, and numerous other industrial purposes.



A Gravity-fed Burner for Kerosene Oil.

As compared with other forms of apparatus for burning oil of various kinds, this apparatus does not require a forced blast, and does not use an atomizer of any kind. The oil is atomized by heat under conditions that prevent the deposition of carbon in the vaporizing chamber. There is thus no interference with the operation of the burner. The burner does not require pressure pumps for forcing the oil, which is fed to it from a reservoir or barrel placed about 10 feet above the level of the burner. The construction is the simplest possible and the flame is controlled with all the ease of a gas burner. The flame resembles very much that of natural gas. Three of these burners in a brick oven about 4 by 5 by 15 feet (300 cubic feet) heat the oven to a temperature of 1,000 degrees Fahrenheit, and consume collectively about four gallons of oil per hour. Five natural gas burners consuming about 700 feet of gas per hour were required to do the same amount of work. It will thus be seen that the cost of operating this burner on kerosene oil (a fuel obtainable anywhere) puts its use practically on a par with that of natural gas.

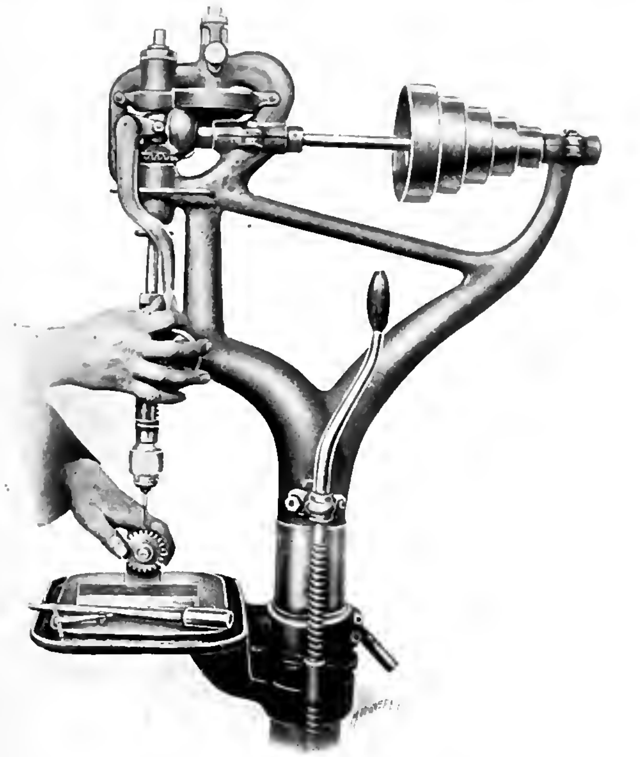
ROCKFORD COMBINED DRILLING AND TAPPING MACHINE.

The bench drill, and the 12- and 14-inch drilling machines manufactured by the Rockford Drilling Machine Co., of Rockford, Ill., are now provided (if desired by the customer) with a tapping mechanism of unusual convenience, built into and a part of the machine itself. The construction of the device will be understood after a study of the accompanying engraving and description.

For drilling, the usual bevel gear connection is made between the horizontal cone pulley shaft and the spindle. The quick reverse for tapping is driven from a separate bevel gear face on the driving bevel pinion on the cone shaft. This

rear bevel face meshes with an intermediate gear on a vertical stud in a housing at the top of the frame. An intermediate spur gear is keyed to this, which in turn meshes with a spur pinion on a sleeve surrounding the upper end of the spindle. The clutch playing between the bevel gear and spur pinion on the spindle thus serves to engage it with either of these gears, giving a forward movement in one direction and a quick reverse in the other.

The operation of the machine for tapping is very simple. The clutch lever on the right-hand side of the spindle is so located that the operator can control it by the thumb and the forefinger of the right hand, which at the same time grasps and operates the knurled hand-wheel which controls the feed. The operator is then free to use his left hand to hold the work, and to rapidly change the pieces. The intermediate gears of the tapping device are mounted on an upright movable shaft which, when lifted up, disengages these gears from the rear bevel face on the wheel drive shaft. When the gearing is thus disengaged the machine is free for straight drilling at high speeds. The tapping mechanism may thus be instantaneously engaged or disengaged without requiring the operator to move from his position.



Rockford Drilling Machine with Built-in Tapping Attachment.

This mechanism has the advantage over the ordinary removable or portable tapping attachment in allowing the work to be done at the normal height. When the usual attachment is used, mounted in the spindle by a tapered shank, the operator is required to hold his work six or eight inches below the natural level. The builders state that they are preparing to furnish this arrangement in modified form to suit their entire line of upright and gang drills.

HOB SHARPENING ATTACHMENT FOR THE WALKER UNIVERSAL GRINDER.

In last month's issue of MACHINERY, in the department of New Machinery and Tools, we described certain improvements in the universal grinder built by the Walker Grinder Co., of Worcester, Mass. These improvements related particularly to the method of mounting the wheel spindle universally so that it can be swiveled to any angle about a vertical or horizontal axis. This universal adjustment is obtained through a wide range in every direction, without any difficulty in the belt drive, which is so arranged that the belt passes freely over the various driving and idler pulleys without change of tension, and without tending to crowd against the flanges. This spindle drive has made possible an ingenious and effective hob sharpening attachment (see Fig. 1) which is the subject of this description.

Method of Grinding Hobs and other Formed Cutters

To understand the principle of this device it will first be necessary to examine the different methods that are employed for sharpening hobs or other form cutters. The common way of doing this is shown in Fig 2. The face *x* of the wheel is trued up to a plane at right angles to the spindle axis. This face is fed against the cutting face of the hob tooth, the feed movement being in the direction of the arrow. The face of the wheel covers the whole surface of the tooth as the work is passed back and forth in front of it. The difficulty of obtaining good results by this method lies in the fact that the wheel wears away (as it must to cut freely and effectively), and as the outer corner is subjected to the most severe duty, it wears away fastest. The wheel thus tends to assume the shape indicated by the dotted line *a b*, which is obviously not fitted for giving the proper shape to the cutting edge.

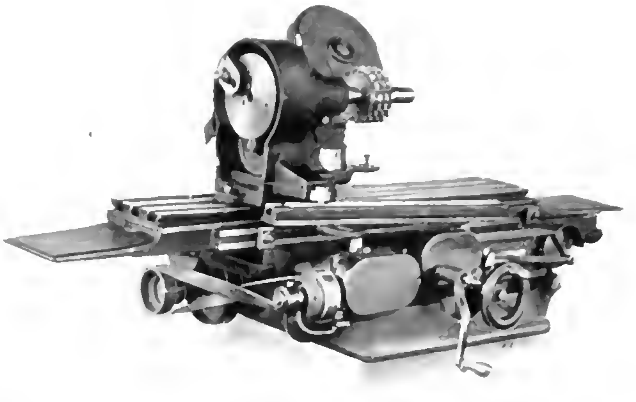


Fig. 1. Hob Sharpening Attachment for the Walker Grinder

The better procedure is shown in Fig. 3. Here the grinding spindle is tilted so that the flat surface of the wheel clears the work; the wheel is set to the proper depth of cut and then fed downward as shown by the arrow, until the bottom of the groove is reached. This is much more satisfactory than the first method, producing a flat radial cutting edge until the wheel has worn back beyond line *a b*. The principal objection to this method of grinding lies in the fact that it requires a vertical feed, which is inconvenient for any ordinary design of grinding machine.

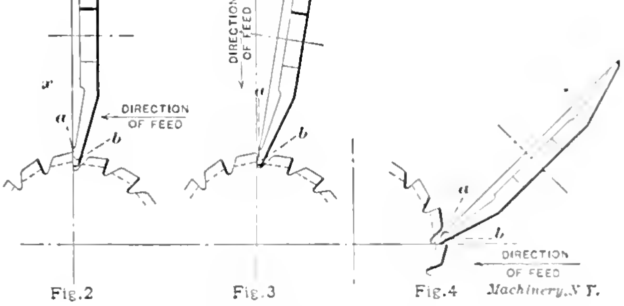


Fig.2 Fig.3 Fig.4

Figs. 2, 3 and 4. Various Methods of Sharpening Hobs and other Formed Cutters.

The objections applying to the other two methods are obviated by the process shown in Fig. 4, which is employed in the Walker grinder. Here the face of the tooth to be ground is placed on a horizontal plane, and the grinding spindle is set at the proper angle to conform to the shape of the groove in the cutter. The radial face of the tooth is thus surface ground by the beveled periphery of the wheel; and by referring to line *a b*, it will be understood that the wear of the wheel simply reduces its diameter and slightly rounds its outer corner, without affecting the finished surface. The feed is horizontal as shown. Other advantages

of this method are a reduction in the heating effect, the possibility of grinding into a sharper corner, and of grinding a spirally grooved cutter. This is impossible by either of the other two methods, as plain surfaces do not clear spiral grooves readily. There is no difficulty on this score with the beveled cutting face in Fig. 4. The Walker grinder has been designed to permit the placing of the wheel in the particular position required for grinding spiral hobs properly.

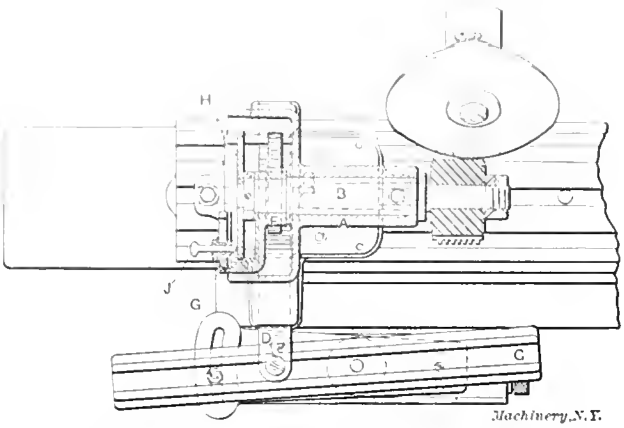


Fig 5. Plan View of Hob Sharpening Device with Helical Attachment.

The Hob Sharpening Attachment.

The mechanism of this attachment is shown in detail in Figs. 5 and 6. The stand *A*, fastened to the top of the grinder table, carries work spindle *B*, which is provided with a tapered hole for receiving the hob or cutter arbor. For hobs with spiral grooves a mechanism is provided for rotating the work in unison with the longitudinal table movement. This rotation is governed by a swiveling bar *C*, identical in construction with that used on lathe taper attachments. The block sliding in this guide is pivoted to the end of cross-bar *D*, which thus receives a greater or less cross movement in unison with the table, depending on the angle at which the slide *C* is set. Rack teeth cut in *D* engage intermediate gear *E*, which in turn meshes with pinion *F* on the spindle. For grinding straight grooved hobs or cutters, the bar *C* is set parallel with the table movement.

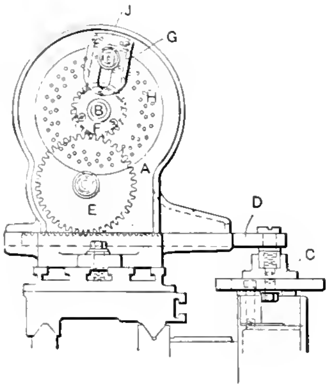


Fig. 6 End View of Device.

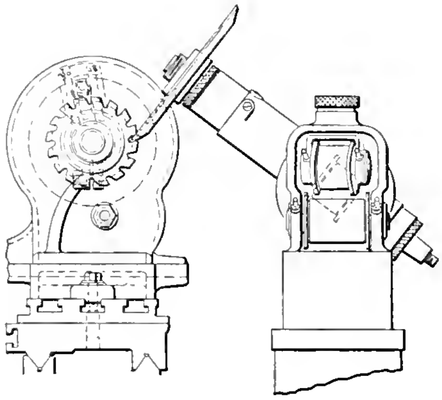


Fig 7. Arrangement of Machine for Grinding a Right-hand Hob.

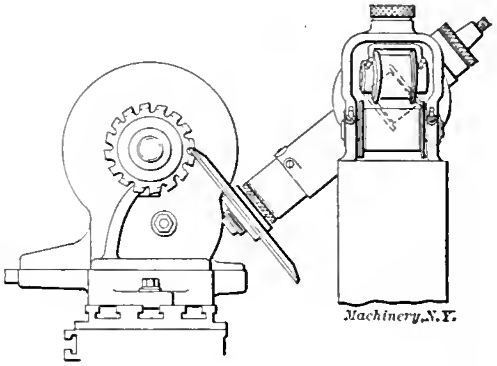


Fig. 8. Arrangement for Left-hand Hob.

The indexing mechanism is plainly shown in Figs. 5 and 6. Pinion *F* is not keyed to spindle *B*, but is part of arm *G*, which carries the index pin, *J*. The index plate *H* is keyed to the spindle. The index pin may be adjusted radially to line up with any particular row of holes in the index plate. The latter may be changed to give any required indexing. It will thus be seen that the rotary movement for the spiral attachment is transmitted from cross-bar *D* to intermediate gear *E* and pinion *F* to index arm *G*, and thence through pin *J* and plate *H* to the spindle *B*.

Method of Setting up the Machine.

Figs. 7 and 8 show the arrangement of the machine for grinding right- and left-hand teeth respectively, when the cutter, as would be the case if made with a solid shank, cannot be reversed in the spindle. The arrangement for the right-hand teeth in Fig. 7 is the same as in Fig. 4. For left-hand teeth the cutter spindle is tipped to the corresponding position below the horizontal, and the grinding is done on the under side of the tooth face, as shown in Fig. 8. This latter illustrates the flexibility of the spindle drive provided.

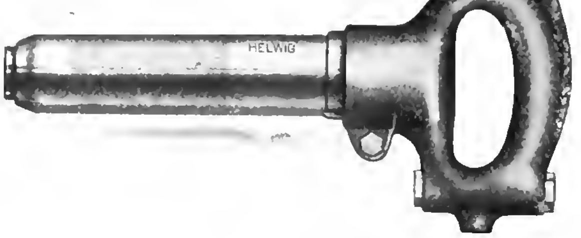
It is understood, as explained in connection with Fig. 4, that the face of the cutter tooth is thus finished by a surface grinding operation, using the automatic cross-feed in the regular manner. The sharp corner of the grinding wheel is maintained by the wear of the periphery. There is practically no danger of drawing the temper of the cutter, and when the tooth is ground it presents a keen edge, without discoverable evidence of round edges and other imperfections.

HELWIG PNEUMATIC CHIPPING AND RIVETING HAMMERS.

The Helwig Mfg. Co., St. Paul, Minn., is building the hammer illustrated herewith. It is designed to meet the severest requirements for tools of this kind, being of large capacity, simple design, substantial construction, convenient of manipulation, and low in cost of operation and maintenance.

The handle is drop-forged and of the closed type, having a shape conforming to the grip of the hand. The locking device makes it impossible for it to get loose on the barrel. The hose connection is at right angles with the barrel, making it more convenient to handle and lessening the pull of the hose on the operator. It also gives more clearance in close quarters, and obviates wear and tear on the hose and the threaded connections.

The valve chamber is hardened and ground, and solidly bedded in the barrel, though it is easily removable. The whole valve mechanism is very simple. The valve is balanced and of the positive type, with a large wearing surface. As it operates in the same direction as the piston, the wear on it is reduced to a minimum, and the full power of the air is utilized for effective work, instead of being wasted in overcoming friction. The piston is a solid piece of tool steel, also hardened and ground. The construction is such that the operator does not feel the hard metallic blow met with in some tools of this kind. This lessens his fatigue and increases his efficiency. The hammer will not operate unless the chisel is in place.



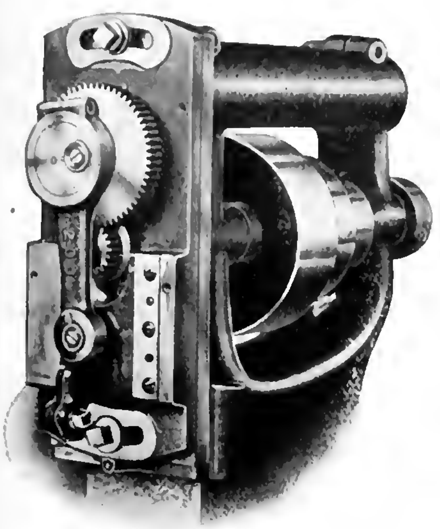
Helwig Chipping Hammer.

This tool is made in a wide variety of sizes and capacities, both for chipping, calking and beading, and for riveting. To

illustrate the power of the tool, it is said that the 4-inch stroke riveting hammer, weighing 11 pounds, will drive ¾-inch rivets steam tight.

SLOTTING ATTACHMENT FOR THE BURKE MILLING MACHINE.

The accompanying illustration shows a back-geared slotting attachment designed by the Burke Machinery Co., 1837 Thirty-fifth St., Cleveland, O., for use with its No. 3 and 4 milling machines. One of the novelties in the construction of this attachment is the geared drive, which makes heavy cuts possible on a high speed miller.

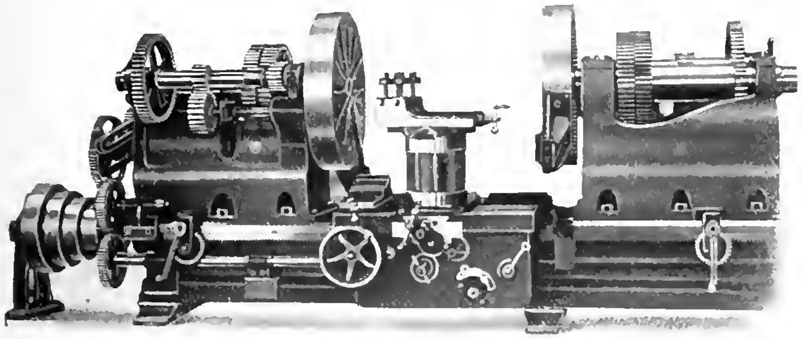

Back-geared Slotting Attachment with Gear Case removed.

The attachment is clamped to the face of the column, and to the over-hanging arm support, making it, for all practical purposes, a part of the machine. The guides for the slide swivel on this support about the axis of the driving pinion, to any angle up to 10 degrees either side of the center. The graduated dial for reading this adjustment, and the bolt for clamping the slide to the desired angular position, are clearly shown in the engraving. The stroke is one inch. The device weighs, complete, twenty-three pounds.

FAY & SCOTT DOUBLE-HEAD FACING LATHE.

The 62-inch double-head lathe shown herewith is a combination of facing machine and lathe. It is particularly designed for use in facing flanges, girders and similar work held in stationary fixtures on the bed. For this purpose it is provided with facing slides and tool-holders on the faceplates. It is also adapted to the boring of cylinders by means of a traveling head boring bar. The machine was constructed from the stock parts of the builders' regular 38-inch standard lathe, raised to swing to 62 inches over the bed, and 50 inches over the carriage.

The machine is fitted with a regular carriage, having an extension for the extra swing; it is provided with the usual feeds and screw cutting features, making the machine available for ordinary lathe work. The head-stocks are each adjustable lengthwise of the bed by a rack and pinion movement; they may be clamped in any position to suit the work in hand. The facing heads, which also form the faceplates of the lathe, are driven by the usual triple-geared mechanism, being provided with internal gear teeth in their rims engaging driving pinions in the head-stock. Each head-stock is driven from a spline shaft passing through the center of the bed. The spindles run in opposite directions to equalize the strain on the work.

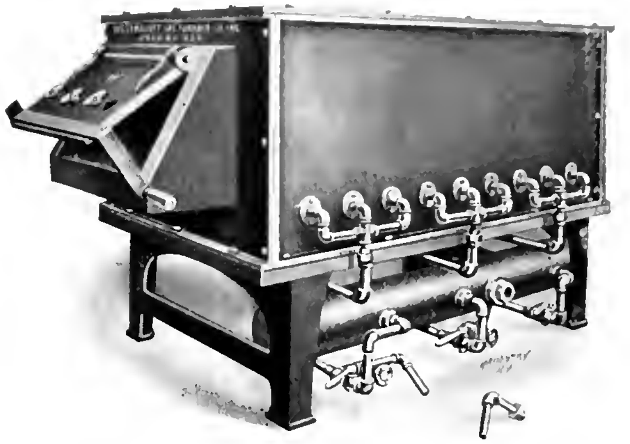

A Modified Lathe, adapted to Facing and Boring Work mounted on the Bed or Carriage.

The back gear ratio is 12½ to 1, the gear ratio with the triple drive into the faceplate is 40 to 1. The maximum distance between the facing heads with a 22-inch bed is 13 feet. The weight is 24,000 pounds. The builders are Fay & Scott, Dexter, Me.

WESTMACOTT HARDENING AND ANNEALING FURNACE.

The accompanying engraving shows a hardening and annealing furnace recently furnished by the Westmacott Gas Furnace Co., Inc., of Providence, R. I., to the Rock Island Arsenal. It is notable for the small gas consumption due to a new style of burner with which it is equipped.

The furnace is intended for annealing and hardening carbon steel, the maximum temperature required being 1,600 F. The space to be heated is 62 inches long and 26 inches wide. Nine burners on each side are provided, or eighteen in all. These are divided into three sets of six each, controlled independently, as shown in the engraving. The furnace operates satisfactorily on about 425 cubic feet of gas per hour; the fuel in this case has a richness of about 425 B. T. U. per cubic foot, and the air pressure is 1½ pound per square inch. The net weight of the furnace is 6,500 pounds.


A Hardening and Annealing Furnace, which shows great Fuel Economy.

CUTLER-HAMMER ALTERNATING CURRENT DRUM CONTROLLERS.

The Cutler-Hammer Mfg. Co., of Milwaukee, Wis., has recently developed a line of drum controllers for use with two- or three-phase slip ring motors, operating cranes, hoists, and other classes of machinery which require frequent starting or stopping. Both the drum and resistance are rated for intermittent duty not exceeding 150 per cent of the motor rating, for both primary and secondary circuits; and they are designed to reduce the motor speed 50 per cent under average load conditions. Where the service is exceptionally severe, or where special specifications are to be met for which the standard controller may not be suitable, the builders are prepared to give estimates on special equipment.

The drums consist of a three-pole primary, combined line and reverse switch, with a cylinder for controlling the secondary starting and regulating resistance, mounted on the controller shaft and driven directly by the operating lever. For all sizes of drums the secondary resistance controller is of open construction. For the types A, B and C drums the primary switch is also of open construction, but for the types D and G drums the primary switch is immersed in oil. The A, B and C drums are arranged for wall mounting, but the D and G drums are for floor mounting, in order to provide properly for the oil tank containing the primary switch. The installation of the latter should provide space for the removal of the oil tank for connecting and inspection. The drums are constructed of the best materials throughout. All contacts

[illegible] of hard drawn copper and are easily [illegible] renewed. The contact segments are firmly mounted on a metal cylinder, which remains perfectly true under all climatic conditions. The oil tanks for the types [illegible] are of seamless steel and will not leak. These tanks should be kept full of a clear mineral oil. Machine oil must not be used.

Resistance is provided in each of the three phases of the motor circuit, mounted in comparatively small frames for convenient installation. Except for the small sizes, the resistance is of the cast metal grid type. The resistance is as compact as possible, consistent with ample capacity for intermittent regulating duty.

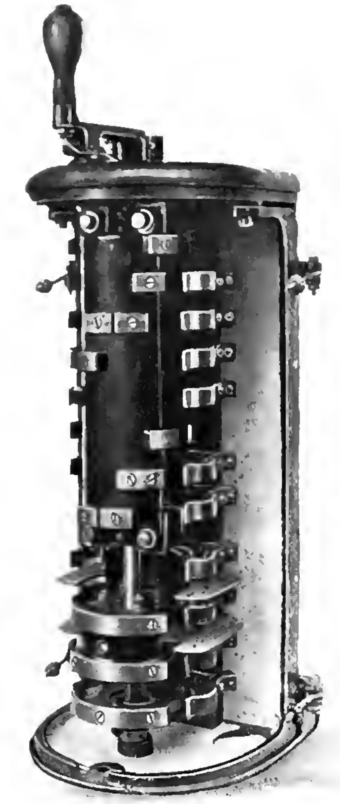


Fig 1. Reversible Drum Controller for Alternating Current.

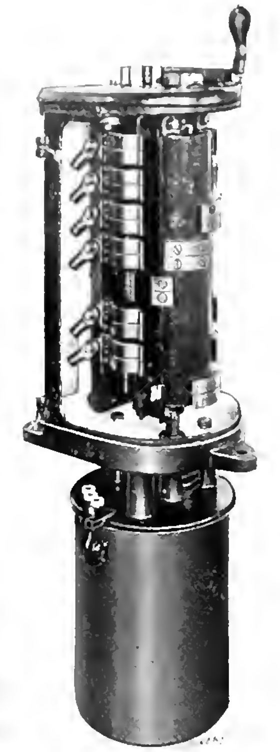
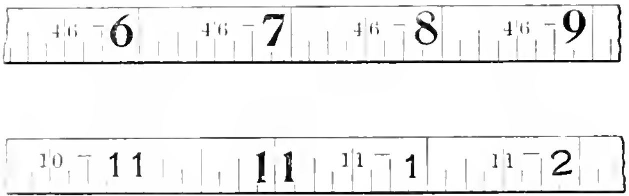


Fig 2. Drum Controller with Oil Tank for Primary Switch.

LUFKIN STEEL TAPES FIGURED FOR INSTANTANEOUS READING.

The accompanying illustration shows at a glance the nature of an improvement in the figuring of steel tapes, which has been devised by the Lufkin Rule Co., of Saginaw, Mich. Everyone who uses a long tape has suffered the inconvenience which arises from the fact that the number of the feet is only registered at the end of each 12 inches. When an exact measurement is required which comes between two foot marks, it is necessary to first ascertain the number of inches, and then go back carefully to discover the last registered foot.



Machinery,N.Y.

Instantaneous Reading Graduations for Steel Tapes, giving both Feet and Inches

The improvement consists, as may be seen, in printing the number of feet in smaller figures, at each inch mark, immediately preceding the number of inches. This makes it possible to read without risk of error the exact measurement at any point. On the upper tape, for instance, the dimension 16 feet, 7½ inches may be read at a single glance. A common error is that of reading 11 feet, when the figures for 11 inches immediately precede the figure for 11 feet. No such error in reading can occur with this new form of "instantaneous readings," as the makers term it, as may be seen in the lower section of tape in the engraving. This form of dimensioning will be furnished without extra charge on all steel tapes made by this firm of ¼- and ⅜-inch width, up to 100 feet long. The design is patented.

BEMIS & CALL ADJUSTABLE SQUARE-JAWED AND PIPE WRENCH.

The well-known "S" square-jawed wrench and the corresponding pipe wrench made by the Bemis & Call Hardware & Tool Co., of Springfield, Mass., have been combined in the form shown herewith. This combination wrench at the present time is made only in the 6-inch size. It is particularly adapted for automobile and gas engine use. The sliding jaws are provided with full bearing on the frame when opened to their widest capacity. The parts are all carefully hardened and tempered for the duty expected of them. The operating nuts of these wrenches are of steel and the sliding jaw is a steel drop forging, notched on the pipe wrench side with teeth for engaging the pipe. It will be found useful for turning pipes or unscrewing bolts and nuts in confined places, such as corners or close to walls. The price of the single pipe wrench has lately been reduced to agree with that of the square jaw style.

Adjustable Combined "S" Pipe and Nut Wrench.

DELTA NEW CUT FILE FOR SAW SHARPENING.

A file specially designed for saw sharpening is being made by the Delta File Works, Carver File Co., Philadelphia, Pa. This file is made on a slim tapered blank in lengths from 4 to 10 inches. The tang is drawn without a shoulder, and the lines on the edge of the file run parallel until very close to the point, where they taper very sharply. The angle of the tooth is made more acute by 10 degrees than that ordinarily used for saw files. This enables more teeth to the inch to be cut, and also strengthens the edge of the file. This edge receives the brunt of the work in saw filing, as it is in action in the gullet at every stroke removing more stock than the side of the file. These improvements combine to give the tool a high efficiency. The makers have reports of tests in two different saw factories giving records of the filing of as many as eight saws with one file.

AMERICAN BLUE-PRINT PAPER CO.'S REPRODUCTION PROCESS.

The American Blue-Print Paper Co., 294 Dearborn St., Chicago, Ill., announces the introduction of a new process of printing by means of which reproductions may be made from black line, blue line or any color print, directly on drawing paper, cloth, tracing paper or cardboard as quickly as blueprints are made. Tracings may be reproduced on cloth or paper, which will be fac-similes of the original and true to scale; there is no difficulty from shrinking as is the case when the reproductions have to be washed in water and dried. The new prints are flat and permanent. The lines do not fade nor the background turn yellow. The body of the paper or cloth is not coated with an acid solution as is in other processes, so that it is in the same condition as when received from the manufacturer. It is stated that the black prints made with this process are jet black and not dark brown like

those made from negatives. Any part of the original not wanted in the reproduction can be blocked out without damage to either original or reproduction.

This process is an extremely rapid one. The firm mentioned above has such facilities for the work that all orders sent are shipped the same day the tracings are received, so that the work is practically done as quickly as though it were not sent out. The process has not been as yet developed for individual use by customers, as it requires unusual care and experience. The demand for prints made in this way has been so great as to severely tax the equipment of the manufacturers.

NEW DESIGN OF LEA SIMPLEX COLD METAL SAW.

The Lea Equipment Co., 136 Liberty St., N. Y. City, has recently re-designed the "Lea Simplex" cold metal saw, introducing important improvements, particularly in the feed mechanism. The machine as a whole is shown in Fig. 1, while the new mechanism is seen in detail in Fig. 2. The general arrangement of this saw is well known. The blade is driven by a pinion whose teeth mesh with slots cut in the blade itself near its periphery, thus giving a drive nearer the cutting point of the saw than can be obtained by other methods. This drive also gives a maximum of capacity for a given diameter of blade, as no clearance for the driving gear on the spindle has to be allowed for. The saw arbor, blade, and driving mechanism are mounted on an arm which is swung upward about a pivot at the rear, to feed the saw into the work.

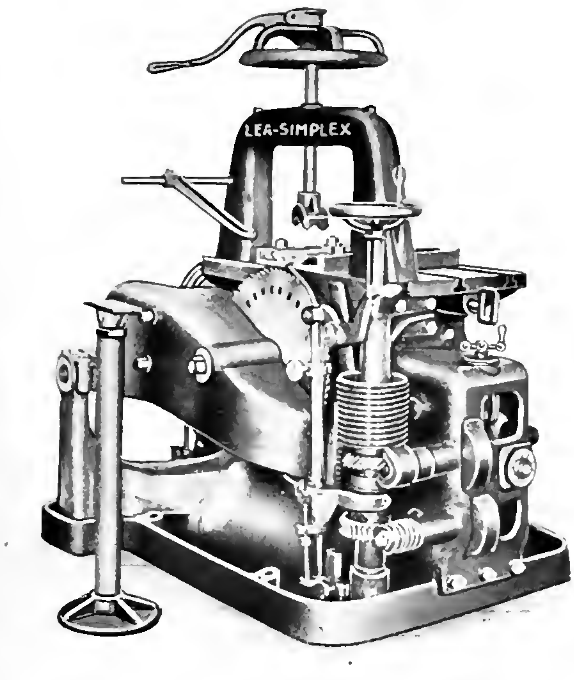


Fig. 1. Lea Simplex Cold Saw with Improved Feed Mechanism.

As shown in Fig. 1, the swinging arm which carries the saw is fed upward in the new design by a worm of large diameter, engaging a segment of a wormwheel clamped to the arm. This worm is driven from a feed-box by either the spiral or worm gearing shown. The former is used for the quick return, while the latter is operated by the variable feed mechanism. The feed mechanism (see Fig. 2) is driven by a sprocket and chain from the driving shaft at the rear of the machine. This sprocket is mounted on the constant speed shaft of the gear-box, which drives the feed worm directly through spiral gearing, as previously mentioned. On this same shaft is mounted the first member of a Sellers friction drive. The intermediate member, with the two beveled, spring-pressed disks, is mounted on a swinging sector below it, while the driven member is mounted on a third shaft at the bottom of the feed box. The intermediate member is swung up or down, thus increasing or diminishing the feed, by means of a screw and ball crank shown projecting through the case at the top. The rate of feed is indicated by a dial at the front of the box as seen in Fig 1.

This improved mechanism takes the place of an older friction cone arrangement, which sometimes gave trouble from oil on the bearing surfaces. The Sellers disks are unaffected by oil. The intermediate disks are made of soft steel, while the driving and driven members are of bronze. The sides of the intermediate disks which bear on the bronze disks are beveled to an angle of about two degrees. When the operator grasps the knob on the intermediate disk shaft, which projects through the side of the casing, this action screws up a spring and increases the pressure on the bearing surfaces. An automatic stop and reverse are provided for the feed mechanism, controlled by an adjustable dog, as shown in Fig. 1. Both the worm and spiral gear shafts are fitted with roller thrust bearings.

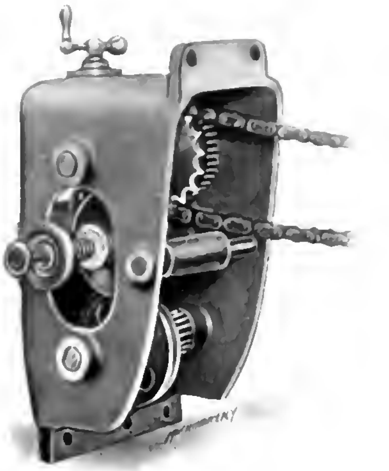
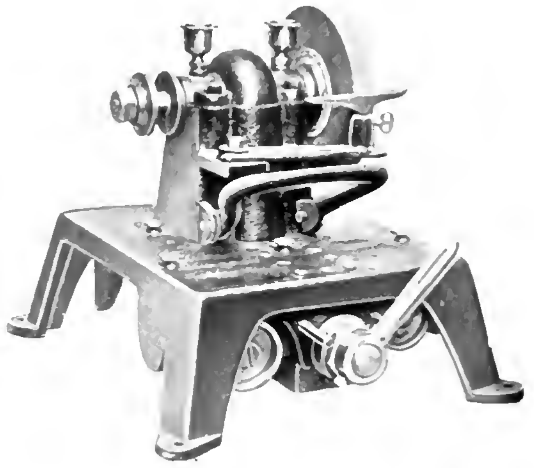


Fig. 2. Detail View of Feed Box, showing Sellers Drive.

Another improvement made on this machine relates to the form of V-block used. This is adapted to holding either round or square stock, as it is made in two sections which may be reversed if required. It is shown in place on the table in Fig. 1. In cutting round stock the two tapered edges are put together, allowing the stock to rest almost in contact with the table. In cutting square stock, the two castings are turned end for end, thus practically making two knee plates. The holes by which the blocks are bolted to the table are lengthened to form slots, so that the blocks may be swiveled to 45 degrees, permitting angular cuts to be taken.

HELWIG PORTABLE PNEUMATIC GRINDER.

The portable pneumatic grinder built by the Helwig Mfg. Co., of St. Paul, Minn. (shown in the accompanying engraving), is intended for use in railroad shops, shipyards, and places where structural erection is going on, and for other places where there is more or less grinding to do. It saves the time and labor required for carrying tools back and forth to the shops.



A Portable Air-driven Grinder for Tool Sharpening.

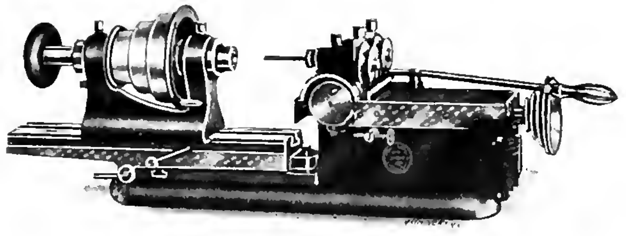
The grinder has a handle by means of which it may be carried from place to place; and it is provided with a clamping device for fastening it to an I-beam, angle iron or other support, convenient to the workman. The tool is made in two sizes. No. 1 weighs 130 pounds, requires 18 by 20 inches of floor space, and may be equipped with two wheels up to 1½-inch

face and 10-inch diameter. No. 2 is smaller, taking a ¾- by 6-inch wheel, and occupying 12 by 15 inches of floor space.

WALTHAM AUTOMATIC INTERNAL GRINDING MACHINE.

The Waltham Machine Works, Newton St., Waltham, Mass., is building the automatic internal grinding machine illustrated herewith. This machine is adapted for grinding holes, from the smallest size up to an inch in diameter. The only limit in size for the minimum hole is that of the smallest practicable diamond charged lap. This machine has the advantage of a drive which permits the maintaining of extremely high spindle speeds; and the further advantage of automatic action, which permits two or more of them to be taken care of by one operator.

The bed of the machine carries ways for the grinding slide at the right, and is provided at the left with an extension on which is mounted the work-carrying head. This can be swiveled from 0 to 45 degrees, and by means of a micrometer screw, readings to minutes may be easily obtained. The swiveling plate has ways of the same profile as the builders' regular 8-inch bench lathe, so that the 8-inch head-stock may be used. The machine can be made, if desired by the purchaser, to fit the head-stock of any other similar lathe, providing standards are furnished for fitting. If the machine is to be used continuously, a special head-stock is recommended, made to take spring chucks. The bed is long enough to permit the use of a back-rest, so that straight or taper holes in the end of small spindles can be accurately ground.



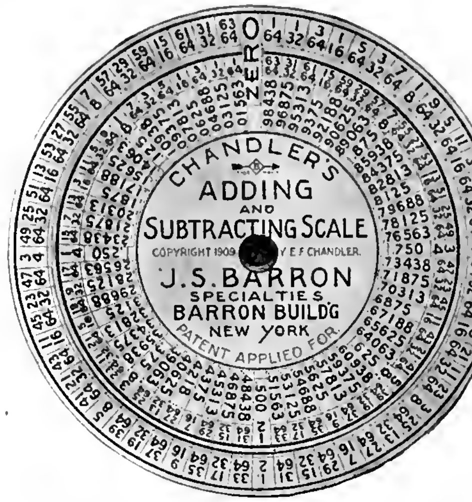
A Precision Internal Grinder with Friction Spindle Drive.

The reciprocation of the grinder head slide on the bed is effected by a cam and slotted link movement, which can be altered to any desired length of stroke within the range of the machine (from 5/16-inch to 2 inches), and to any convenient number of strokes per minute as determined by the cone pulley which drives this mechanism. The cross-slide on which the wheel spindle is mounted is provided with an automatic feed. This is operated by a ratchet mechanism which strikes the adjustable knurled screw seen at the front of the bed in the engraving. By altering the adjustment of this screw, any feed from 1/15,000 to 1/1,500 inch can be given at each stroke of the slide. A stop is provided which throws out this cross movement when a predetermined diameter has been reached. The cross-slide can be withdrawn from alignment with the work by a lever, so that the diameter of the work can be more easily measured. Springs return the cross-slide to exactly its original position.

Two styles of grinding head are made, either one or both of which will be furnished as desired. The high-speed head is shown in the illustration. In this a small straight spindle is driven by two friction disks, mounted on each side of it. The two driving pulleys for these disks are plainly shown. The belt from the countershaft passes down under both of these pulleys and revolves them in the same direction. The friction disks attached to the pulleys spin the grinding spindle between them in the same way that a pencil might be spun between the thumb and forefinger. This method would appear to permit a much higher speed than could be maintained with a belt-driven spindle. Since the belt itself runs comparatively slow, it may be larger and of more durable construction than would be possible if it drove the spindle directly. For larger work where slower speeds can be used, a plain direct belted grinding head is used. On both styles provision is made for maintaining vertical alignment.

CHANDLER'S ADDING AND SUBTRACTING SCALE FOR FRACTIONS.

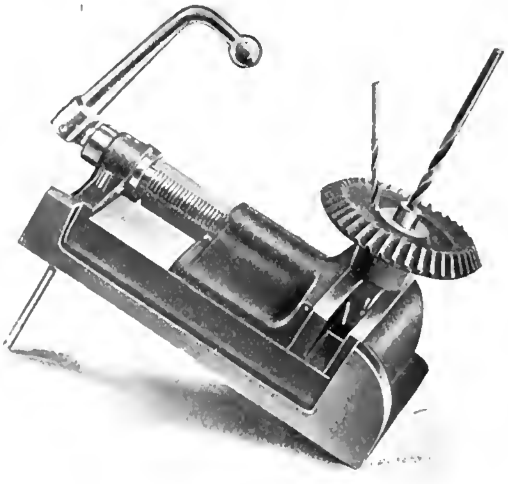
The device shown herewith for adding and subtracting fractions and their decimal equivalents, has been placed on the market by James S. Barron, Barron Building, New York City. The scale is formed by two celluloid disks pivoted at the center, and each provided with two rows of concentric graduations, one of which gives the common fractions and the other the decimal equivalents. The fractions are located on the upper and lower disks, and when two of them are to be added, the disks of the circular slide rule are shifted to bring these two fractions together. The sum will then be found opposite the notch cut in the small disk. Both the fraction and the decimal equivalent are displayed, the latter showing through the notch on the lower scale. For subtraction, the slot on the small disk is set opposite the minuend, when the answer will be found on the large disk opposite the subtrahend on the small disk. The instrument is made of celluloid, so it may be washed whenever it gets soiled. It should prove a very useful device, particularly for draftsmen, machinists, tool-makers, etc. It is sent postpaid to any address for $1.00.



A Circular Slide Rule for Adding and Subtracting Fractions and their Decimal Equivalents.

MOHN UNIVERSAL VISE FOR DRILLING, MILLING, ETC.

The universal vise for holding work for drilling and milling operations, etc., shown herewith, is built by W. D. Mohn & Co., Reading, Pa. The simplicity of its construction is at once apparent, particularly in the matter of setting for drilling angular holes. This is effected by a rod. which may be extended more or less to tip up the vise to the angle required There are no loose parts, as even the wrench is permanently mounted in place on the screw.



A Simple Adjustable Vise for Drilling, Milling, etc.

The base of the tool has a ledge on all four sides, so that it may be clamped securely to a machine table from any side without springing either the vise or the machine. The front side in the view shown in the illustration is machined, so that the vise may be set on edge. The sliding jaw has a vertical groove (which does not show plainly in the illustration) for holding round work. The handle is carefully proportioned to allow firm pressure to be brought to bear on the work, without danger of an excessive strain, the handle having a length proportioned to the size of the vise. The screw and nut cannot be ruined by an attempt on the part of the workman to increase the leverage by a piece of pipe stuck over the end of the handle, as this is bent at right angles, as shown, to prevent such abuse.

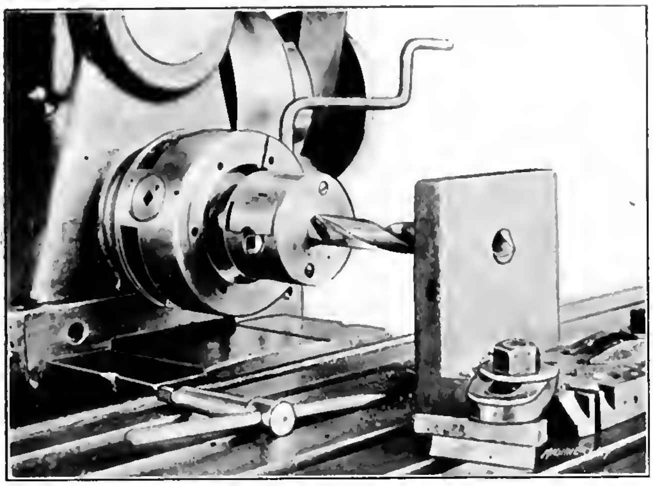


Fig. 1. Casler Eccentric Boring Head, Centered for Drilling.

The tool is made in three sizes. The smallest has a jaw 3½ inches in width and 1 inch deep, giving a maximum opening of 2 inches; the weight is 6½ pounds. The largest size has a jaw 6½ inches wide and 1¾ inches deep; the maximum opening is 6 inches, and the weight is 45 pounds.

CASLER ECCENTRIC BORING HEAD.

The eccentric boring head, illustrated herewith, is designed to be fitted to milling machines, drill presses, boring machines and lathes, and is used to bore holes accurately and to size on any class of work where it is convenient to hold the work stationary, rather than to fasten it to a rotating spindle. It is particularly adapted for use on milling machines, in laying out and boring holes in jigs and tools. It saves time in that it offers means for making minute adjustments quickly and surely, without the uncertainty of adjustment found in using a boring bar with an inserted cutter held by wedges or set-screws. It is a difficult matter to adjust such a cutter with a hammer to exactly the right diameter.

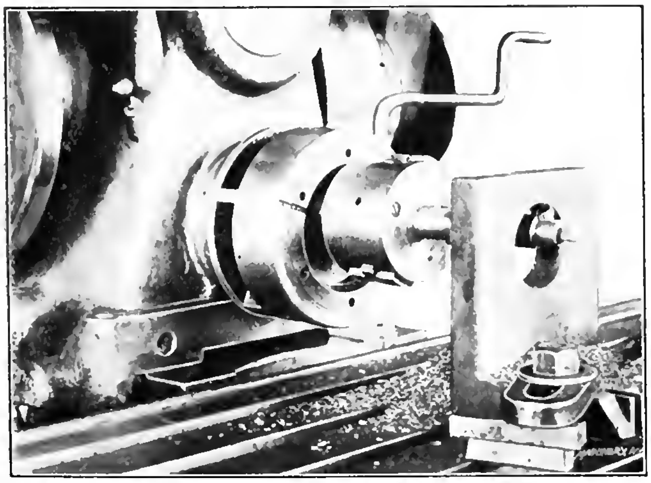


Fig. 2. Enlarging the Drilled Hole with a Boring Tool.

Figs. 1 to 4 show the device in use and Fig. 5 shows its construction. The tool consists of a body *A*, which is threaded to the spindle *B* of the tool on which it is used. The outer face of this body is recessed to receive a plate *D* into which is threaded the tool-holding chuck *C*. *D* is of smaller diameter than the recess in which it is laterally adjustable, so that the chuck may be set at any position from exact concentricity with the center line of the spindle to the maximum offset shown by dimension *F* in the face view. This latter adjustment is controlled by a screw in the side of the body *A*. The head of this screw is provided with graduations reading to 0.001 inch, and has a squared socket so that it may be operated by the chuck wrench. It is not shown in Fig. 5, but may be seen plainly in Figs. 1 and 3. When the adjustment has been made, the floating disk *D* is clamped by screwing down the threaded ring *E*, firmly binding the whole head together.

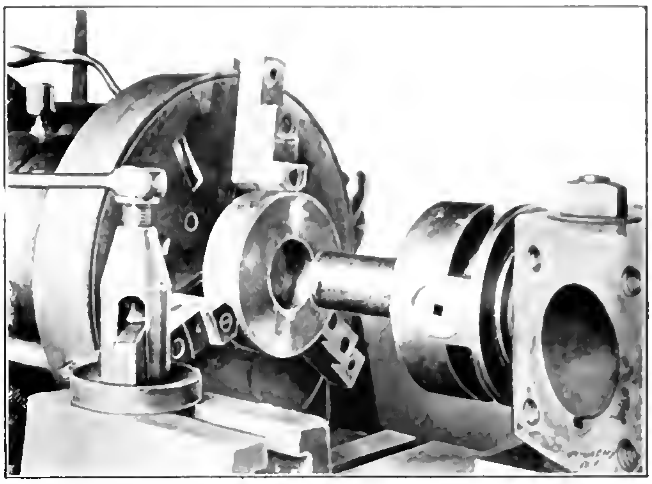


Fig. 3. Use of Adjustable Head in Turret Lathe. Chuck replaced by Heavy Boring Tool.

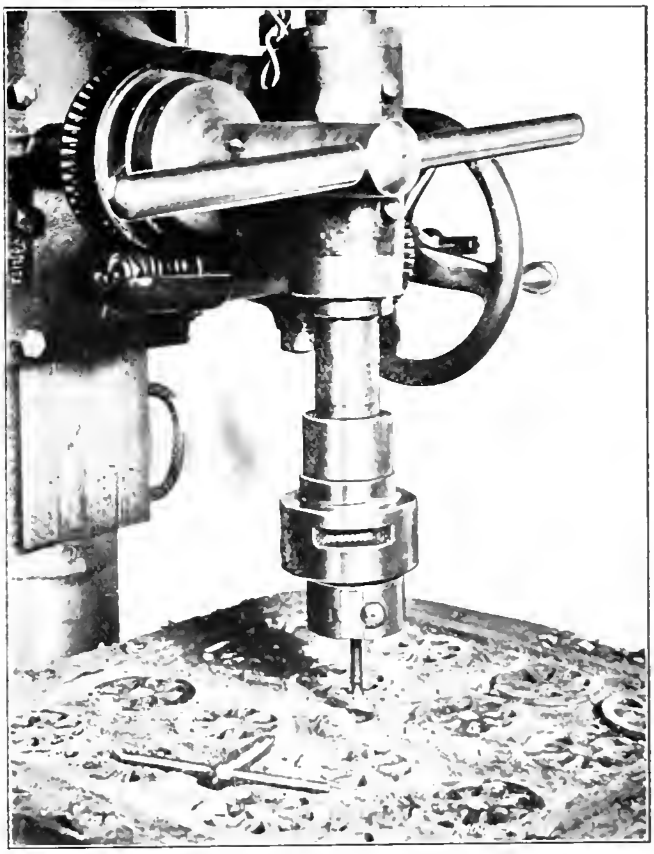


Fig. 4. Boring Head in Use on Drill Press

In using the tool for boring moderate sized holes, the drill chuck is first set concentric with the boring head, and the ordinary twist drill is used in the chuck to start the hole, as in Fig. 1. After the hole has been brought nearly to the size by the use of twist drills, the drill is replaced by a tool with a single cutting point, similar to a lathe boring tool (see Fig. 2). By means of the offset movement of the drill chuck, this tool is easily brought to the proper position to

[illegible] to [illegible] to the required diameter. But very few tools [illegible] a wide range of work, for the reason that [illegible] between the minimum and the maximum diameters [illegible] tool will cover, is equal to four times the offset [illegible] the boring head.

In cases where a tool which could be held in the drill chuck would not be heavy enough, the latter can be removed from the boring head and a heavy bar of the required length inserted in its place; cutting tools can be secured in this bar by set screws for the coarse adjustments, and the finer adjustments obtained by the graduated screw on the boring head. The head is shown thus equipped in Fig. 3, where it is being used as a stationary tool in the turret machine for a boring operation. Fig. 4 shows its use in the drill press.

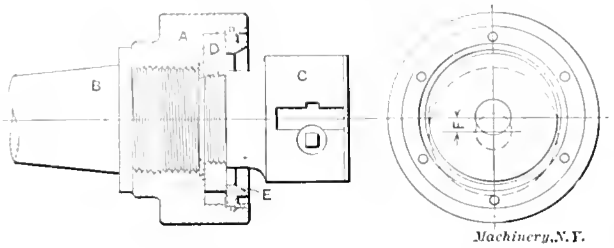
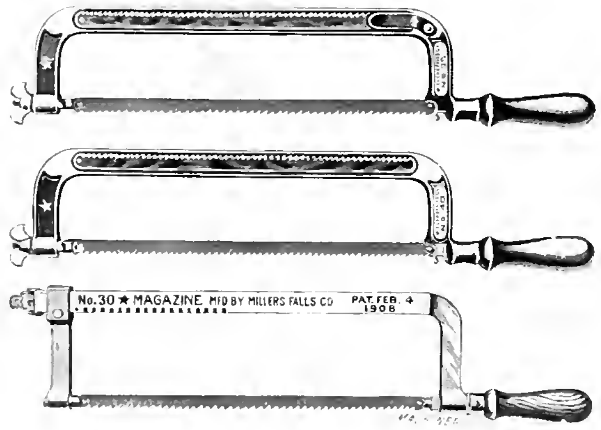


Fig. 5. Details of Construction of Eccentric Boring Head.

It should be noted that the head allows drills or tools to be passed clear through the chuck into the spindle hole, if desired. The end of the drill chuck or boring bar is supported very close to the end of the spindle, so that very little space is required for the head. The rigid construction of the tool (which will be easily appreciated from Fig. 5) permits the use of heavy cuts, as the whole device forms practically an extension of the spindle. The Marvin & Casler Co., Canastota, N. Y., is the builder.

MILLERS FALLS CO.'S MAGAZINE HACK-SAW FRAME.

The Millers Falls Co., 28 Warren St. New York City, has devised a new form of hack-saw frame which provides a receptacle for extra blades. This provision may be truthfully described as "filling a long-felt want," as it is not uncommon to see a hack-saw frame with extra blades tied to it with a string to keep them from getting lost. The improvement will be, perhaps, more appreciated for individual than for factory use.



Various Styles of Hack-saw Frames, with Provision for Carrying a Supply of Blades.

This hack-saw frame is made in the three styles shown in the accompanying engraving. The upper frame for 12-inch blades is made from cast iron. The magazine is formed by a deep recess cast on each side of the back of the frame, into which six 12-inch blades can be placed for storage, three on each side. The blades are held in place by a flat retaining spring. The second frame is the same as the previous one, with the exception of the provision for holding the blades in the magazine. In this case they are simply sprung into shields or pockets at the ends of the recesses. The adjustable style of frame is made to hold blades from 8 to 12 inches inclusive. These have the magazine in the back of the frame, which is hollow, being made of rectangular tubing. There is room here for a dozen blades. The depth from the back to the cutting edge is 3½ inches.

ROOT COUNTER.

The C. J. Root Co., Bristol, Conn., manufacturer of counting machines, has produced a new design which presents a number of advantages over other machines previously built. The instrument is contained within a case fastened with a Yale lock as shown, and it is so constructed that the mechanism is safeguarded against any tampering from the outside. It is provided with a glass cover, but even should this cover be broken, the figures cannot be changed until the apparatus is unlocked.

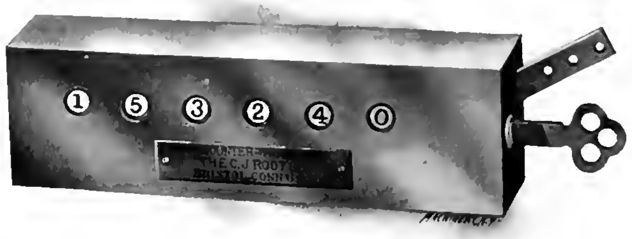


Fig. 1. The "Root" Counter, with Lock Cover to prevent Tampering.

The mechanism is shown with the cover open in Fig. 2. As may be seen, it is of the simplest form imaginable. There are no springs and the action is positive. It is impossible for the figures to jump. It will register at any reasonable speed and lock the dials at each change of the figures. Very little power is required to move it, even when the whole six figures are changed at once. The wearing surfaces have been reduced to a minimum. Resetting the counter is a matter of the utmost simplicity. The cover is thrown back, and each dial in turn is pulled out ¼ inch, set at the desired figure, and returned, beginning at the right-hand figure. The closing and locking of the cover again holds the dials firmly at the new setting, without any possibility of change except with the movement of the counting lever.

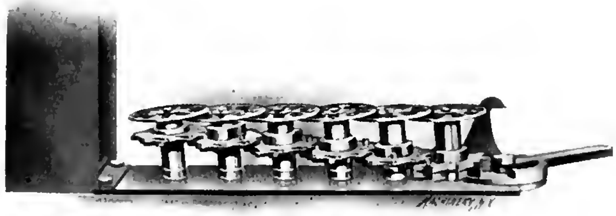


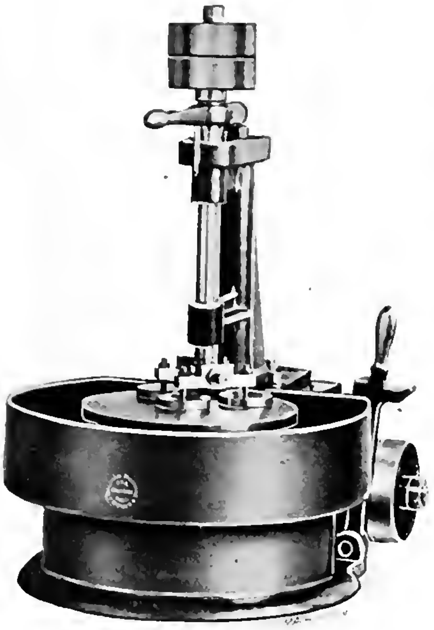
Fig. 2. Cover Raised, showing Simplicity and Positiveness of Mechanism.

WALTHAM FLAT LAPPING MACHINE.

The Waltham Machine Works, Newton St., Waltham, Mass., builds the flat grinding or lapping machine shown herewith. It is intended for the finishing of flat parts on a revolving disk or lap of glass, tin, cast iron, or other material, charged with an abrasive of a kind and grade suited to the material worked and the finish desired. The principal points of interest in the machine are a solid, compact construction, every part being above the bench and easy of access; the geared drive to the work and lap spindles; and the pressure equalizing arrangement for the driving arms.

In using this machine, the work is secured (usually by shellac) to suitable cast-iron blocks such as the four seen resting on the lapping plate in the engraving. These blocks are guided by center holes in their upper faces in which are pressed center points mounted in arms on the upper shaft.

These four points are mounted on the opposite ends of two arms, pivoted on a rock shaft as shown. This rock shaft is pivoted in turn to the vertical spindle, which is provided with weights at the top to give the desired pressure between the work and the lap. The system of pivoted arms and cross-bars evidently equalizes the pressure on the four pieces of work. The weights may be changed to suit the area and material of the work being finished.



A Lapping Machine for Flat Surfaces.

The upper shaft and that carrying the lap both revolve—the former four times as fast as the latter, and in the opposite direction. This constantly changes the position of the work on the disk, and breaks up all the lines formed by the continued action of the abrasive. By swinging the head carrying the upper shaft and by adjusting the distance of the center points which guide the disks, the work may be so located that exactly the full surface of the lap is covered while in operation.

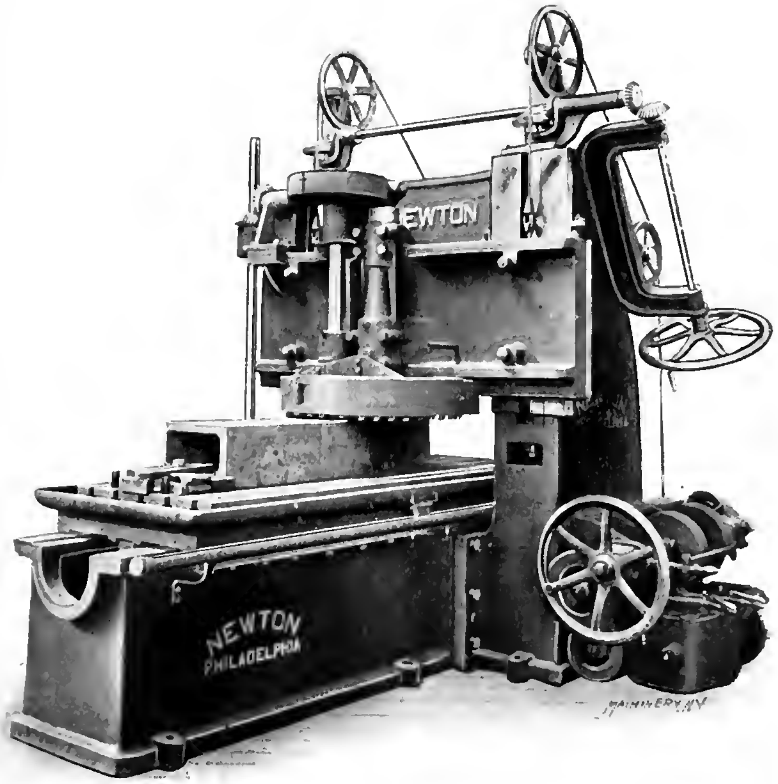


Fig. 1. Newton Vertical Spindle Rotary Planing Machine, with Adjustable Cross-rail.

The diameter of the lapping disk is 12 inches. The weight of the machine is 365 pounds.

NEWTON VERTICAL SPINDLE ROTARY PLANING MACHINE.

The Newton Machine Tool Works, Inc., Philadelphia, Pa., has developed a vertical spindle rotary planing machine, specially adapted to machining turbine segments such as required in the building of the Curtis turbine by the General Electric Co. The machine itself, as shown in Fig. 1, has the drive applied directly to the cutter-head, by means of a pinion engaging internal teeth in a rim on its upper face. The cutter-head or face-plate gives a width of cut of 30 inches over the extreme diameter of the cutting tools. The power is furnished by a 10-H. P. motor with a speed variation of 750 to 1,000 revolutions per minute. This is connected by the spur and bevel gearing shown with the worm and worm-wheel keyed to the driving pinion.

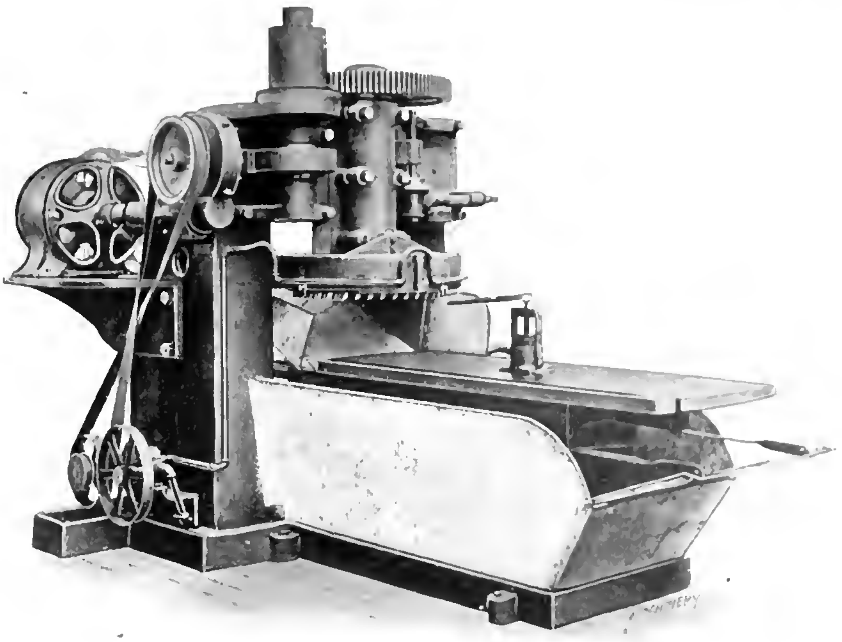


Fig. 2. Rotary Planing Machine with Revolving Table, for Changing Work while the Machine is in Operation.

The saddle which carries the spindle has a firm bearing on the upright, on which it has a hand vertical adjustment, giving a range of 8 to 26 inches from the points of the tools to the top of the work-table. The latter is 30 inches wide, and 7 feet 3 inches long, with a working surface 6 feet long. It is entirely surrounded by an oil pan. The feed movement is through a spiral gear and rack. Nine changes of geared feed are provided, ranging from 0.941 to 9.75 inches per minute. Hand adjustment and power quick return are provided, if a reversing motor is used; this gives a fast traverse in either direction. The hand-wheels for adjusting the rail and the table, and the levers for engaging the feeds and fast traverse motion, are located on the working side of the machine within easy reach of the operator.

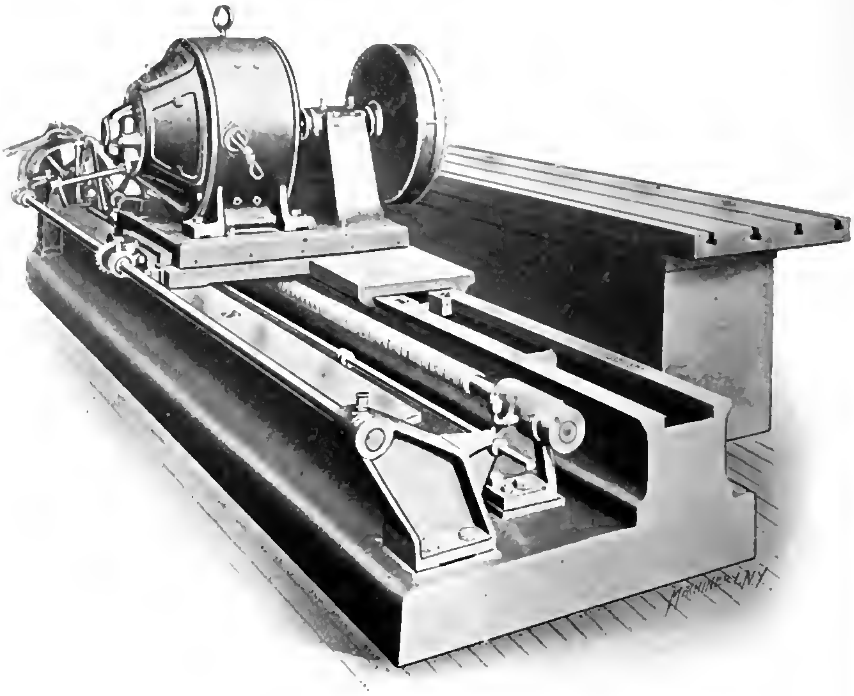
Fig. 2 shows a machine of this type provided with an auxiliary table, which may be revolved about a central pivot. This allows work to be set on one end while the work at the other end of the table is being machined. When the cut is finished the platen is run back and the table is swung half way around, presenting the new lot of work to the cutter, while the old work is in position for changing. This gives practically continuous operation.

DIAMOND MACHINE CO.'S TRAVELING-HEAD FACE GRINDER.

The heavy face grinding machine shown herewith is built by the Diamond Machine Co., of Providence, R. I., for the use of structural iron workers, bridge builders, safe makers and manufacturers in similar lines, where it is necessary to grind to close dimensions such parts as beams, columns, steel safe-plates, cast iron floor plates, etc.

As shown in the illustration, the grinding head is direct connected to an electric motor, which, together with a very heavy outboard bearing is mounted on a large base moving on ways. The motor has an extended shaft to carry the grinder chuck. The work is stationary, being bolted to the large platen in front of the 22-inch emery ring, while the ring rotates and also moves slowly back and forth from end to end of the platen. The reversing is done by a hand lever when the machine is in use, but automatic stops are provided at each end of the $8\frac{1}{2}$-foot traverse, to prevent over-travel should the attendant neglect to reverse the feed. The maximum cross feed of the grinder is $\frac{1}{2}$ inch, and is operated by a hand wheel and miter gear on a splined shaft in the front of the machine. The longitudinal travel of 20 feet per minute is obtained from the triple-threaded feed-screw shown; the lead screw is driven by a second motor not visible in the illustration.

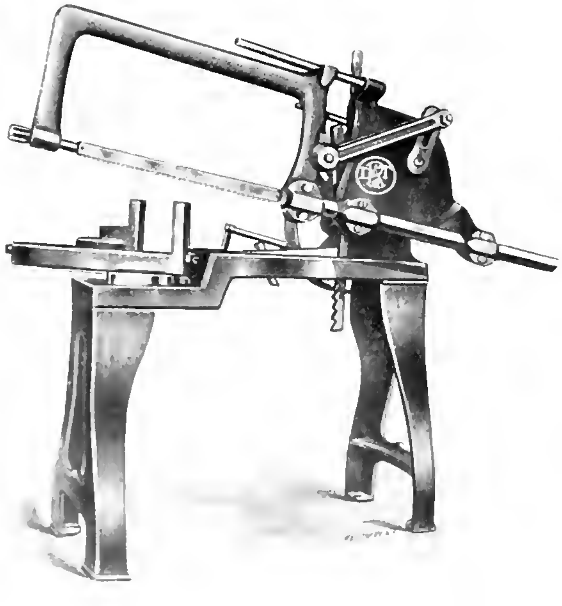
The grinder is direct connected to a standard Westinghouse totally enclosed motor, type "S" compound wound, direct current, giving 10 horse-power at 1,100 R. P. M. Where required, an alternating current motor may be supplied in place of the direct current machine. The size of the motor to operate the lead screw is dependent upon the amount of metal to be removed.



A Traveling-head Grinder for Heavy Surfacing.

ROBERTSON POWER HACK-SAW.

The power hack-saw shown herewith is made by the Robertson Drill & Tool Co., 1848 Niagara St., Buffalo, N. Y. It is called by its maker the "Royal 1909 Power Saw." It incorporates a number of improvements which will be readily understood from the following description:



Power Hack-saw made by Robertson Drill and Tool Co.

The driving mechanism is contained, as may be seen in the engraving, in a hollow gear box which is pivoted about the driving-shaft, and carries the guides for the saw-slide. The crank-shaft is connected to the drive-shaft by spur gearing inside of the gear box; the crank gives a stroke adjustable from 4 to 9 inches in length. The saw frame slides on a long, square guide, which is in line with the blade, and nearly in line with the thrust of the crank movement. This gives a smooth reciprocating action without the cramping met with in the usual construction. The feed is by gravity and means are provided for increasing the pressure as the saw wears. The saw is relieved on the return stroke. The vertical handle shown in the rear lifts the frame, while placing new work in the vise. This handle operates a notched lever, that holds the frame at any desired height in even inches, within its capacity. The frame can also be raised to a vertical position, thus providing ample space for handling large work held and conveyed by a crane.

The vise has a swiveled jaw for holding taper work, and itself swivels on the bed, being provided with graduations up to 45 degrees. This permits the taking of angular cuts. It will be noted that the bed is lowered where the vise is located. This enables the saw to be started at a good cutting angle when the largest work (8 by 8 inches) in the capacity of the machine is being operated on.

. The parts are fastened together as far as possible with tongue and grooved connections, insuring first-class alignment. All plane surfaces are milled. The length of the blade used may be from 14 to 17 inches. The machine should run at from 60 to 70 strokes per minute. A high-speed design is furnished by the makers which has a tank for holding lubricant, which is pumped onto the saw. The pump is located in the head, and is geared to the driving pinion, which operates the pump only when the saw is cutting. Suitable provisions are made in the motor for straining the lubricant, and returning it to the tank for re-using.

* * *

Alteration sales are a common excuse made by a certain class of tradesmen for alleged reductions of prices. The gullible public is asked to believe that so great is the need of alterations to accommodate new stock in a growing business, that the merchant will sell his present stock at prices below cost in order to make the clearing out necessary for the changes. The fact that the business of the merchant is *selling goods* for profit and not making alterations stamps most of such claims as deceitful devices, and they insult the average intelligence, but strangely enough, though entirely unsubstantiated by logic, they are daily made the pretence of price reductions. The question is, who is most deceived, the public or the proprietors themselves. Whatever the answer is, the practice is a strange and interesting example of the confusion of cause and effect existing in the minds of a large part of apparently intelligent people.

NEW MACHINERY AND TOOLS NOTES.

All-Steel Screw-Driver: Billings & Spencer Co., Hartford, Conn. This screw driver is forged in one piece, including both handle and blade. The former has a shape which gives the workman a firm grip on the tool.

Sectional Flanging Press: Wm. H. Wood, Media, Pa. A flanging press of 200 tons capacity, adapted to the sectional flanging of work too large to be done in a single operation. Three plungers are provided, one for holding the work, one for outside flanging, and a third for reverse flanging.

Test Indicator for Lathe Work, etc.: Benjamin F. Ennis, 214 W. Beard Ave., Syracuse, N. Y. This tool is an indicator of sensitive construction, arranged to be conveniently used for testing the truth of internal or external revolving surfaces. It may also be used as a depth gage for comparative readings.

Motor-Driven Saw: Crescent Machine Co., 56 Main St., Leetonia, O. In this machine the motor is mounted on an extension of the base and is directly belted to the saw arbor. The machine can be located in any position desired, independently of line shafts. It is provided with complete adjustments, making it suitable for cutting sharp tools.

"Toggle-grip" Wrench: Lever Co., 45 Cedar St., New York. In this tool the sliding jaw is set to the desired adjustment by means of the usual knurled screw. The jaw may then be closed firmly on the work by a lever operating a toggle movement which firmly holds the wrench on the nut, without the possibility of slipping.

Automatic Unloader for Air Compressors: Hunneymen Co., Concord, N. H. This is a device for regulating the delivery of air from the compressor to the receiver. It is operated by the variation of the receiver pressure, and controls the valve action of the compressor, being thus more economical of power than the safety valve arrangement often used.

"Indestructible" File Handle: J. L. Osgood, Buffalo, N. Y. This design obviates the splitting of the handle—an accident which is liable to be dangerous, as well as costly in the aggregate. The tang is held in a steel tube, which receives all the strain of compression due to the driving in of the file. This steel tube is flanged and headed over the ferrule, which is thus held firmly in place.

Threading Tool: William Avery & Co., Foxboro, Mass. The design of this tool permits the swiveling of the holder in the shank to agree with the angle of the thread. The tool may be used as a solid or spring holder, at will, the change being effected by the simple removal or insertion of a pin. A tongued and grooved connection keeps the springing motion radial to the work, preventing sidewise movement.

Tait Universal Tool-Holder: Van Doren Mfg. Co., Chicago, Ill. This holder consists of two pieces between which the cutting blade is clamped by the action of the tool face screw. These blades may be round, square or of several sections for boring, turning, parting and side tools or other forms. The holder is made in eleven sizes ranging from ¼ x ½ x 4 inches for the smallest up to 1¾ x 2¼ x 18 inches for the largest.

Heavy Lincoln Miller: Hendey Machine Co., Torrington, Conn. This miller is intended for the heaviest formed cutter work for interchangeable manufacturing. The table has a working surface if 15 by 54 inches, and an automatic feed of 36 inches. Twelve feed changes are provided, in a gear box of the standard Hendey-Norton type. The cone pulley has three steps for a 4-inch belt.

The Universal Woodworkers' and Patternmakers' Vise, made by the G. M. Yost Mfg. Co., Meadville, Pa., is so constructed that it can be used in the usual method with the vise jaws flush with the edge of the bench, or it may be universally adjusted by swiveling about two axes at right angles to each other. The jaws have different forms in their different faces, to hold a variety of work. It is unnecessary to mortise the bench in mounting the vise. The jaws are 8 inches wide and 16 inches long.

Automatic Calculating Time Stamp or Chronograph: Baird Mfg. Co., 1592 North Halstead St., Chicago, Ill. This instrument is designed to print the elapsed time on a card or ticket, and is useful in keeping track of the delivery of messages, telephone calls, and cost accounting systems of various kinds. The mechanism is simple, compact, and durable. It may be set into a desk flush with the top, with only the printing levers exposed. A ribbon is provided which is self-feeding, presenting a new and fresh surface for every impression.

Semi-Automatic Nut Burring Machine: National Machinery Co., Tiffin, Ohio. In this machine the nuts to be burred are placed by the operator in an inclined trough at the side of the machine. They are taken from the bottom of the trough and passed through the machine without further attention. The cutting head automatically adjusts itself for different thicknesses of nuts and is provided with safety trips for blank nuts, etc. As the operator does not work in close proximity to the cutters, the chance for accident is practically eliminated.

Internal Fire Continuous Furnace: W. S. Rockwell Co., 50 Church St., New York, N. Y. This furnace is of the rotary type, provided with a grooved helical lining which feeds the material through from end to end of the furnace, as the latter revolves on the supporting rollers provided for it. The oil or gas used as a fuel is injected directly into the chamber in a direction opposite to that of the travel of the material. The machine, as will be seen, is of the continuous-action type, constantly receiving fresh parts, and delivering them at the front with the heat treatment properly applied.

Grinder for Sharpening Threading Dies: National Machinery Co., Tiffin, O. This machine grinds the chasers for belt cutter dies in such a way as to give them the proper bevel and clearance, enabling each chaser in the set to do an equal portion of the work. This results in better threads and in lengthening the life of the die. It will sharpen any size or type of threading chasers on the market. A suitable chart is furnished for making the necessary settings for various diameters, and it is an easy matter to change from one size to another.

Quick-Acting Tool-Makers' Vise: Mutual Machine Co., Hartford, Conn. This vise comprises a movable jaw, sliding on longitudinal rods seated in the fixed jaw, and adjustable thereon by a screw working in an adjustable yoke. The position of this yoke on the rods may be quickly changed by turning a locking disk out of engagement with ratchet-shaped teeth cut on the inner sides of the rods. This constitutes the quick-adjustment feature. All the parts are finished and hardened. The jaws measure 3 by 1¾ inches, and open out to 2 inches in width.

Simplex Multiple Spindle Automatic Screw Machine: Boston Bolt Co., 40 Farnsworth St., Boston, Mass. This is an automatic screw machine designed and built in England, of which a number have been sold in this country. It is to be built here by the Boston Bolt Co. It is of the multiple spindle type, in which the turning tools are carried in a stationary head and the work spindles are mounted in an indexing drum. A feature of the machine is an adjustable feed cam by means of which the movement of the tool slide may be varied to exactly suit the dimensions of the work being turned.

Electric Pyrometer: Leeds & Northrup Co., Philadelphia, Pa. This pyrometer is of unusual construction, in that it combines the functions of an instrument of the deflection measurement type, with the accuracy and constancy of the Wheatstone Bridge method of measurement. The current used in measuring is obtained from any direct current system, and is practically independent of voltage fluctuations. A regular stock ammeter without shunt is used. The operation of measuring consists in balancing the bridge for about the desired temperature (within 200 degrees) and then reading the finer calibration on the ammeter dial.

Large Traversing Head Boring Machine: Beaman & Smith Co., Providence, R. I. This machine is of the type in which the spindle is carried by a vertically adjustable saddle on a horizontal adjustable column or head, the work being clamped

to a suitable floor-plate. The machine is particularly interesting from its size. The spindle is 6½ inches in diameter and has a 72-inch feed. The vertical adjustment is from 2½ to 10½ feet above the table. A revolving work-table is provided, having a working surface of 6 by 8 feet. This table is revolved by a 5 horse-power motor which is also used for its adjustment lengthwise in the bed.

"Perfection" Wrench: Perfection Wrench Co., Port Chester, N. Y. This wrench provides a combination of quick adjustment and toggle joint grip. In adjusting, the jaws are set to graduations. The force of the grip is controlled by turning a set-screw, which, however, does not need to be altered every time the wrench is changed from one size nut to another. The wrench may be adapted for use in piping work by removing the hardened smooth false jaws, and replacing them by hardened serrated jaws. The tool may be used as a vise also, or as a parallel drill press clamp, being finished to hold the work true on the machine platen.

Horizontal Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This horizontal boring machine (which is also adapted for drilling and milling) is of the type in which the work-table is adjusted longitudinally and crosswise of the spindle, on an extended knee, which is, in turn, vertically adjusted on the face of the column. The particular feature of the new design is a single pulley drive. All of the feed and speed changes are effected by change gearing. Speeds range from 7 1/3 to 75 8/10 revolutions per minute and the feed changes from 0.05 to 0.115 inch per revolution of the spindle.

Single-Phase Motors for Machine Driving: Wagner Mfg. Co., St. Louis, Mo. This line of motors is particularly suited for direct connection to machine tools. The line includes designs for all frequencies from 25 to 140 cycles, and a wide range of sizes from ¼ to 40 H. P. in either a constant speed or variable speed construction. A feature of the design of these motors is the provision of an automatic governor apparatus for starting the machine with a heavy torque, on the repulsion principle. When speed has been obtained, the action of the governor transforms the rotary winding to the squirrel-cage form, after which the motor operates as a regular induction type machine.

Excelsior Multiple Punch: Excelsior Tool & Machine Co., East St. Louis, Ill. This machine bears no resemblance to an orthodox punching machine, though it performs the same work. It is intended for punching any required layout of holes in sheet iron at one operation. A horizontal die-plate, stripper plate and punch holder is provided for the full size of the sheet, with loose punches mounted in place over the die holes. A heavy and strongly supported roller is passed over the top of the punches, depressing them one after the other, as the roller comes in contact with them. This roller is set at a slight angle, so that it does not have to strike a transverse row of the punches simultaneously.

Releasing Tap and Die Holder: Wells Bros. Co., Greenfield, Mass. This is a tap and die holder of the pull-off or releasing type. It is of unusually simple and effective construction. When threading on the work the tool is driven by a positive jaw clutch. This operates until the movement of the tool-slide stops, when the continued action of the tap or die pulls the jaws of the positive clutch out of engagement, allowing the holder to revolve freely with the work. When the spindle is reversed, a friction roller clutch of simple form takes hold, and withdraws the die, releasing again as soon as the latter starts to work on a new blank. The positive clutches are of hardened steel, securely fastened in place. The use of the friction reverse permits the parts to take hold quickly and quietly and saves the re-engagement of the positive clutch.

* * *

Bids for the construction of a 500-foot steel tower to be used as a wireless telegraph station at Washington have been received. When this station is in operation, it is stated that it will be possible for the Navy Department to be in constant communication with all vessels on the Atlantic seaboard.

TEST ON "STERLING" HIGH-SPEED POWER HACK-SAW.

The "Sterling" high-speed power hack-saw machine, equipped with a 17-inch "Sterling" hack-saw blade (products of the Diamond Saw and Stamping Works, Buffalo, N. Y.), cut off the 6-inch disk of machinery steel shown herewith, in one hour and fifteen minutes. The same blade was then used for cutting six disks from a 5-inch round bar of hammered axle steel, which were completed as follows:

1st cut, 25 minutes; 2nd cut, 28 minutes; 3rd cut, 32 minutes; 4th cut, 34 minutes; 5th cut, 35 minutes; 6th cut, 37 minutes.

After completing this work, the blade was taken out in good condition. The durability of its serviceableness is evident in comparing the slight increase in time required from the third to the sixth cuts. The same saws have been used to cut off sixty-pound steel rails—an operation which can be completed in from six to ten minutes.

A Six-inch Disk of Machinery Steel cut off by a "Sterling" Hack-saw Blade in 75 Minutes.

An important feature of the machine in relation to the durability of the blade, is the provision for placing it in the holder with the teeth either forward or backward, so that after one-half of the blade has been used, by reversing the saw, a fresh portion of the cutting surface is presented, thus saving nearly one-half the blades required for a machine of this capacity. The machine is also provided with a pump and lubricant and suitable draining facilities. This serves to keep the blade cool when running at high speed.

* * *

The United States Steel Corporation announced February 18 that the price of steel so firmly maintained by the company during the past few years would be cut to meet the competition of independent makers, excepting the price of steel rails. It is expected that the price of $28 for rails which has ruled for the past several years will be maintained by the five largest companies by a tacit understanding to that effect. The companies are the United States Steel Corporation, Cambria Steel Co., Lackawanna Steel Co., Bethlehem Steel Co., and the Pennsylvania Steel Co. The announcement of the cut in prices of from $4 to $7 per ton or more is followed by the threat that the wages of employes in steel mills will be reduced in all probability. The reduction of the tariff on steel products, now under consideration by Congress, is probably the reason for the cut in prices and the rumor that wages probably will be reduced.

* * *

The Delaware, Lackawanna & Western Ry. opened a new tunnel to traffic through Bergen Hill, N. J., February 14. The new tunnel contains two tracks which, with the old tunnel, makes four tracks through the hill. The new tunnel is interesting from an engineering point of view in that it is lined throughout with concrete and the rails are laid on creosoted wood ties imbedded in concrete with creosoted blocks for ballast, also laid in concrete. The tunnel is seven-eighths of a mile long.

PERSONAL.

James Duguid, machine shop foreman of the Grand Trunk Railway, Stratford, Ontario, has been promoted to the position of general foreman of the Toronto shops.

Charles Geldart, toolmaker in the Grand Trunk Railway shops, Stratford, Ontario, has been promoted to machine shop foreman, succeeding Mr. James Duguid.

John B. Guthrie has been appointed representative of the Carpenter Steel Co., Reading, Pa., in the Pittsburg district, with office in the Columbia Bank Building, Pittsburg, Pa.

John P. Cosgro has been appointed district manager of Allis-Chalmers Co., with office in El Paso & South Western Building, El Paso, Texas.

A. L. Lovejoy, formerly treasurer of the Becker-Brainard Milling Machine Co., is now manager of the sales department of Pratt & Whitney Co., New York.

J. J. Keefe, well known to the pneumatic tool trade, has entered the employ of the Independent Pneumatic Tool Co., Chicago, Ill., as sales manager, with headquarters in Chicago.

John Edgar, formerly machine tool designer with the Becker-Brainard Milling Machine Co., is employed by the Everett-Metzger-Flanders Co., Detroit, Mich., designing special machine tools for the manufacture of automobiles.

Mrs. Frances A. W. McIntosh, formerly advertising manager of the Buffalo Forge Co. and associated companies, has resigned that position and opened an office at 103 Anderson Place, Buffalo, N. Y., where she will prepare catalogues, advertising copy and general advertising literature.

Fred A. Mitchell has been appointed foreman of the tool room of the New Departure Mfg. Co., Bridgeport, Conn., succeeding Mr. Leland Nelson. Mr. Mitchell served an apprenticeship with the Pratt & Whitney Co., Hartford, Conn., and later worked for the Veeder Mfg. Co., of Hartford. He has been with the New Departure Mfg. Co. for about five years in the capacity of model-maker and foreman of the model department, which he still will supervise.

Prof. H. Wade Hibbard has resigned his position as head of the railway engineering department of Sibley College, Cornell University, to fill a similar position with the University of Missouri. Prof. Hibbard began teaching in the University of Minnesota in 1895, where he was professor of machine design and locomotive engineering. In 1898 a fund became available in Cornell University for the development of a railway engineering department, and Prof. Hibbard became a member of the faculty and developed the course.

J. E. Woodwell of the firm of L. B. Marks and J. E. Woodwell, New York City, has been retained by Messrs. McKim, Mead & White, architects, as consulting engineer for the entire mechanical and electrical equipment, including the heating and ventilation, electric lighting and power, mail handling devices, etc., of the new U. S. Post Office to be erected at the Pennsylvania Terminal Station in New York City. The automatic mail handling machinery will be a special feature of the building.

Ethan Viall, whose contributions on machine shop practice have made his name familiar to our readers, has joined the editorial force of MACHINERY to act as western traveling representative, with headquarters at Decatur, Ill. Mr. Viall is an expert with the camera and his contributions will be profusely illustrated with half-tone views, as in the past, showing shop operations, machines, tools, kinks, and the thousand-and-one devices that American manufacturers are continually bringing forth to facilitate production and reduce cost.

John S. Considine, of Columbia, Pa., has been made assistant track supervisor of the Pennsylvania Railroad Co. This promotion is important as it marks the departure of the company from a long standing rule, that ordinary track laborers could not be promoted to positions higher than track foreman, they not being considered eligible for the higher positions. The company, heretofore, has employed graduates of technical schools for official positions in maintenance-of-way and mechanical departments. Hereafter an employe not having the advantages of a college education, but who displays extraordinary ability, will be considered eligible for higher positions.

* * *

OBITUARY.

J. S. Spencer, head of the J. S. Spencer Machinery Co., Springfield, Mass., died January 18, aged fifty-eight.

Herbert Burroughs, treasurer of the Builders Iron Foundry, Providence, R. I., died suddenly at the Fort Pitt Hotel, Pittsburg, Pa., January 2, aged forty-five.

William C. Stimpson, who was head instructor in forging and foundry work at Pratt Institute, Brooklyn, N. Y., for several years, died at his home in Milford, Conn., January 13.

Otis Eddy Wood, who died in January at his home near Ithaca, N. Y., at the age of seventy-seven, is said to have been the first Morse telegraph operator who learned to read messages by sound.

Ephriam K. Smith, one of the founders of the Diamond Match Co. and maker of the first safety match produced in the United States, died in Philadelphia, Pa., February 16th, aged sixty-nine years.

George W. Shotwell, whose death was mentioned in the February issue of MACHINERY, was not president of the Diehl Mfg. Co., Elizabethport, N. J., but a member only of the family of the president, Mr. Burnett C. Kenyon.

Louis J. Atwood, president of the Plume & Atwood Mfg. Co., Waterbury, Conn., died February 22, aged eighty-two years. He was one of the pioneer manufacturers of the Naugatuck Valley and the inventor of many devices.

John F. Russell, an inventor of national reputation, died in Springfield, Ohio, February 14, aged seventy-one years. Mr. Russell was associated with William N. Whitely in the development of the modern reaper. He took out many patents including improvements on harvesting machinery, steam locomotives, etc.

Edward M. Twiss died at the Dickinson Hospital, Northampton, Mass., February 4, aged sixty-three. For many years he had been foundry superintendent of the Florence Machine Co. of Northampton, and was a very successful iron foundryman, having held important positions in other foundries.

Carroll D. Wright, president of Clark College, Worcester, Mass., died February 20th in his sixty-ninth year. Mr. Wright was noted as a statistician and for his work as United States Commissioner of Labor. He was commissioner of labor for twenty years, his term dating from 1885 to 1905.

Prof. Benjamin Franklin Clarke, Professor Emeritus of mechanical engineering at Brown University, died December 29 of pneumonia at his home in Providence, R. I. Prof. Clarke was born in Newport, Me., in 1831, and since his graduation from Brown University in 1863 has been connected with the faculty. He was twice acting president of the university.

Joseph Wharton, one of the largest individual iron manufacturers in the United States, founder of the Wharton School of Finance and Political Economy of the University of Pennsylvania, president of the American Iron and Steel Association, writer on financial, industrial and scientific subjects, died at his home in the suburbs of Philadelphia, January 11, aged eighty-three years.

W. C. Young, vice-president of the W. C. Young Machine Co., Worcester, Mass., builders of machine tools, died at his home in Worcester, January 30, in his sixtieth year. Mr. Young was well known in Worcester, having lived there for more than forty years. He had served on the city council and on the school board. The business of the company will continue as before.

David E. Harding died at his home in Mansfield, Mass., February 3, in his eighty-third year. He was born on a farm in West Mansfield, his father being one of Massachusetts pioneers, who had settled in Mansfield in 1775. In 1881 he entered into partnership with S. W. Card who was then making taps and dies. The business prospered and in 1891 it was made a stock company of which he was elected treasurer, and which office he held at the time of his death.

Edward F. C. Young was buried December 9. He was born near Morristown, N. J., in 1835 and was educated in the public schools of Jersey City. Mr. Young had been active in politics and was a director in street railway corporations and banking institutions. He is succeeded in the presidency of the Jospeh Dixon Crucible Co. by Mr. George F. Smith, vice-president. Mr. Wm. H. Corbin, counsel for the company, has been elected vice-president.

Alexander Beaudry, president and secretary of Beaudry & Co., Inc., Boston, Mass., died suddenly February 10 at his residence at Weymouth Heights, aged seventy years. He invented the first Beaudry hammer, early in the seventies, and embarked in the manufacture of it in 1880. Since then he has brought out many types of hammers and presses, having twenty-eight patents on tools of this character. The business of the company will be conducted the same as heretofore, as Mr. Beaudry's death will not in any way affect the conduct of the business. He had taken no active participation in it for the last few years.

Jose F. DeNavarro died of heart disease on February 3 at his home in New York, aged eighty-six years. He was born in Spain, graduated from the Spanish Royal Naval Academy and came to America as a teacher in the Jesuit College at Baltimore, Md. He afterward became interested in banking and transportation enterprises, and one of his most notable works was the building of the Manhattan Elevated Railroad, New York. He was the constructor of the first apartment house in New York, and was largely responsible for the establishment of the Portland cement industry in the United States, using the rotary kiln process.

WALTER M. ALLEN.

Walter M. Allen, works manager of the Warner & Swasey Co., died at his home in Cleveland, Ohio, February 8, in his forty-third year. His parents lived in Bristolville, Ohio, where he was born, and his father became engaged in the lumber business in Cleveland, but died when Mr. Allen was seven years old. Upon his father's death, his mother and three children returned to her early home in Cherryville, Me., and his early education was acquired there in the local schools. As a boy he showed great aptitude for things mechanical, but the small shops of that coast town—a box factory and a few boat works—did not satisfy his ambition. When only sixteen or seventeen years old he frequently went to the nearest railroad station, a distance of thirty miles, to study and make drawings of the locomotives that passed. When eighteen he was apprenticed to the machine trade in the works of the Warner & Swasey Co., and throughout his apprenticeship displayed great earnestness, ability and integrity. In 1891 he was made head of the drafting-room in which department he had displayed unusual ability, and during the next two years the details of design and construction of the 26-inch telescope of the Naval Observatory, and the 40-inch instrument of the Yerkes Observatory, were very largely developed under Mr. Allen's direction. In 1893 he was in charge of the firm's exhibit at the Columbian Exposition, Chicago, and on his return, when scarcely twenty-seven years old, was made superintendent of the works, which position he held with general satisfaction during the next six years. In 1904 he was made works manager, which position he held at the time of his death. The position involved not only general oversight of the works, but an active part and general responsibility in the business management as well. Mr. Allen ranked high as a designer of machinery and tools, being a man of quick perception and good judgment. He was well informed on engineering subjects generally and took an active part in planning and constructing the present new shops. He was a member of the American Society of Mechanical Engineers, Cleveland Engineering Society, Cleveland Chamber of Commerce, The Colonial Club of Cleveland, and the Automobile Club of Cleveland. He is survived by a wife and two sisters.

EDWIN REYNOLDS.

Edwin Reynolds, one of the most distinguished American mechanical engineers, died at his home in Milwaukee, Wis., February 19. Mr. Reynolds was born on a farm and learned the machinist's trade in Connecticut. In his early years he entered the employ of George H. Corliss, Providence, R. I., then the most prominent engine builder in America, and finally became general superintendent. He left the Corliss company to take charge of the E. P. Allis Co.'s works in Milwaukee, which at the time was in the hands of a receiver, to put it on a paying basis. He succeeded in doing this to a marked degree through his improvements in engines and mining machinery. The Reynolds-Corliss engine became famous as an engine of close regulation, high speed, and low steam consumption, and the works prospered. In his early career with the Allis works he took a contract for a 20 by 42 engine for the Trenton Iron Works which was required to run at 160 revolutions per minute. This high speed required a special valve gear and large ports, and the leading Corliss engine builder, George H. Corliss, would not consider the order. Reynolds built the engine successfully, and it was a great advertisement for his company. His most notable achievement, so far as the general public is concerned, was the design and construction of the great 8,000 horizontal and vertical compound engine for the Manhattan Elevated Railway power station in New York about 1900. The general features of the design of these engines were worked out by Mr. Reynolds on a railway train going to Milwaukee after having secured the contract in New York. The requirements were for great power and close regulation, and the ordinary design would have made necessary cylinders so large that it would have been very difficult to cast them without flaws and other serious defects. Mr. Reynolds conceived the idea of connecting high- and low-pressure cylinders to one crank pin and putting the generator between two sets of cylinders, the crank-pins standing 135 degrees apart. The result was a great success, as the world knows. A notable achievement in mining engineering made by Mr. Reynolds was the substitution of solid for flexible foundation under steam stamps. It had been the general practice to erect mine stamps on a springy foundation, and the result had been unsatisfactory. Mr. Reynolds very sensibly pointed out that the steam stamp was made to crush rock and that it was very poor engineering to mount it on a "feather bed," as he called it, and it was simply a matter of a solid foundation in order to get the very best effect of the blow. He took the responsibility of erecting the first steam stamp with a solid foundation, and the efficiency and durability were much increased. Mr. Reynolds was president of the American Society of Mechanical Engineers 1901-1902. He was consulting engineer of the Allis-Chalmers Co. at the time of his death.

* * *

The United States naval fleet of sixteen battleships anchored in Hampton Roads, Va., February 22, thereby completing the famous round-the-world cruise begun there December 16, 1907. The fleet doubled South America, passing through the Straits of Magellan, proceeding thence to Valparaiso, Magdelena Bay, San Francisco, Hawaii, Samoan Islands, Australia, Yokohama, Cheefoo, Suez Canal, Gibraltar, and Hampton Roads. The total distance traversed by the fleet was over 42,000 miles, and the vessels are said to be still in fit condition for further service, but, of course, they will go into dry-dock for cleaning and general repairs.

* * *

The Cunard Line steamer *Mauretania* beat all records for a day's run from Sunday noon until Monday noon, February 7-8, when she logged 671 nautical miles, making an average of 26.84 knots for the twenty-five hours.

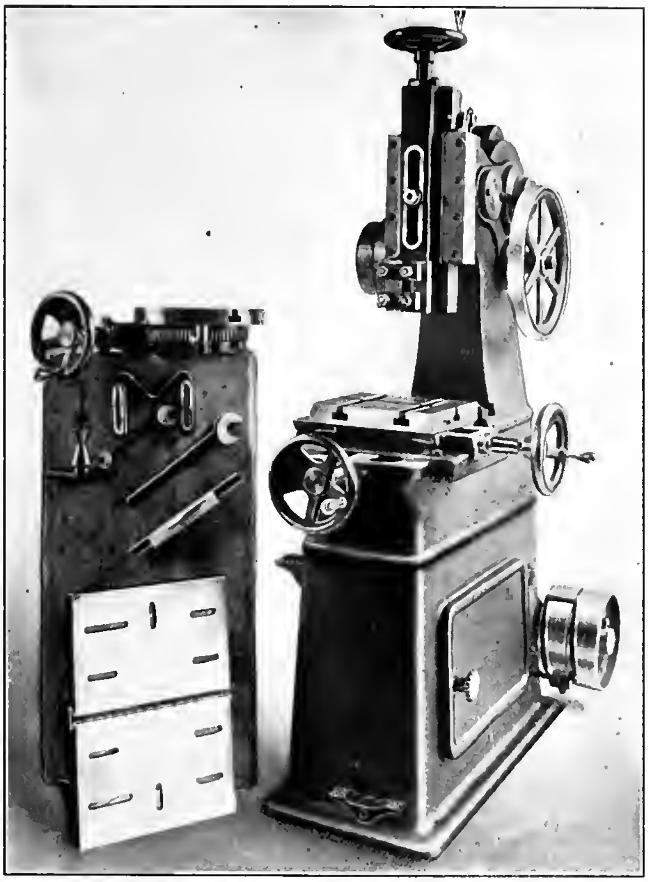
AN ENGLISH SLOTTING MACHINE.

JAMES VOSE.

The accompanying engraving illustrates a small slotting machine designed for rapid handling of the many jobs which are best dealt with on a vertical planing machine. The points of easy manipulation and large capacity have been kept in mind by the designer—Mr. A. Haworth—who has had extensive workshop experience with leading British concerns.

Though having so short a maximum stroke as 5 inches, a quick return motion is provided. The length of the guiding area of the ram is ten times its breadth. No counter-shaft is required, apart from that integral with the machine, which provides for two cutting speeds, and can be driven direct from the line-shaft. A flywheel is provided, placed at the side of the machine, so that the workman may easily adjust the position of the ram when setting work. The ram is adjustable within a range of 7½ inches by a hand-wheel and screw, while the machine is in motion.

The top slide of the table may be set central with the ram by means of a spring-backed plunger, and an attachment, shown at the left, allows work placed on the table to be self-centering. The tools supplied with the machine—for slotting keyways—are of a special nature, do not require forging, and are held central in a tool-holder which fits in a central groove in the face of the ram. An adjustable dead-stop enables quantities of pieces to be duplicated. A circular attachment is supplied and is provided with an index dial of 360 divisions. A spring plunger gives 2, 3, 4, 6 or 8 divisions without necessitating the use of the index dial. This attachment is extremely useful for cutting square, hexagonal, etc., internal or external shapes, in addition to circles or combinations of circular and rectilinear outlines. An auxiliary table 20 inches long and 14 inches wide is another useful extra, enabling work of a bulky outline to be clamped down for machining. A positive belt shipping arrangement, absolutely preventing self-starting, conduces to safe working by the operator.



An English Slotter for Toolmaking and Similar Work.

Some of the leading capacities and dimensions are given as follows: Stroke, zero to 5-inch; depth admitted under head, 12½ inches; traverse to or from body, 14 inches, and transverse travel, 14 inches. Pulleys, gears, etc., up to 24 inches diameter can be keywayed. The surface of the top-table is 15 x 12 inches. The driving pulley is 20 inches diameter for 3-inch belt and has a speed of 240 revolutions per minute. The machine weighs about 1,230 pounds. It is built by A. Haworth & Co., Luton, England. As giving some indication of British prices for tools built in fair-sized lots, the machine illustrated, including the circular table and work-centering attachment, but not the extra table, is marketed here at about $180.

* * *

AMERICAN ANTI-ACCIDENT ASSOCIATION MEETING.

The American Anti-Accident Association held its first meeting February 11 at 215 West 23rd St., New York, with Thomas D. West, Sharpsville, Pa., presiding. The meeting was held in two sessions, the program being as follows:

Afternoon Session.—"The Fundamental Features Involving Work for the American Anti-Accident Association," by Mr. Thomas D. West; "Hoodlumism in Holiday Observance," by Mrs. Isaac L. Rice, President of the Society for the Suppression of Unnecessary Noise, New York City; "Fire Wastes Through Carelessness," by Mr. C. M. Goddard, President of the National Fire Protection Association, Boston, Mass.; "Our Shameful Lead in Railway Accidents, and the One Sure Method of Checking It," by Edward Bunnell Phelps, Editor of the *American Underwriter*, New York City; "The Child, and Accidents of our Unbridled Laxity," by Thomas D. West, President of the American Anti-Accident Association, Sharpsville, Pa.

Evening Session.—"Museum of Safety and Sanitation," with lantern slides, by Dr. William H. Tolman, Director of the American Museum of Safety, New York City; "Industrial Accidents and the Inventors," by Joseph J. O'Brien, Member of the International Congress of Inventors, Washington, D. C.; "Safety Devices in the Machine Shops and Manufacturing Plants," by Prof. John E. Sweet, Syracuse, N. Y.; "An Analysis of 5,500 Machine Shop Accidents," by Mr. L. P. Alford, Member of the Editorial Staff of the *American Machinist*, New York City; "Wage Workers' Accident Insurance and Compensation Fraternity," also Municipal Anti-Accident Boards, by Mr. Thomas D. West. The association extends a general invitation to government and municipal officials, professional men, commercial travelers, manufacturers, managers and superintendents, merchants, labor leaders, mechanics, factory inspectors, fire and life insurance officers, teachers and all other citizens to become interested in the work. The organization is due to the president, Mr. Thomas D. West, who for many years has been greatly interested in the prevention of accidents. He believes in the theory of teaching workmen to take care of themselves and to cooperate with manufacturers in the use of all devices intended to lessen the maiming and death roll in manufacturing and transportation.

* * *

The expert knowledge required to properly adjudicate patent causes, due to the growing complexity of the art, has made the need of a special court of last resort to decide patent cases, keenly felt by all concerned in such litigation. A bill has been introduced in the House of Representatives and favorably considered, for providing a special court of appeals consisting of two judges, assigned permanently, and one federal district judge, with salaries of $6,000 a year each. It is to be hoped that the bill will be passed and the special court established.

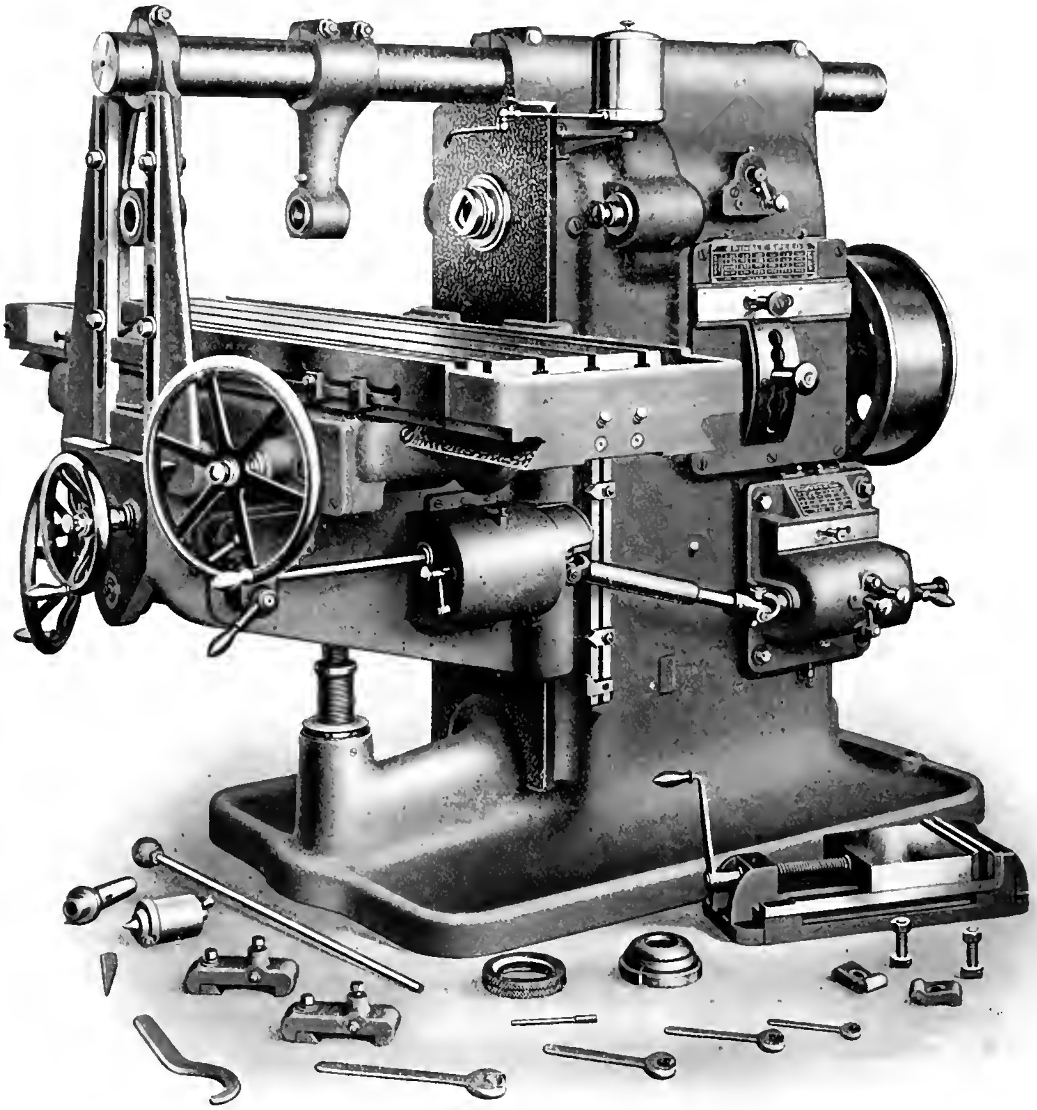
* * *

The torpedo boat destroyer *Tartar* of the English navy, using liquid fuel and steaming under war conditions, exceeded, on January 15, 38 knots an hour, thus beating her official trial record. The trial record was made in December over the official course of the Admiralty between Southampton and Maplin Sands, when the speed attained was between 35 and 36 knots an hour. Previous to this official trial, the *Tartar* made almost 36 knots an hour, beating, at that time, all records for ships of her type. The *Tartar* has been in service since April, 1907, and is a sister ship of the *Mohawk*, which also uses liquid fuel. These boats are 270 feet long, and have engines of 14,500 horse-power.

Brown & Sharpe Mfg. Co.,

The Quality and Quantity

of Work Turned Out on the B. & S. Constant Speed Drive Milling Machine is a Forcible Example of the Rigidity of its Construction.



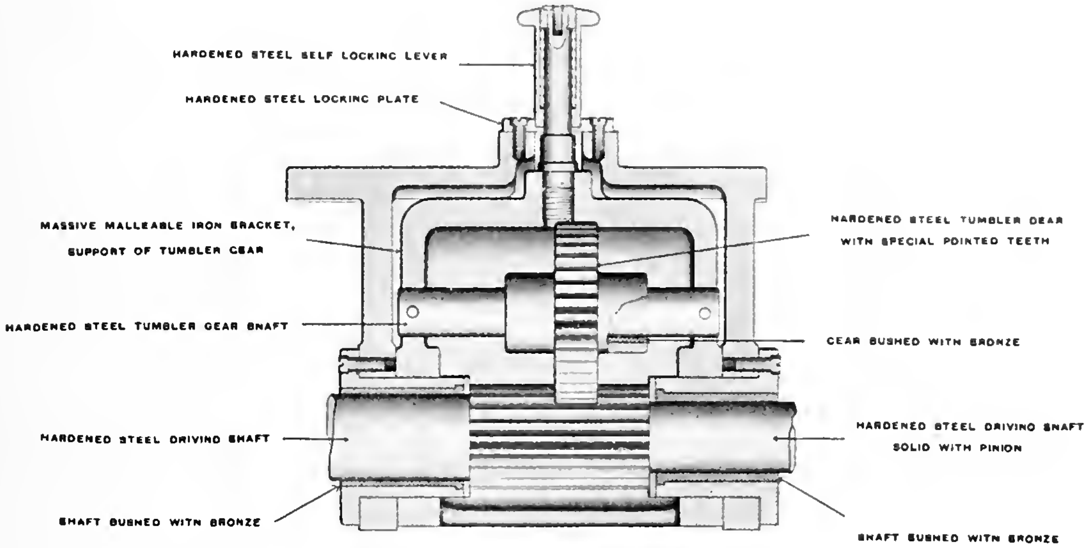
No. 5-B HEAVY PLAIN MILLING MACHINE
(SHOWN ABOVE)

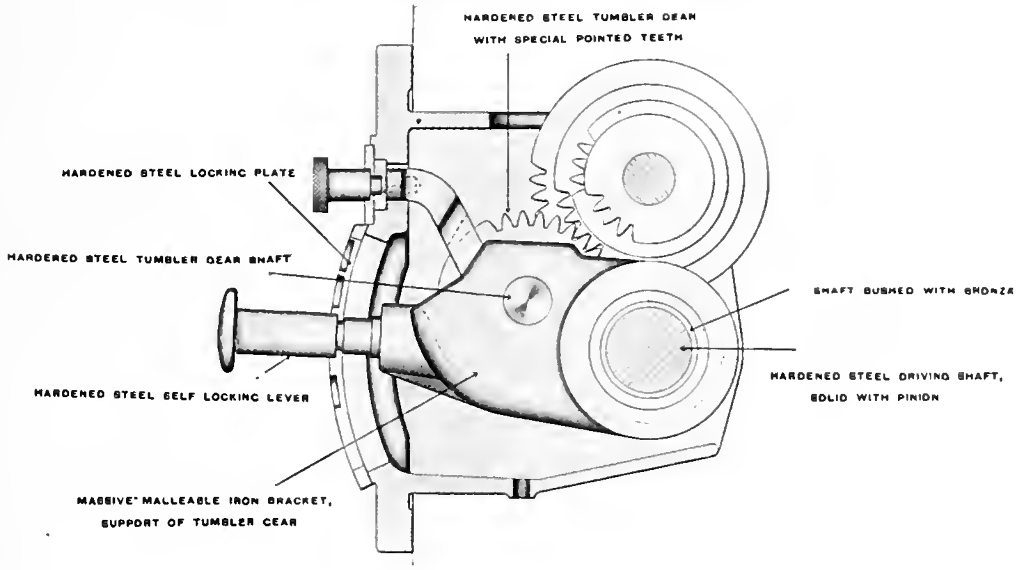
THE entire line of Constant Speed Drive Milling Machines is designed for heavy service and as a whole is a striking illustration of solidity in construction. The rigid control of the moving parts as the table, saddle and knee, together with the quietness of the running gears when the machine is under heavy service show that the design is correct and solidity has been attained.

Providence, R. I., U. S. A.

Tumbler Gear Mechanism

—a Vital Part in the Construction of a Milling Machine, the Design of which is being Daily Demonstrated Mechanically and Practically Correct.





STUDY carefully the above cuts. Note the compactness and heavy proportions of the supporting parts. All shafts are rigidly supported close to where pressure is applied. The tumbler gear itself is strongly supported in a massive malleable iron bracket trunnioned around two heavy stationary bushings, thereby resisting all twisting and cramping strains. It is locked by a heavy hardened steel self-locking lever in a massive hardened steel plate.

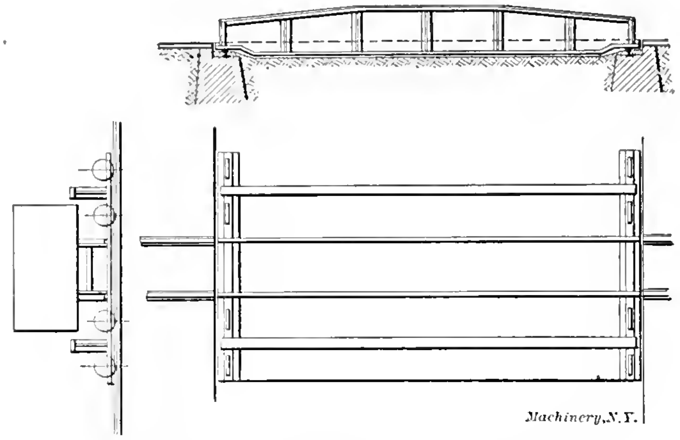
WANTED, PUBLISHED DESCRIPTION OF TRANSFER TABLE.

A reward of forty pounds sterling is offered by Messrs. Harris & Mills, 23 Southampton Buildings, London, W. C., England, to the first person handing them a public paper containing a description of a traverser of the form shown in the accompanying illustration, which complies with the following conditions:

1. The paper must have been published during the last hundred years.

2. The paper must have been published earlier than July 28, 1908.

3. It must be a public paper; according to the Patent Law of Germany any printed paper, printed book, printed lecture or printed report becomes a public paper when it has been exposed at a public library, or if it could have been bought at a bookseller's. Even a printed catalogue or printed prospectus is considered a public paper when forwarded to more than a thousand persons.



"Traverser with raised main girders on the outer side of the profile of the vehicles, moving on a track consisting of only two rails."

4. The description of the traverser, given in the said public paper, must be sufficiently clear to have enabled experts to make use of the idea to construct a similar traverser.

5. The paper must be handed in to Messrs. Harris & Mills before 3 P. M. on March 15, 1909.

6. The traverser must be like a bridge on rollers; the traverser must have raised main girders on the outer sides of the profile of the vehicle, as represented in the drawing.

7. The traverser must move on a track consisting of only two rails.

8. It is not essential whether the traverser has a pit or not. It is, however, more probable that there will be a pit.

9. The traverser may, just as well, have only four rollers instead of the eight rollers represented in the drawing.

* * *

IMPROVED HIGH-SPEED STEEL.

On another page of this issue will be found an account of an English high-speed steel that is claimed to be far superior to the other high-speed steels in general use. In the note Professor Arnold is reported as stating that in all probability every high-speed steel manufacturer in England would soon be making the same steel as the secret could not long be kept. It appears that this prediction was a fact at the time as at least one other maker was then making a water-hardened steel. We understand that "Ultra Capitol" steel, a new high-speed steel, for which George Nash & Co., New York, are the American agents, can be hardened in water and has a capacity of five to eight times the best standard high-speed steel now on the market. It is not claimed for the new steel that it will largely displace the regular grade of high-speed steel, including "Capitol" steel, because the present limitation of machine tools, makes it impossible to realize its full capacity, but it is probable that it will be used for some time to come for work that requires extreme durability of cutting edge. Of course this and other water-hardened high-speed steels will have a very marked effect on machine design, and the efforts of machine tool builders will be to develop lathes, planers, milling machines, etc., to realize the full possibilities of the new product.

* * *

CONSOLIDATION OF CINCINNATI MACHINE TOOL COMPANIES.

The Cincinnati-Bickford Tool Co., Cincinnati, Ohio, was incorporated last month for the purpose of manufacturing a full line of metal-working drilling machinery, with the following officers: August H. Tuechter, president; Sherman C. Shauer, vice-president and general manager; W. H. Shafer, secretary; George P. Gradolf, treasurer; and H. M. Norris, engineer.

This company is a combination of the Cincinnati Machine Tool Co. and the Bickford Drill and Tool Co.; and the officers of the new concern are well known in the trade, having been for many years connected with the two concerns represented in the combination, which will undoubtedly prove a potent factor in the machine tool trade as it contains all the elements of strength and progress.

* * *

The *Brass World* gives the following composition (patented by Wm. J. Leddell of Summit, N. J.) for use in making castings in metal molds: Zinc, 90 pounds; aluminum, 5 pounds; copper, 5 pounds. In cases where a harder alloy is desired, for bearings, etc., the proportions of aluminum and copper may be increased: Zinc, 87½ pounds; aluminum, 6¼ pounds; copper, 6¼ pounds. These alloys are said to have the characteristics of low shrinkage, ability to run into metal molds with sharpness, and freedom of crystallization. In addition, they have the important recommendation of being inexpensive. Where a greater fusibility is desired for castings of extreme sharpness, or where thin shapes are to be cast, the inventor advocates the use of one-half per cent or less of cadmium in the mixture. The use of metal molded castings is increasing, as many parts may be cast so accurately as not to need machining.

* * *

SOCIETY NOTES AND COMING EVENTS.

AMERICAN PEAT SOCIETY held a meeting in New York February 13, at the Chemists' Club, 108 West 55th St., New York, at which papers were presented on the value of peat as a fuel and the condition of peat production in the United States. Thousands of acres of peat lands await development which will be veritable mines of calorific value when people learn of their potential possibility.

THE AMERICAN SOCIETY OF HUNGARIAN ENGINEERS AND ARCHITECTS has been organized with the object of bringing into closer touch engineers and architects of Hungarian extraction living in this country, to give moral support and information to newcomers, and to encourage the exchange of engineering, technical and industrial information between the technical men of Hungary and of the United States. The president is A. Henry Pikler, manager of the transformer department of the Crocker-Wheeler Co., and secretary, Zoltan de Nemeth, of the New York Edison Co. The business address of the society is P. O. Box 103, New York.

March 11-12.—Annual convention of the New England Hardware Dealers' Association in Springfield, Mass. S. H. Thompson, Lowell, Mass., president.

March 27-April 3.—Mechanical and Electrical Exhibition, under the auspices of the Worcester County Mechanics' Association, in Mechanics' Hall, Worcester, Mass. The exhibition will include machinery in the operation of manufacturing goods, and is under the direction of Mr. H. F. Campbell, superintendent, room 6, Mechanics' Hall, Worcester.

May 12-14.—Annual meeting of the National Supply and Machinery Dealers' Association, at the Fort Pitt Hotel, Pittsburg, Pa. Secretary-Treasurer A. T. Anderson, 41 Wade Building, Cleveland, Ohio. The association has a membership of 141 manufacturing concerns.

September 25-October 2.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the Tribune Building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

May 18-20.—American Foundrymen's Association convention. Cincinnati, Ohio, Hotel Sinton, headquarters. Richard Moldenke, secretary, Watchung, N. J.

June 16-18.—Annual convention of Railway Master Mechanics' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 16-23.—An exhibition of machinery, tools and supplies for the railway supply trade will be held under the auspices of the Railway Supply Manufacturers' Association in connection with the railway conventions at Atlantic City, N. J. Membership dues in the association are $25 per year and carry one badge only. Additional badges may be obtained by members for $5 per badge. Contracts have been let for the erection of exhibition structures covering 59,000 square feet, exclusive of aisles. The charge to exhibitors will be 40 cents per square foot, to cover the cost of erection, etc. The association has prohibited the distribution of souvenirs. Application for space should be made immediately to Mr. Earl G. F. Smith, secretary, 345 Old Colony Building, Chicago, Ill.

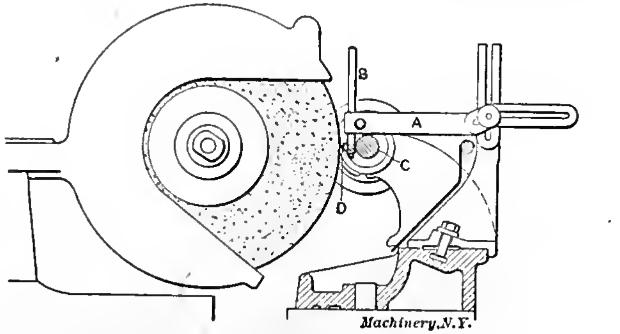
June 21-23.—Annual convention of the Master Car Builders' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

Supplement to MACHINERY, April, 1909.

Operations for the Article in this number entitled "Machine Shop Practice—Cylindrical Grinding.—I."

SHOP OPERATION SHEET NO. 94.

Paul W. Abbott. MACHINERY, April, 1909



Grinding a Hardened Mandrel—Truing the Wheel.

1. Clean the platen of the grinder (in this case a Landis) carefully and set the head- and tail-stocks far enough apart to take the mandrel to be ground between their centers. Be sure that there are no particles of dirt or emery under the head- and tail-stocks, so that they may be clamped down firm and true.

2. Test the head-stock, tail-stock, and wheel spindles to see if there is any play in the bearings. All lost motion in these parts should be eliminated by the means provided to prevent chatter marks and inaccurate work.

3. Select an emery wheel ½ or ⅝-inch wide, of medium grade (60M Norton grading being about right), and mount it upon the spindle. The hole through the center of the wheel should be large enough to be a sliding fit on the spindle, and it is desirable to have either rubber or leather washers between the wheel and the flanges.

NOTE.—When selecting a wheel, the material to be ground, the amount to be removed, and the quality of the finish desired should be considered. More complete information on this subject will be found in the Machine Shop Practice article in this issue.

4. Revolve the wheel by hand and see if the sides run true. A 10-inch wheel should not run out sideways more than 1/64 inch.

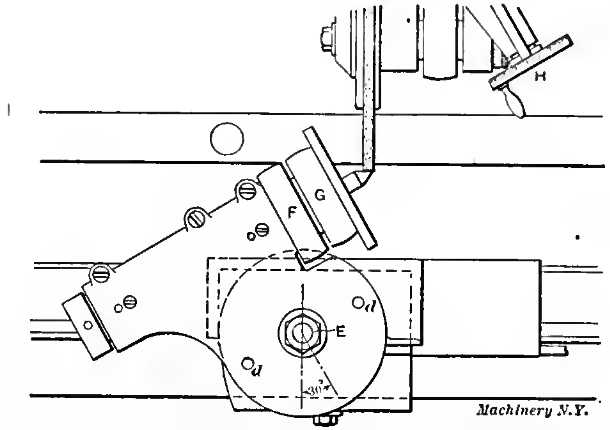
5. Place a piece of work, or an arbor, between the centers, and clamp a truing fixture to the table of the machine as shown in the illustration. Adjust the arm *A*, which holds the stud *B*, until both of these parts are against the piece *C* between the centers, to obtain the required rigidity.

6. Start the machine and set the dogs which regulate the stroke so that the diamond *D* will pass by the wheel on each side about ⅛ inch. Bring the wheel, which should revolve at the speed required for grinding, into contact with the diamond *D* and take light cuts, using water. When taking finishing cuts let the wheel pass by the diamond a few times without advancing it.

NOTE.—The number of times that the wheel has to be trued, depends on the character of the work and the kind of wheel used. When it is necessary to remove considerable stock, the wheel must be trued each time a piece receives a finishing cut.

SHOP OPERATION SHEET NO. 95.

Paul W. Abbott. MACHINERY, April, 1909.



Grinding a Hardened Mandrel—Truing the Centers.

NOTE.—The degree of accuracy to which work can be finished in a grinder, depends partly upon the condition of the machine centers and the corresponding condition of the centers in the work. The illustration shows the head-stock of a universal machine swiveled to an angle of 30 degrees in order that the centers may be accurately ground.

1. Remove the head- and tail-stock centers, which are made interchangeable, and insert the latter in the head-stock. Loosen the nut *E*, remove the dowel pins from the holes *d*, and set the head-stock to an angle of 30 degrees. The angle may be determined by the graduations found on the side of the head-stock.

2. Set the pin used for locking the spindle when grinding on "dead" centers, so that the spindle can revolve, and shift the belt to the pulley *F* which drives it. Start the machine and adjust the traverse dogs, as described in Shop Operation Sheet, No. 96, so that the wheel will overlap the center being ground about ⅛ inch on each side.

3. Bring the wheel into contact with the center by the handle *H*, and take a sufficient number of cuts to true it, using a copious supply of water. Test the angle to which the center is ground with a 60-degree gage; if a slight adjustment is necessary, move the platen by the fine adjustment provided for it. The center should be ground to conform exactly to the center gage.

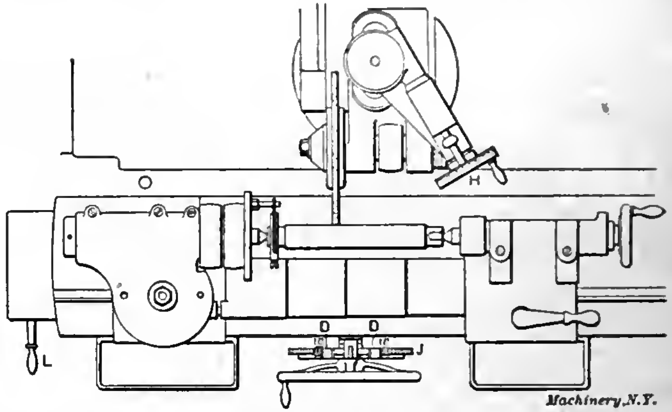
4. Remove the center and place it in the tail-stock. Insert the head-stock center in its spindle and grind the center true, allowing it to remain in the spindle.

5. Loosen the nut *E* and return the head-stock to the zero position. By the insertion of dowel pins in the holes *d*, the head-stock spindle is brought into accurate alignment with the platen.

6. Lock the head-stock spindle and shift the belt to pulley *G* which is for driving the work on dead or stationary centers. Work is ground on dead centers to secure accuracy, for then errors in the machine are not reproduced in the work.

SHOP OPERATION SHEET NO. 96.

Paul W. Abbott. MACHINERY, April, 1909



Grinding a Hardened Mandrel—Grinding.

NOTE.—It is assumed that the center holes were lapped true after hardening the mandrel.

1. Fasten a dog to one end of the mandrel and place the latter between the centers which should be perfectly clean and well oiled.

2. Start the machine and adjust the dogs *D* around the periphery of the wheel *J* until the grinding wheel overlaps the arbor body about ¼ inch. Fine adjustments of these dogs may be obtained by turning the worms *w*, but when they are to be moved some distance these worms are lifted out of engagement with the wheel *J*.

3. By the means provided in the counter-shaft above the machine, adjust the peripheral speeds of the work and wheel to about 25 and 5,000 feet per minute, respectively.

4. Adjust the traverse of the wheel by the lever *L*, until it moves about ¼ inch for each revolution of the work.

5. As the arbor should have a taper of 0.0005 inch to 1 inch, set the swivel table over slightly, using the fine adjusting screw provided.

6. Bring the wheel into contact with work and take one or two roughing cuts. Measure each end of the mandrel with a micrometer for size and taper, and, if necessary, adjust the table. Continue to rough grind, using the automatic feed and removing about 0.002 inch at each cut, until the mandrel is within 0.003 inch of the finished size. A liberal supply of water should be used

7. Change the wheel traverse until it is about ⅛ inch per revolution of the work, and again true the wheel, using the diamond. Take finishing cuts removing 0.0005 inch at each cut. Continue grinding until the small end of the mandrel is from 0.0005 to 0.001 inch under the nominal size, this depending upon the size of the mandrel.

NOTE.—Back rests are used on grinding machines for supporting the work in order to secure accuracy and at the same time permit heavier cuts and more rapid feeds and speeds. No rests are shown in the illustration but one or two should be used, even on short stiff work, to absorb the vibrations.

TABLE OF HORSE-POWER OF GASOLINE ENGINES.

Table I. Horse-Power of Gasoline Engines.

Bore	Stroke								
	Bore + 0	Bore + ¼"	Bore + ½"	Bore + ¾"	Bore + 1"	Bore + 1¼"	Bore + 1½"	Bore + 1¾"	Bore + 2"
2	0.72	0.80	0.89	0.98	1.08	1.17	1.25	1.35	1.44
2¼	1.01	1.12	1.22	1.34	1.45	1.57	1.68	1.81	1.90
2½	1.39	1.53	1.67	1.81	1.95	2.09	2.23	2.37	2.51
2¾	1.85	2.02	2.19	2.36	2.53	2.70	2.87	3.04	3.20
3	2.40	2.60	2.80	3.00	3.21	3.40	3.61	3.81	4.00
3¼	3.06	3.28	3.52	3.76	3.99	4.22	4.45	4.70	4.92
3½	3.81	4.09	4.36	4.63	4.90	5.18	5.45	5.72	6.00
3¾	4.71	5.02	5.34	5.65	5.97	6.28	6.60	6.91	7.23
4	5.71	6.06	6.42	6.78	7.13	7.50	7.85	8.20	8.55
4¼	6.84	7.24	7.64	8.05	8.45	8.85	9.25	9.66	10.06
4½	8.25	8.68	9.16	9.62	10.08	10.54	10.96	11.41	11.89
4¾	9.57	10.07	10.57	11.09	11.58	12.08	12.59	13.09	
5	11.16	11.72	12.28	12.84	13.40	13.95	14.50		
5¼	12.92	13.54	14.15	14.76	15.40	16.00			
5½	14.84	15.51	16.20	16.86	17.54				
5¾	16.96	17.70	18.42	19.19					
6	19.25	20.05	20.85	21.65					
6¼	21.78	22.61	23.50	24.33					
6½	24.43	25.43	26.43						

Table is figured by assuming revolutions per minute = 1000, and mean effective pressure = 90 pounds per sq. inch, corresponding to 68½ pounds compression. Multiply figures in table

For 60 pounds compression by 0.933
70 . . . 1.011
80 . . . 1.066
90 . . . 1.100
100 . . . 1.111

Table II. Horse-Power of Gasoline Engines, figured from A. L. A. M.'s formula $\frac{D^2}{2.5}$ = H.P., where D is the diameter of the bore.

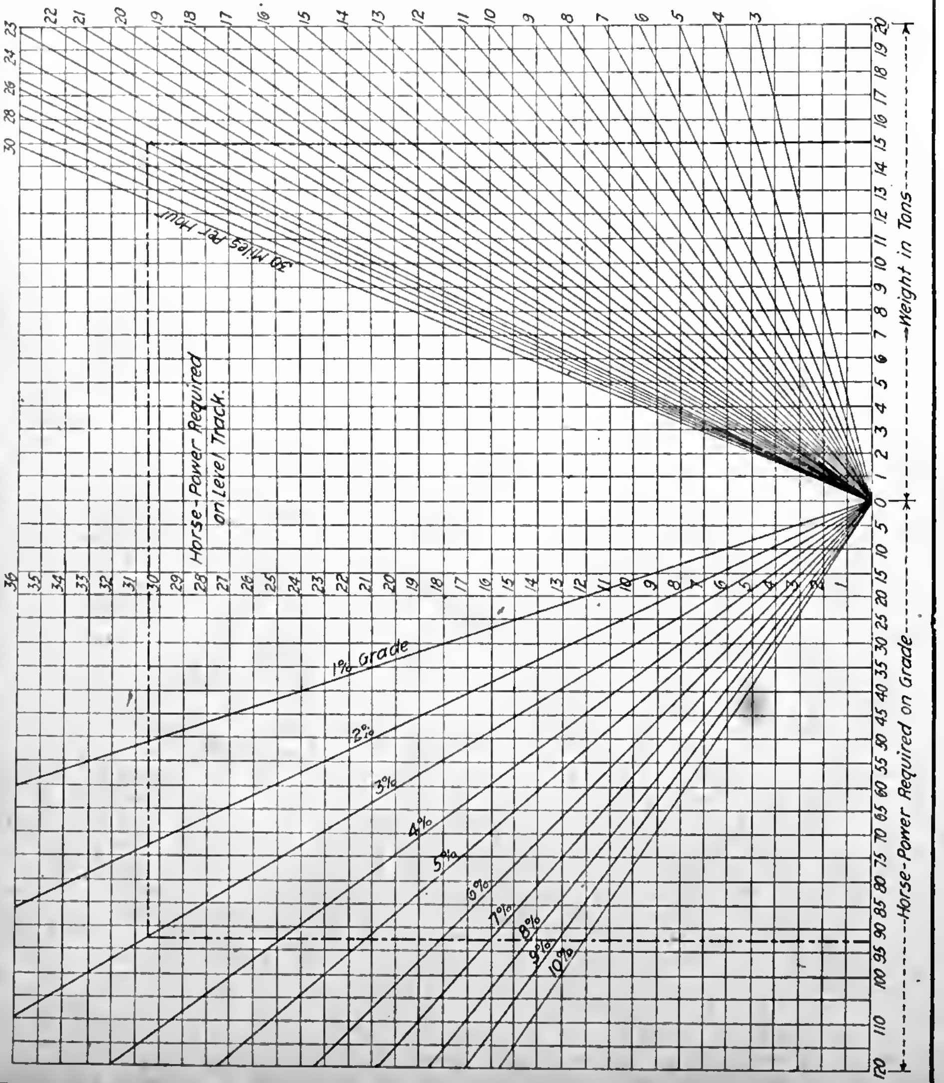
Bore, inches	2	2¼	2½	2¾	3	3¼	3½
Horse Power	1.6	2.025	2.5	3.025	3.6	4.225	4.9
Bore, inches	3¾	4	4¼	4½	4¾	5	5¼
Horse Power	5.625	6.4	7.225	9.1	9.025	10.0	11.025
Bore, inches	5½	5¾	6	6¼	6½		
Horse Power	12.10	13.225	14.40	15.625	16.90		

Contributed by Morris A. Hall

HORSE-POWER REQUIRED FOR MOVING CARS.

Example:— Find Horse-Power required to move a car weighing 15 tons at a speed of 25 miles per hour, both on level track and up a 3 per cent grade.

Find weight in tons, 15, on right-hand vertical scale; follow horizontal line from this point to intersection with line for 25 miles per hour speed. From this intersection follow vertical line to scale for Horse-Power required on level track, reading off 30½ H.P. Follow the same vertical line further to intersection with 3 per cent grade line. From the intersection follow the horizontal line to the right-hand vertical scale, finding 93 H.P.



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I.—DIMENSIONS OF CRANE HOOKS.

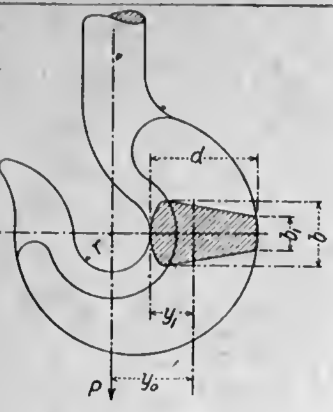

Fig. 1.

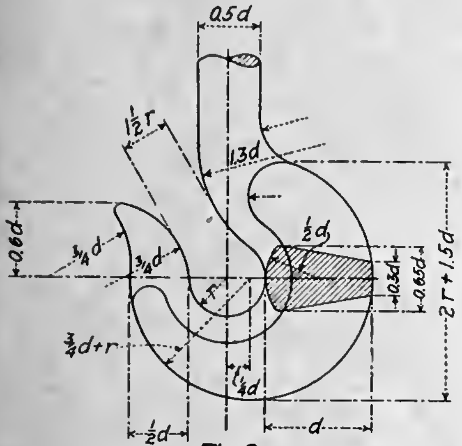

Fig. 2.

Formulas for Crane Hooks.

A = area of section shown in the illustration, in square inches,

f = allowable fiber stress in pounds per square inch

P = load in pounds,

R^2 = square of the radius of gyration in inches.

For b, b_1, d, r, y_0, and y_1, see Fig. 1.

$$\frac{P}{f} = \frac{A}{1+\frac{y_1 y_0}{R^2}} \qquad A = \frac{b+b_1}{2} \times d$$

$$y_1 = \frac{b+2b_1}{b+b_1} \times \frac{d}{3} \qquad y_0 = \frac{b+2b_1}{b+b_1} \times \frac{d}{3} + r$$

$$R^2 = \frac{(b^2+4bb_1+b_1^2)\,d^2}{18(b^2+2bb_1+b_1^2)}$$

Assume $b = 0.65d$, and $b_1 = 0.3d$; then

$$\frac{P}{f} = \frac{d^3}{7.2d + 11.615r} = \text{constant in table.}$$

Directions for using Table for Crane Hooks.

P, f and r are assumed, to suit the requirements; f may be assumed to equal from 16,000 to 25,000 pounds per square inch. Divide P by f and find the quotient in the column headed by the required radius r in the table. Then follow the horizontal line from this quotient to the left-hand column headed d. The figure in this column gives the required width d of the crane hook, and all the other dimensions are found from Fig. 2 as functions either of d or r.

Contributed by H. J. Mastenbrook.

II.—DIMENSIONS OF CRANE HOOKS.

d	Values of r																	
	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	8.00
2.00	0.39	0.34	0.30	0.27	0.25	0.23	0.21	0.18	0.16	0.14	0.13							
2.25	0.51	0.45	0.40	0.37	0.33	0.31	0.28	0.25	0.22	0.20	0.18							
2.50		0.58	0.52	0.48	0.44	0.40	0.37	0.33	0.29	0.26	0.24	0.22						
2.75		0.73	0.66	0.60	0.55	0.51	0.48	0.42	0.38	0.34	0.30	0.28						
3.00			0.81	0.74	0.69	0.64	0.60	0.53	0.47	0.43	0.39	0.36	0.34					
3.50			1.16	1.08	1.00	0.94	0.88	0.79	0.71	0.65	0.60	0.55	0.51					
4.00				1.47	1.38	1.30	1.23	1.10	1.00	0.92	0.85	0.79	0.73	0.69				
4.50				1.94	1.82	1.72	1.63	1.48	1.35	1.24	1.15	1.07	1.00	0.94				
5.00					2.34	2.22	2.11	1.92	1.76	1.63	1.51	1.41	1.33	1.25	1.18			
5.50					2.92	2.78	2.65	2.42	2.23	2.08	1.93	1.81	1.70	1.60	1.52			
6.00						3.40	3.25	2.99	2.77	2.57	2.41	2.26	2.13	2.01	1.91	1.82		
6.50						4.08	3.91	3.61	3.36	3.13	2.94	2.76	2.61	2.48	2.35	2.24		
7.00							4.66	4.32	4.03	3.77	3.54	3.34	3.16	3.00	2.86	2.72	2.60	
7.50							5.46	5.08	4.75	4.46	4.20	3.96	3.76	3.58	3.41	3.25	3.11	
8.00								5.91	5.54	5.21	4.92	4.76	4.43	4.21	4.02	3.84	3.68	3.42
8.50								6.80	6.40	6.03	5.68	5.41	5.14	4.91	4.68	4.49	4.30	3.96
9.00									7.32	6.92	6.55	6.24	5.94	5.67	5.42	5.20	4.99	4.62
9.50		Figures in body of table							8.30	7.86	7.47	7.11	6.77	6.47	6.20	5.96	5.72	5.31
10.00		are values of $\frac{P}{f}$								8.88	8.44	8.05	7.68	7.37	7.06	6.78	6.52	6.07
10.50										9.96	9.48	9.06	8.66	8.30	7.97	7.67	7.38	6.87
11.00											10.60	10.10	9.70	9.31	8.95	8.61	8.28	7.73
11.50											11.70	11.20	10.80	10.30	9.97	9.62	9.27	8.66
12.00												13.70	13.10	12.60	12.10	11.70	11.20	10.50

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MACHINERY

April, 1909.

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—4.

BRAKES AND BRAKE MECHANISM.

R. B. BROWN.

BRAKES for electric cranes may be divided into two types, viz., solenoid, or magnetic brakes, and mechanical brakes. Electrical or magnetically operated brakes are generally ordinary strap or clamp brakes, which are held off by the action of a magnet or solenoid, electrically connected with the motor in such a manner that when the current is cut off from the motor from any cause, the magnet releases the spring or weight, as the case may be, and allows the brake to come into action. The solenoid commonly in use consists of a coil of wire connected in series with the motor, and a plunger working inside the coil as shown in Fig. 9, which represents, in a general way, the form of solenoids manufactured in several sizes by various electrical firms.

Solenoids should be so proportioned that their action is not delayed when the current has been cut off, due to residual magnetism. On the other hand, a too rapid application of the brake is to be avoided, since it has occasionally bent armature shafts; to effect this end the solenoid forms in itself a dashpot, the air being throttled in the small hole at the top of the body. Arrangements are usually made in the winding of the solenoid to enable it to lift off the brake when the controller is on the first contact, otherwise the motor would drive against the brake.

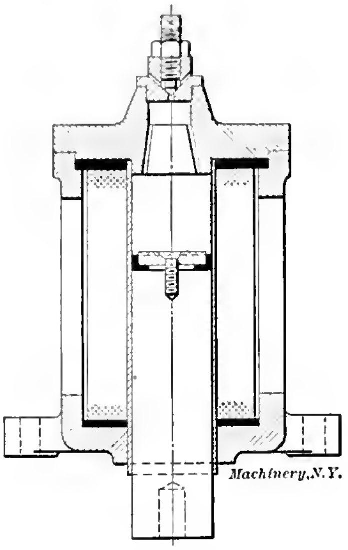


Fig. 9. Solenoid used to Operate Brake for Electric Cranes.

For cranes above five tons capacity the solenoid brake is applied principally as a means of stopping the motor quickly, to facilitate rapid reversal, and it should, of course, always be powerful enough to hold the full load in the event of the mechanical brake failing. The disadvantages of relying entirely on a solenoid brake are due to the fact that it does not permit of steady lowering, since, when the motor is reversed, the brake lifts entirely off and consequently allows the load to run down unchecked until the current is cut off again. This arrangement has been found fairly satisfactory for cranes under five tons (and is, in fact, often used on larger cranes), one reason being that the friction of the crab itself helps to retard a light load to some extent. A better method of lowering for small cranes is shown in Fig. 10, where an ordinary solenoid brake is used which can be released and controlled by a foot treadle for lowering.

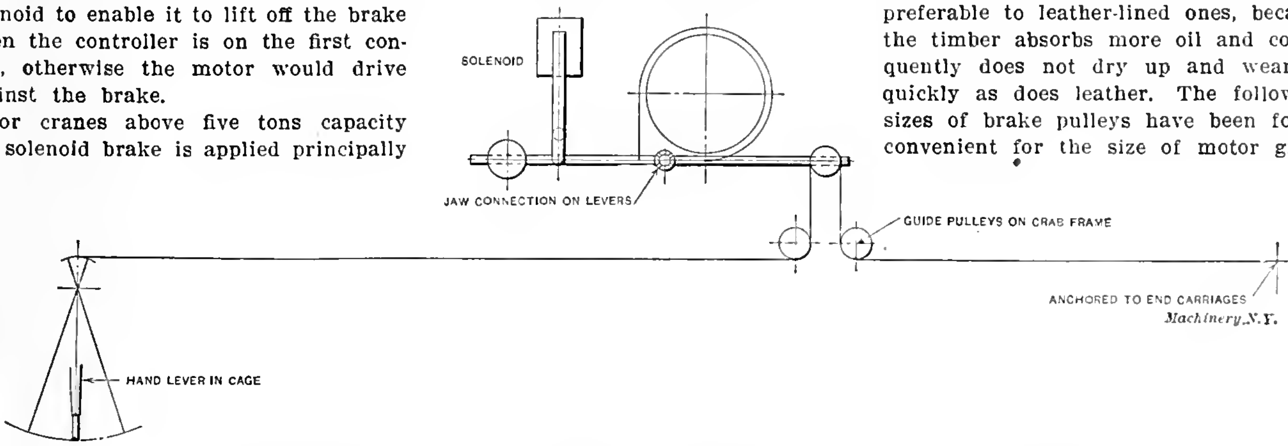


Fig. 10. Solenoid Brake, which can be released and controlled by a Foot Treadle for Lowering the Load.

When a crane is fitted with both a solenoid brake and an automatic mechanical brake, the principal function of the solenoid brake, as already stated, is to absorb the momentum of the armature and gear and stop the motor rapidly, and since this action must take place with the motor running in either direction, the clamp type of brake has been found the most suitable, although the ordinary type of strap brake is frequently used. The solenoid brake is most conveniently applied on the armature shaft itself, since the momentum is more readily absorbed at that point and a smaller solenoid can consequently be employed; but it is a mistake to cut the size of the solenoids too close.

For convenience, motors are sometimes made with the shaft extended at both ends, so that the driving pinion can be fixed on one end and the brake pulley on the other; this arrangement obviates the necessity of coupling a short shaft to the motor and providing an extra and somewhat expensive outer bearing. Brake pulleys are made of cast iron, and, while they should be as large as possible, in order to reduce the tangential force, at the same time the peripheral speed should not, if possible, be more than 2,000 to 2,500 feet per minute, or an inconvenient amount of heat will be produced. In any case, they will, of necessity, become more or less heated, a fact which makes timber-lined brakes preferable to leather-lined ones, because the timber absorbs more oil and consequently does not dry up and wear so quickly as does leather. The following sizes of brake pulleys have been found convenient for the size of motor given below, the full load speed being limited to 750 revolutions per minute for motors up to 20 B. H. P., and 500 revolutions for those above.

Brake Horse-power.	Diameter, inches.	Brake Horse-power.	Diameter, inches
5	10	30	18
10	12	35	18
15	12	40	21
20	15	45	24
25	15	50	24

A compact and typical design of a clamp brake is shown in Fig. 11.

The calculations for all types of clamp brakes are identical, and the horse-power of the motor being given, it is necessary in the first place to find the size of the solenoid. Take for example a 20 B. H. P. motor running at 500 revolutions per minute. If the brake pulley is 15 inches diameter, the tangential effort will be

$$\frac{20 \times 33{,}000 \times 12}{500 \times \pi \times 15} = 335 \text{ pounds.}$$

The [illegible] coefficient of friction for greasy wood on iron is 0.3; therefore, the force required at the center of the blocks will be [illegible] 0.3 = 100 pounds.

The ratio of the levers depends on the stroke of the magnet. Suppose the stroke, in the present case, to be limited to 2 inches, and the blocks are adjusted to lift off ⅛ inch, the ratio will be 2 : 0.25 = 8 to 1, and, consequently, the weight required to stop the motor will be 100 ÷ 8 = 12.5 pounds. It is always advisable to allow for a little extra weight, say 25 per cent, in practice, to cover the momentum, etc., so that in the present example it would be better to provide a 15-pound weight. A small adjusting weight is added to make up the difference between the weight of solenoid core and the actual weight required.

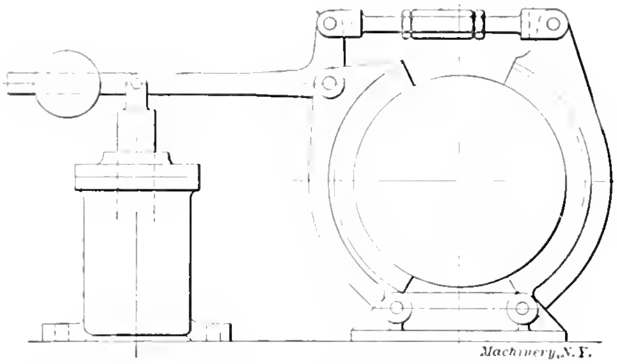


Fig 11 Typical Design of Compact Clamp Brake for Electric Cranes.

Several electrical firms supply an armature brake complete and self-contained on the motor, in which case the weight is generally replaced by a spiral spring.

When a strap brake is more suitable, as in the case shown in Fig. 10, the calculations are somewhat different. The size of the pulley remains the same as given in the previous table, and, as in the case of the clamp type, wood-lined straps are the most serviceable. Having found the tangential effort on the pulley, as before, it is necessary to proportion the levers to give the required pull on the strap. The quantity depends on the proportion of the pulley enclosed by the arc of contact of the strap, the value of coefficient of which will be found in Table VIII. In the diagram over this table it will be seen that if the tangential effort on the brake due to the load is acting in the direction shown by the arrow, the fixed end of the strap will be at F and the slack end, that is the end attached to the lever, at x. To find the pull on the slack end it is only necessary to multiply the tangential effort P by the value opposite the angle θ and under the coefficient μ. For example, the brake for a 10 H. P. motor running at 500 revolutions is 12 inches diameter. The tangential effort

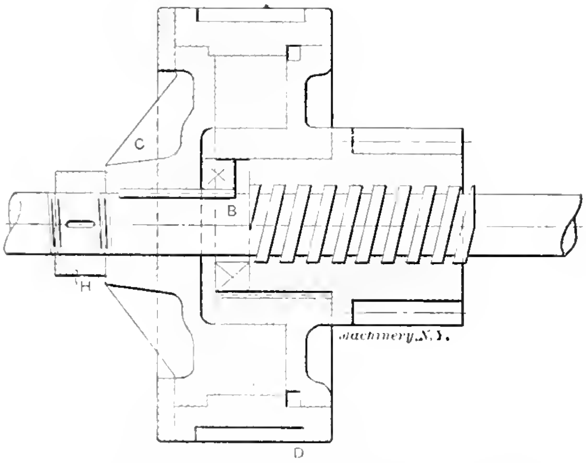


Fig 12 Automatic Screw Brake for Overhead Electric Cranes.

$$P = \frac{10 \times 33{,}000}{\pi \times 1 \times 500} = 210 \text{ pounds.}$$

If $\theta = 210$ degrees, the value of $x = 0.5$ for wood blocks on an iron pulley. Therefore the pull at $x = 210 \times 0.5 = 105$ pounds. The pull on the fixed end can be found from the table in a similar manner, although a table is hardly necessary, since it will readily be seen that the pull at F will equal $x + P$, or the pull on the slack end plus the tangential effort.

The above coefficient may be found independent of the table by calculating the ratio of the tension $\frac{T}{T_1}$ in fast and slack ends of strap from the following formulas.

$$\frac{T}{T_1} = 2.718\ \mu\ \frac{L}{R}.$$

Where μ = coefficient of friction (0.3 for wood on iron).
L = length of contact in inches.
R = radius of pulley in inches.

For example, take the preceding case; then

$$2.718 \times 0.3 \times \frac{22}{6} = 2.99 = \frac{T}{T_1}.$$

$$P = T - T_1;\ \text{but}\ T = 2.99\ T_1.$$

Therefore $P = 2.99\ T_1 - T_1 = 1.99\ T_1$, or $T_1 = \frac{P}{1.99}$.

Since $P = 210$ pounds, $T_1 = \frac{210}{1.99} = 105$ pounds.

And $T = P + T_1 = 210 + 105 = 315$ pounds.

The short lever should be given about half an inch travel, to allow the strap to lift as clear as possible of the pulley; therefore, if the magnet has a stroke of two inches, the ratio of leverage will be 4 to 1, and the pull required 105 ÷ 4 = 26 pounds, showing that this type of brake requires a larger magnet than the clamp type.

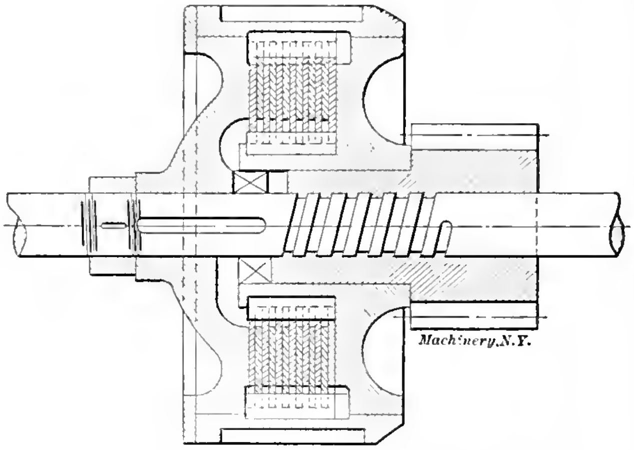


Fig 13. Friction Brake with a Number of Friction Disks.

Brake straps should be made of a good quality mild steel or wrought iron; they can then be stressed up to 5 tons per square inch in the net section, and consequently kept light and pliable.

There are several forms of automatic mechanical brakes used on overhead travelers, foremost among which is the screw brake, as shown in Fig. 12. This brake consists of a pinion of phosphor bronze, or steel, bushed with gunmetal, mounted on a thread which is cut in one of the intermediate driving shafts B. The steel or iron casting C is fixed to the driving shaft by means of a key which allows the necessary lateral movement for the adjustment, regulated by the nut H. The ratchet D, which is cored out to hold oil, and bushed with gunmetal, runs loose on the boss formed by the jaws. All working faces are preferably lined with gunmetal. One or two pawls, according to the size of the brake, engage with the ratchet, being thrown out of gear by a suitable arrangement.

The action of the brake is as follows: When lifting the load, the resulting pressure on the pinion due to the screw holds it hard up against the ratchet face and, the pawls having been lifted out of gear, the whole brake revolves together without resistance. As soon as the lifting ceases and a slight reverse has taken place, the pawls fall into gear, and the load is held secure by friction. In order to lower the load, the motor must be reversed and run on light power, this having the effect of reducing the pressure on the friction faces and allowing the load to slip steadily.

Some makers employ several friction disks in place of the two faces in the form just described. This design is shown in Fig. 13. This type is more powerful in proportion to its size than the other design, but is preferably enclosed in an oil bath to ensure complete lubrication between all the faces. The two jaws in both types are necessary to prevent the pinion backing from the face when the load is too light to keep them together, as when lowering the empty hook.

To calculate the size of the brake shown in Fig. 12, it is necessary to make the diameter such that, allowing for the lowest possible coefficient of friction, it is always in excess of the reaction from the pinion at the radius to the center of the pressure of the frictional surface.

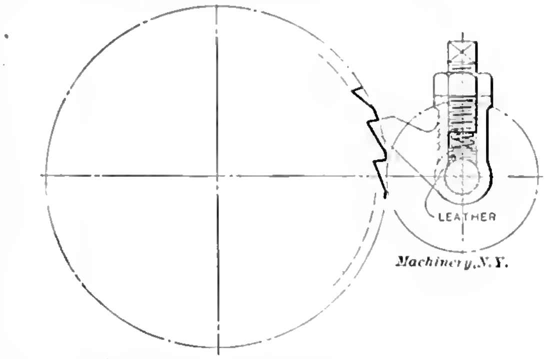


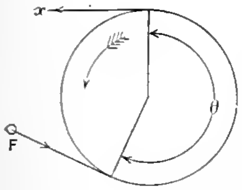
Fig. 14. Arrangement for Releasing Ratchet when Load is Lifted.

If r = radius of pitch circle of pinion = 6.2 inches,
W = load on teeth,
R = radius to center of pressure of disks = 8.7 inches,
p = pitch of thread,
μ = minimum possible coefficient of friction = 0.04,
N = number of frictional faces.

Then $\frac{W r}{R}$ must equal $\frac{N W \times 2 r \pi}{p} \times \mu$.

Take for example the brake shown in Fig. 12 and let it be necessary to find the maximum safe load it will sustain at the pitch line of the pinion.

TABLE VIII.



μ = coefficient of friction = 0.2 for iron to iron, 0.3 for wood to iron, 0.4 for leather to iron. P = pull on brake rim. x = strain on loose end of brake strap. F = strain on fast end. θ = arc embraced by strap (in degrees). Table gives tension on brake straps when P = 1.

θ	Value of x.			Value of F.		
	μ = 0.2	μ = 0.3	μ = 0.4	μ = 0.2	μ = 0.3	μ = 0.4
30°	9.09	5.89	4.29	10.09	6.89	5.29
45	5.89	3.76	2.71	6.89	4.76	3.71
60	4.29	2.71	1.92	5.29	3.71	2.92
75	3.35	2.08	1.45	4.35	3.08	2.45
90	2.71	1.66	1.14	3.71	2.66	2.14
105	2.26	1.37	0.93	3.26	2.37	1.93
120	1.92	1.14	0.77	2.92	2.14	1.77
135	1.66	0.98	0.64	2.66	1.98	1.64
150	1.45	0.84	0.54	2.45	1.84	1.54
165	1.29	0.73	0.47	2.29	1.73	1.47
180	1.14	0.64	0.40	2.14	1.64	1.40
195	1.03	0.56	0.35	2.03	1.56	1.35
210	0.93	0.50	0.30	1.93	1.50	1.30
240	0.76	0.40	0.23	1.76	1.40	1.23
270	0.64	0.32	0.18	1.64	1.32	1.18
300	0.54	0.26	0.14	1.54	1.26	1.14

The maximum permissible pressure per square inch on the area of the two friction faces, to agree with a coefficient of friction of 0.04, is 600 pounds, which agrees with average practice.

The area of the two friction faces = 126.2 square inches.

Total resistance at center of pressure of faces = 126.2 × 600 × 0.04 = 3,029 pounds.

The reaction on the pinion teeth to correspond with this load $= \frac{3{,}029 \times 8.7}{6.2} = 4{,}250$ pounds

It has been shown above that the axial pressure required on the faces to sustain the load is 126.2 × 600 = 75,720 pounds, and having the load on the pitch line the purchase of the screw will have to equal $\frac{75{,}720}{4{,}250} = 17.8$.

The circumference of the pitch circle of the pinion is 19.6 inches, therefore the pitch of the screw will be $\frac{17.8}{19.6} = 0.9$, or, for practical purposes, 15/16-inch pitch.

Some arrangements must be adopted for the pawls in order to release the ratchet when the load is being lifted, otherwise an objectionable noise will be made. One common arrangement is shown in Fig. 14 in which there are two pawls, one of which is set at half the pitch of the ratchet and mounted on a shaft which is driven through light spur gearing from the brake shaft, as shown. The pawls are moved by this shaft through the friction due to the leather pads which are pressed onto the shaft by a spring.

Another, and somewhat simpler, construction is that shown in Fig. 15. In this arrangement the weighted pawl *A* is thrown in and out of gear by the hinged friction clips *B*, which are adjusted by means of the spring bolt *C*. In either of the above designs the pawls should always be so constructed that in the event of the friction drive failing they will fall into gear with the ratchet.

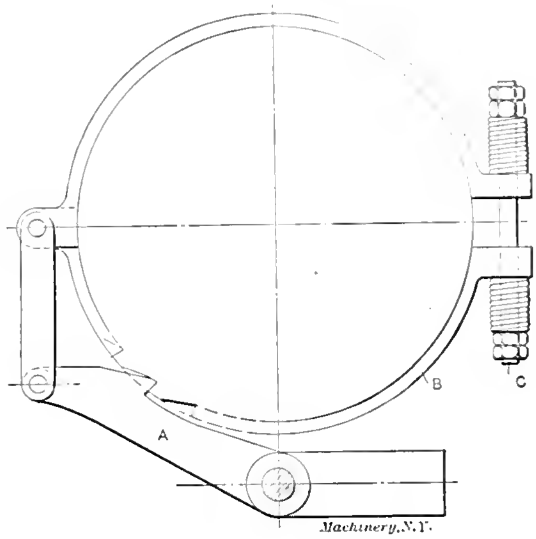


Fig. 15. Another Arrangement for Releasing Ratchet when Load is Lifted.

Shafts and Bearings.

Very little of more than a general nature can be said about the shafts and bearings for overhead cranes, since they possess no individual difference to those used for any other type of machinery. Although the calculation of the shafts is a simple matter in itself, it is no uncommon thing to find shafts stressed abnormally high, due to the fact that the size has been guessed at and not checked by calculation. A weak shaft is an annoyance, because, quite apart from the fact that breakage may take place, the deflection causes heating and binding and a consequent heavy loss of power. The forces due to the combined bending and torsion should always be considered in the ordinary way, and the diameters so proportioned that the stress does not exceed 6 tons per square inch for large shafts and axles, or 5 tons for small shafts.

No definite rule can be given for the limiting stress, it being rather a question of practical consideration and discretion. For example, if a heavy shaft is carrying its load near the bearing, it is safe to subject it to a stress that would not be permissible for a light shaft carrying a gear at some distance from the bearing, as for instance a shaft carrying a number of gears.

Overhung wheels should be avoided where possible, but where such have to be adopted the stress in the shaft ought

to be kept low, more especially if subjected to constant reversal, as for instance the pinion on the end of a motor shaft. Double keys placed at right angles are preferable for fastening gears on high speed reversing shafts.

Ordinary cast iron plummer blocks are generally used for steel framed crabs, and should as far as possible be standardized, in order to permit manufacturing to stock. Bearings should be fitted with split brasses and adjustable caps where practicable, in order to allow of ready inspection and repair. One of the principal objections to the plate-sided crab lies in the fact that several of the shafts have to be carried in solid bearings. Large and substantial grease or oil lubricators should be fitted to all bearings.

The calculations and general details given above apply to all types of crabs, irrespective of the frame formation, or general design. The principal variations are in the type of brakes, due to the fact that certain makers have patents or particular designs of their own, the bulk of which are nevertheless only modifications of the two principal types mentioned.

The type of crab shown in Fig. 2 (January issue) which, it may be remarked, has only been shown for reference purposes, is subject to considerable modification when the number of ropes exceeds four, and it generally takes the form shown in the outline diagram Fig. 16.

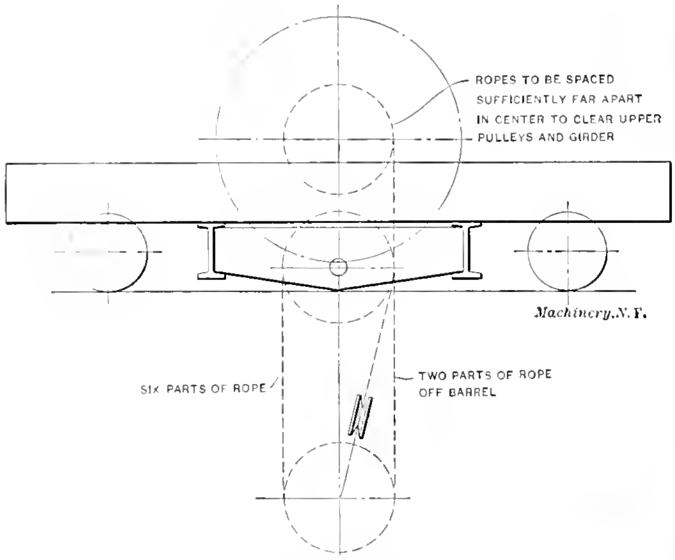


Fig 16. Modification of Crane Crab when the Number of Ropes exceeds Four.

Many makers use four ropes for cranes up to 50 tons, six up to 75 tons and eight up to 100 tons, or in other words limit the load off the barrel to 25 tons, and these quantities may be takèn as a maximum.

* * *

In a large watch factory there is a considerable force of men constantly emplcyed, called "bug hunters," to discover obscure defects in watch movements, which have developed in the regular tests for time-keeping to which the movements are subjected. With any practicable system of inspection of jigs, fixtures and product, there will be, on work of so delicate a nature as a watch, certain parts passed which contain defects not discovered, and scarcely discoverable. When the movements are assembled containing such parts, the discovery of the cause of the irregularity in the time-keeping is not easy. The men detailed to inspect the defective movements and clear up the trouble belong to a peculiar class and have what might be called a sixth sense, which enables them to almost instantly, in the majority of cases, tell the cause, no matter how obscure. When once located, the remedy is easy. It is in the matter of location that the ability of these men lies, more than in their mechanical skill. It is difficult to account for this sense, because it cannot be consistently attributed to a latent sense of hearing, sight or feeling. In the case of large machinery defective operation will make itself known to the operator by sound, manipulation, or sight, but in the case of a delicate watch movement, these senses can be used to a limited extent only, to locate defects.

IMPROVEMENTS MADE BY MOTOR-DRIVEN TOOLS IN A REPAIR SHOP.

The illustrations, "before and after taking," strikingly show the improvement of conditions of a typical belt-driven repair shop and the same shop re-organized and re-arranged for motor-driven tools. The photographs were taken in the repair shop of Peter Doelger's Brewery, New York City, and Fig. 1 shows the shop as equipped just before the change. The machinery was driven by shafts, counter-shafts and belts, including right-angle transmission and mule pulleys. Fig. 2 illustrates the same shop after the plant had been equipped throughout with motor-drive and two new motor-driven machines had been installed.

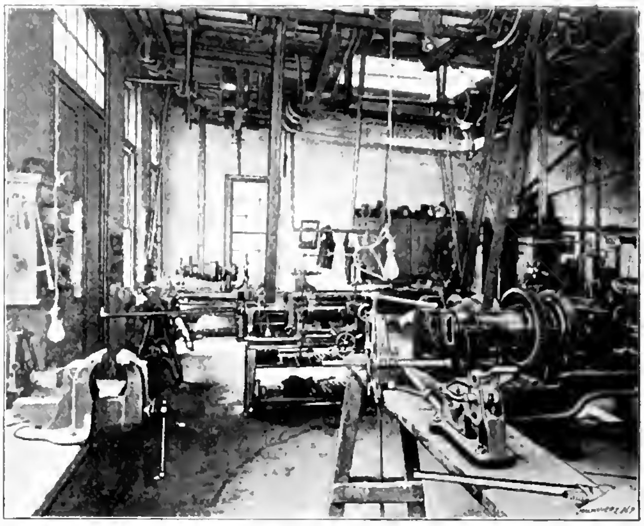


Fig. 1. Old Repair Shop in Peter Doelger's Brewery, showing Complications of Line-shafts, Counter-shafts, and Transmission Belts.

The shop now contains a 36 x 36-inch Hamilton planer, driven by a 5-horse-power motor, the motor running at 1,000 R. P. M.; 9-inch pipe threader, driven by a 5-horse-power 1,000 R. P. M. motor; 2-inch pipe threader, driven by a 1-horse-power 1,200 R. P. M. motor; drill press driven by a 2-horse-power 1,100 R. P. M. motor; 18-inch Hamilton lathe driven by a 4½-horse-power variable speed motor, having a speed range from 580 to 1,740 R. P. M.; and a small 1-horse-power portable saw.

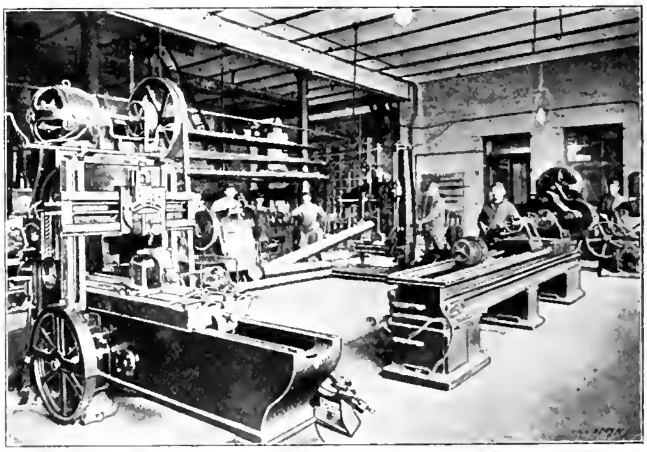


Fig. 2. Reorganized Repair Shop in Peter Doelger's Brewery, showing Motor-driven Machine Tools.

Neither the planer nor the 18-inch lathe were in the old shop, but even without these tools the transmission system was complicated. It will be noted in Fig. 1 that a quarter-turn belt and several reversing belts were necessary. The machines were much crowded, and it was impossible to handle work of considerable size, owing to lack of space. In the new shop the machines are arranged without reference to the line shaft or counter-shafts, being placed exactly where wanted and to facilitate the handling of the work. Each machine has plenty of space around it.

All the motors driving the various machines illustrated were built by the Crocker-Wheeler Co., Ampere, N. J., to whom we are indebted for the photographs and data.

SPECIAL TOOLS AND DEVICES FOR AUTOMOBILE FACTORIES.*

ETHAN VIALL.†

The shop practice at the factory of the E. R. Thomas Motor Co., Buffalo, N. Y., is equal to that of any other concern engaged in automobile work, although the growth of the concern has left it somewhat cramped for room. As in most shops, much of the work is done in the regular, or what might almost be called standard, way, but here and there are interesting, original or unusual devices that attract the attention of the mechanic.

One of the first things to attract the writer's notice was the device, shown in Fig. 1, for holding the rear axle while turning the spindles. The reason why these axles cannot be turned on centers, is that the spindles are not in line, but are bent at an angle in order to give the wheels the proper inclination when in place. In the fixture shown, the axle is bolted securely to the cross pieces in the long, slotted drum or sleeve in such a way that the spindle to be turned is in line with, and supported by, the tailstock center. With this arrangement the spindles are accurately machined in the least possible time. This device, as well as most of the other special tools, was designed and made by Lucien Haas, tool designer, and C. B. Buxton, assistant superintendent.

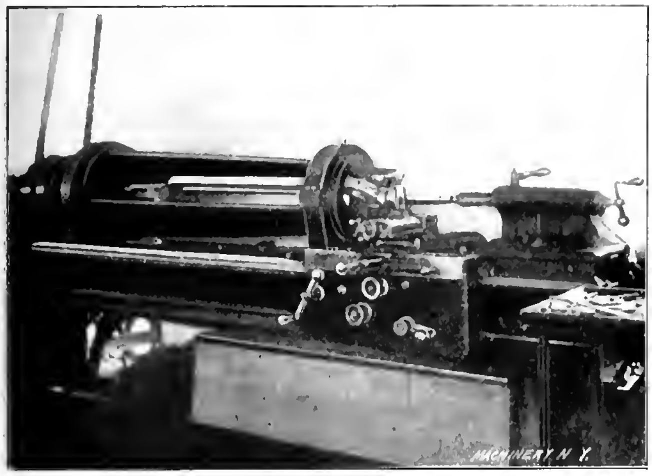


Fig. 1. Fixture for Holding Rear Axle while turning Spindles.

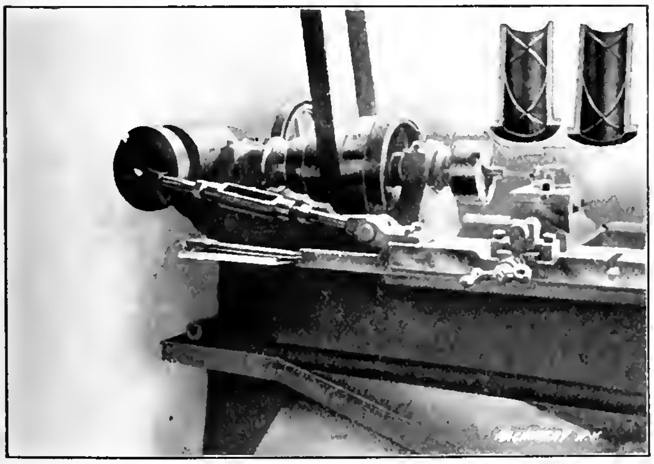


Fig. 2. Machine for Grooving the Inside of Brass Bushings, and Sample of the Work Done.

The cutting of oil grooves on the inside of brass bushings is a difficult problem, and until the machine shown in Fig. 2 was made, all brass bushings used in the construction of the Thomas machines were grooved by another firm, making a specialty of this work; but since the old lathe was made over as illustrated, the bushings have been both double- and single-grooved at less than one-fourth of the previous cost. In the upper right-hand corner of the half-tone, is shown a bushing which has been split in two in order to show the way in which the machine does its work. The principle of this simple, effective machine will be readily grasped by inspecting the illustration.

Another old lathe which has outlived its usefulness as such, and has been made into a special machine, is shown in Fig. 3. This machine is used for facing or counterboring various automobile parts, the old tailstock having been replaced by a special sliding stop operated by means of a hand-lever and accurately set by a micrometer screw adjustment; so that once set for a given stroke, any number of pieces may be machined exactly alike. The live spindle is fitted with a special chuck having a hardened and ground spring collet, and the shanks of all the counterbores and facing tools used in this machine are also hardened and ground in order to eliminate as much as possible the errors caused by warped or untrue shanks.

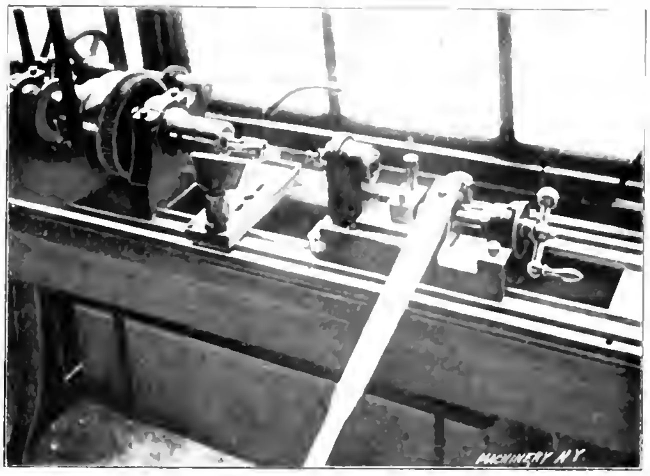


Fig. 3. Facing and Counterboring Machine, with Micrometer Stop.

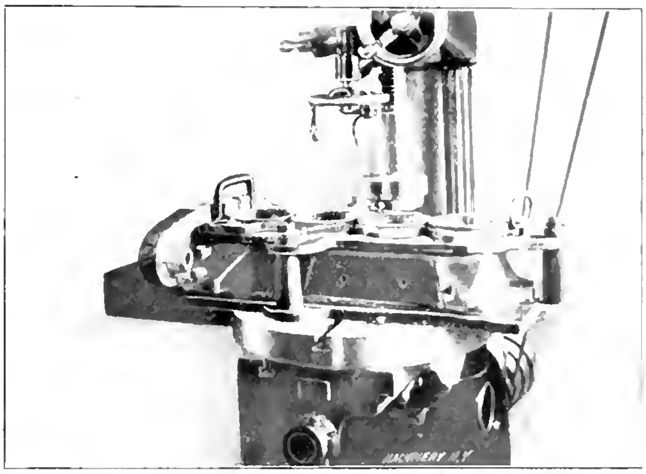


Fig. 4. Jig and Boring Tool for Boring out Cylinder Holes in Crank Case.

Fig. 4 shows the way the cylinder holes in the upper half of an aluminum four-cylinder crank-case are machined. The manner in which the boring tool cutters are guided in the jig bushings by the hardened and ground shoulder on the tool, is very plainly shown. Handles are placed on the top of the jig for convenience in handling, when putting it on or taking it off.

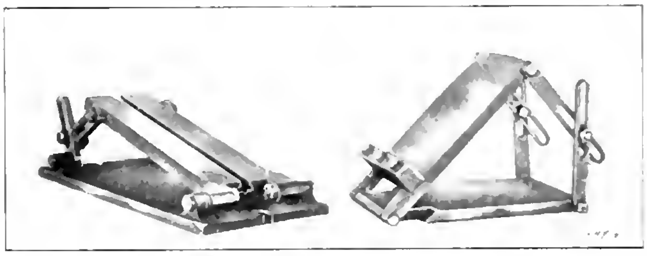


Fig. 5. Adjustable Angle-plates for Milling Machine and Drill Press

Toolroom Kinks.

In the toolroom are a number of interesting things, not the least of which are the adjustable angle plates for the lathe, drill-press and milling machine; those for the two last-named machines being shown in Fig. 5. In Fig. 6 are shown some special removable-pin racks for holding gangs of milling cut-

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* See also MACHINERY, March, 1909, engineering edition: "Organization and Equipment of an Automobile Factory."

† Associate Editor of MACHINERY.

ters. As the illustration shows, the whole gang may be lifted off the board and taken to the milling machine without unnecessary handling of the individual cutters. The ends of the pins are drilled so that cotters may be inserted if wanted. This is the best scheme for keeping small gang mills together that the writer has ever seen.

Limit gages for inside work are made of heavy tubing with pins run through crosswise near the ends, as shown in Fig. 7. The method of writing the sizes of the gages on cards which hang close to them, is a good one, as it not only makes it easy, in the first place, to find the gage wanted, but also to replace it correctly after use. The size is, of course, stamped on the gage itself in the usual way, but as everyone knows who handles tools of this kind, the figures are too indistinct, even when rubbed with chalk, to be easily read. The holes for the pins in these gages, as well as the holes for the handles of all sizes of socket wrenches, are drilled in the jig shown in Fig. 8. This jig is an improvement over the usual jig of this character and Mr. Haas has so designed it that it will center accurately and hold firmly anything that will go through the hole in the clamping-slide which carries the drill bushing, three sizes of which are shown. These drill bushings are hardened and ground and then lapped to fit the stationary bushing in the clamping-slide. The knurled nut that draws the slide down onto the piece to be drilled has a coarse thread and, after the jig is set for any particular size, a pin placed in one of the holes in the nut makes a very effective locking-lever, as a quarter turn will tighten or loosen the clamp.

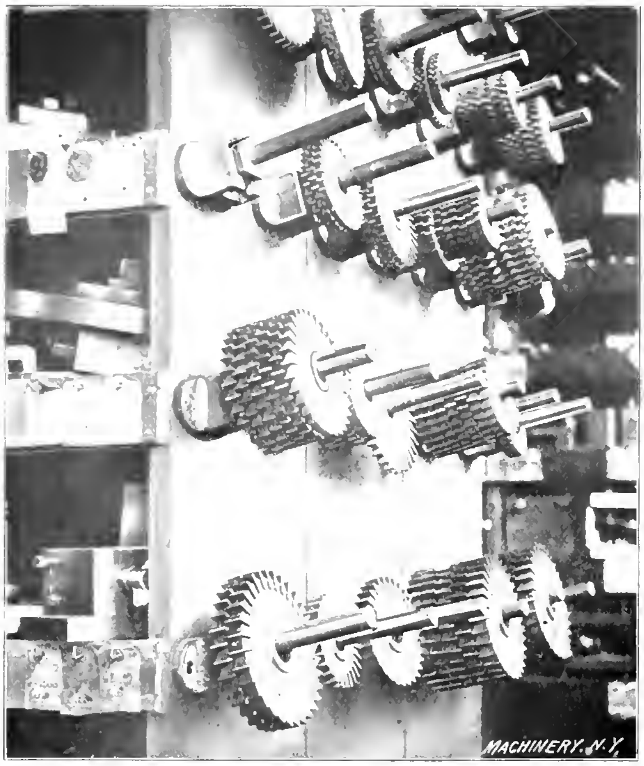

Fig. 6 Gang-mill Removable Storage Pins.

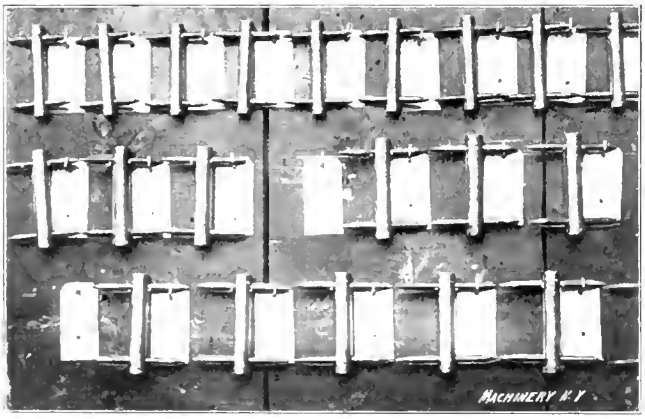

Fig. 7. Cheap Limit Gages with Size Cards.

The tool-chart shown in Fig. 10, a copy of which is kept in the various departments, enables the different foremen to order exactly the tools wanted, and also makes it easy to keep up the supply in the tool storage bins, for as soon as the tools of any type begin to run out an order for a new supply of that particular kind is given to the blacksmith foreman, who refers to his chart and makes up the tools wanted as soon as possible.

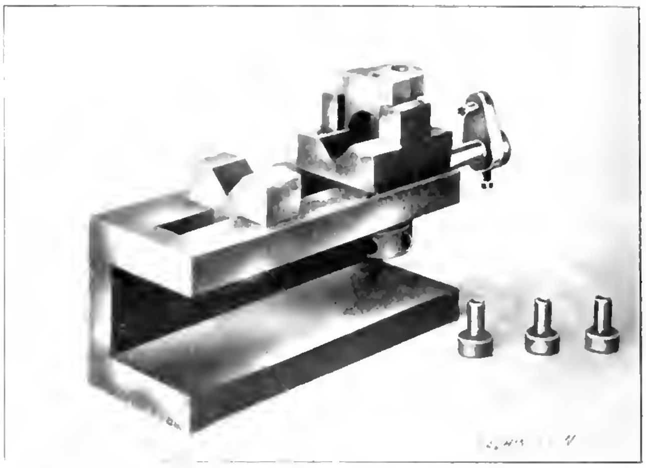

Fig. 8. Jig for Holding Round Bar Stock while drilling Cross-hole.

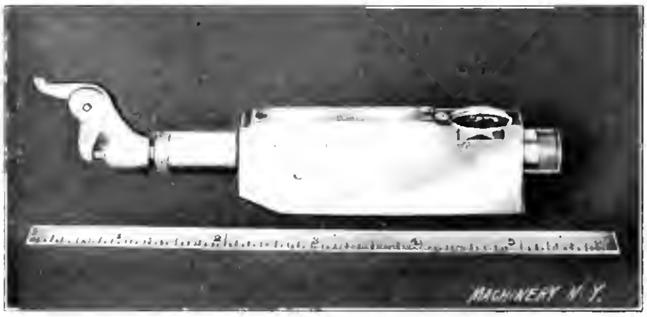

Fig. 9. Home-made Dial Indicator.

Fig. 9 shows an indicator made by Mr. Buxton when he was working as a toolmaker ten or twelve years ago; the dial is about 5/8 inch in diameter and the whole device is less than 5½ inches in length, as shown by comparison with the 6-inch scale in front of it.

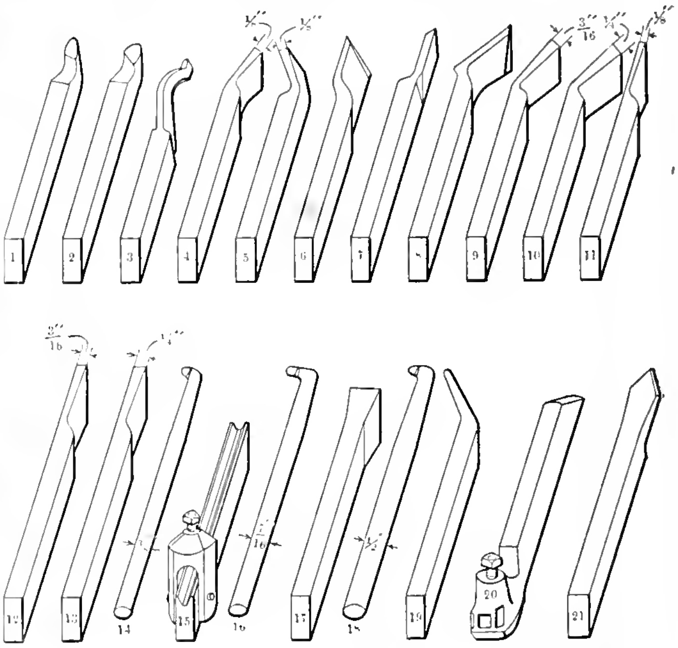

Fig. 10. Chart of Standard Lathe Tools which are ordered by Number.

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During 1908 15,413 automobiles were registered in New York State, this being an increase of 1,446 over the number registered the previous year.

SAFETY VALVES.

At the meeting of the American Society of Mechanical Engineers, February 23, a paper on Safety Valves was presented by Mr. Frederic M. Whyte of the New York Central Railroad. In the opinion of the author, the engineering profession in general has been somewhat ignorant of the principles of safety valves, their relative capacity, and the capacities required for various conditions of steam generation. In marine work, certain formulas have been devised for calculating the sizes of safety valves, which have been more or less blindly accepted; but in locomotive work even a greater uncertainty prevails, although there is promise that the present unsatisfactory condition may be improved. The general practice in locomotive work has been to determine in an off-hand way the size and number of safety valves to be used, and former practice has entirely guided the designer. The capacity of the valve has been indicated in an unsatisfactory manner, being expressed as a "size," meaning the diameter of something more or less uncertain, while the other dimension, the lift, which is necessary to give an indication of the capacity, has been entirely ignored. It should be remembered that to know even the capacity of available valves is not sufficient; the important factor is to know how much steam is to be released, and in what length of time it should be released. In view of these various factors the suggestion was made by the author of the paper that instead of indicating the capacity of a valve in a rough way, by the diameter of some opening, the method be adopted of expressing the capacity in pounds of steam at certain pressures.

Another important factor in safety valves is the reliability of the spring, and the effect of the heat upon it. It should be possible to make adjustment easily, and at the same time the valve parts should be so arranged that it would be practically impossible for the valve to get out of adjustment.

On the question of the relation of valve capacity to steam generating capacity, the fact should not be ignored that in locomotive work the total valve capacity has not in the past been made as great as the maximum steam generating capacity, and this may be considered as ample proof that so great a valve capacity is not necessary. The reason for this is, of course, that on account of using the exhaust steam for producing the forced draft, when the demand for steam from the boiler is reduced or entirely cut off, the forced draft is also automatically reduced or cut off, and the generating capacity is reduced so that it is not necessary that the safety valve release the full generating capacity. Probably it is largely a question of opinion what percentage of the total generating capacity the valve ought to provide for, but it is likely that if attention is centered on this question, some fairly definite solution may result. The author concluded the paper by inviting discussion of these particular subjects in relation to safety valves.

During the discussion of the paper many different views were expressed. Mr. Philip G. Darling, of Manning, Maxwell & Moore, who has for two years past conducted extensive experiments on safety valves, presented a contribution, illustrated with lantern slides, on Safety Valve Capacity. He started from the premises that safety valves must have a relieving capacity at least equal to the boiler evaporation, as otherwise the boiler pressure will continue to rise, although the valve is blowing. Thus, with the exception of mechanical reliability, the most important factor in a safety valve is its capacity. Mr. Darling then proceeded to show an apparatus and describe the methods employed for determining safety valve lifts; he gave the results of tests made with this apparatus upon different valves, analyzed a few of the existing rules governing valve sizes, and finally proposed a definite rule, giving the results of the tests on which it is based.

Two factors in a safety valve geometrically determine the area of discharge and hence the relieving capacity: the diameter of the inlet opening at the seat and the valve lift. The former is the nominal valve size, the latter is the amount the valve disk lifts vertically from the seat when in action. In calculating the size of valves to be placed on boilers, rules, which do not include a term for this valve lift, or an equivalent, such as a term for the *effective* area of discharge, assume, in their derivation, a lift for each size valve. Nearly all existing rules and formulas are of this kind, rating all valves of a given nominal size as of the same capacity.

To find what lifts standard make valves actually have in practice and thus test the truth or error of the assumption that they are approximately the same for the same size valve, an apparatus was devised and tests upon different makes of valves conducted. With this apparatus the valve lift can be read to thousandths of an inch at any moment, and an exact permanent record of the lift during the blowing of the valve is obtained which is somewhat similar to a steam engine indicator card in appearance, and of a quite similar use and value in analyzing the action of the valve.

A portion of this apparatus, showing the safety valve and the gage for reading off the valve lift, is illustrated in the accompanying engraving, Fig. 1. The valve, during tests, is mounted on the boiler in the regular manner, and a small rod is tapped into the top end of its spindle; this rod connects the lifting parts of the valve directly with a circular micrometer gage, the reading hand of which indicates the lift upon a large circular scale or dial. The rod through this gage is solid and continues upward, maintaining a direct connection to the pencil movement of the recording gage above it, previously referred to. The experiments undertaken showed that with the exception of a small preliminary simmer, which some of the valves have, they open abruptly to a full lift, and close almost as abruptly when a certain lower lift is reached. Different makes of valves of the same nominal size are of greatly different capacity. Of seven 4-inch stationary safety valves, the lowest lift at the opening was 0.031 inch, and the highest 0.137 inch, while the lowest lift at the closing was 0.017 inch, and the highest 0.088; of six 3½-inch muffler locomotive valves tested, the lowest lift was 0.040, and the highest, 0.140 inch at the opening; while the lowest lift was 0.023 inch and the highest 0.102 inch at the closing.

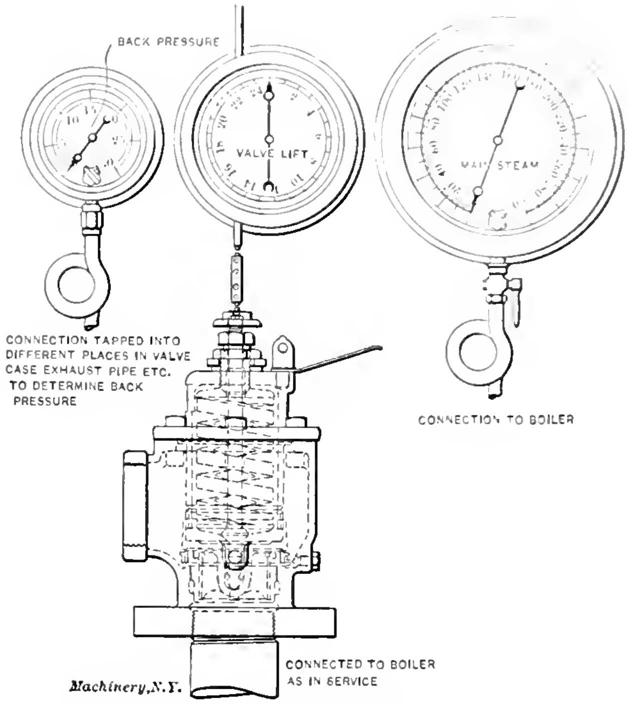
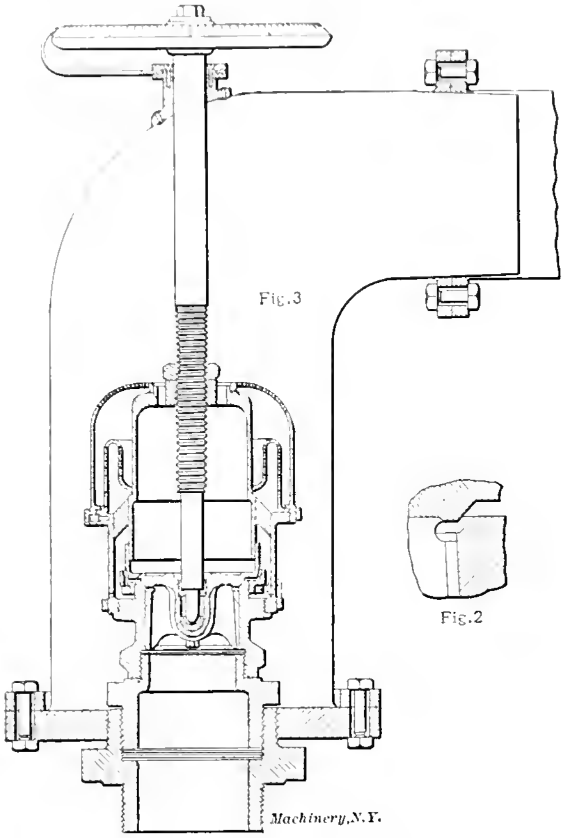


Fig. 1. Apparatus used in Tests for Determining Valve Lifts

The valves tested all had 45-degree bevel seats. The four wings of the valve probably reduce the flow slightly from what it would be if the theoretical area of opening is calculated, but as the wings are cut away at the seat, as shown in Fig. 2, a definite correction of the existing areas is impossible.

"The great variation—300 per cent—in the lifts of these standard valves of the same size," said Mr. Darling, "is startling, and its real significance is apparent when it is realized that under existing official safety valve rules, these valves, some of them with less than one-third the lift and capacity of others, receive the *same* rating and are listed as of equal relieving value."

That the lift of a safety valve is the true measure of its capacity, other things being equal, has long been recognized. As early as in 1875, a committee reporting to the U. S. Board of Supervising Inspectors stated as the result of its investigations that the diameter of a safety valve is not an infallible test of its efficiency, but that the lift which can be obtained in a safety valve, other conditions being equal, *is* the test of its efficiency. The rules followed in safety valve design, have not, however, taken full cognizance of this, and the result is shown by the variation in capacity of valves of nominally the same size. Existing rules are, therefore, not safe to follow, and Mr. Darling proposed the following formula:



Figs. 2 and 3. Cross-section of Valve Opening and Arrangement for Measuring Capacity of Valves.

$$E = 105 \times l \times D \times P,$$

where E = steam evaporation in pounds per hour,
l = valve lift in inches,
D = valve diameter in inches,
P = steam pressure (absolute).

Transposed, the formula becomes:

$$D = 0.0095 \frac{E}{l \times P}$$

Modifications are given for locomotive practice, where,

$$D = 0.055 \frac{H}{l \times P}$$

in which H = total heating surface in square feet.

For cylindrical multi-tubular, vertical and water tube stationary boilers the formula becomes

$$D = 0.068 \frac{H}{l \times P},$$

and for water tube marine and Scotch marine boilers

$$D = 0.095 \frac{H}{l \times P}.$$

In order to determine the constant or coefficient of flow at different lifts and how it is affected by variation in valve design and adjustment, an extended series of tests was recently undertaken at the Stirling boiler department of the Babcock & Wilcox Co. at Barberton, Ohio. The feed water of the boiler was measured, and the entire steam discharge of the boiler was through the valves being tested. The valves were all previously tested and adjusted on steam; and without changing the position of the valve disk and ring, the springs of these valves were removed and solid threaded spindles inserted, as shown in Fig. 3. At the top of these spindles a graduated disk was placed, by means of which the lift could be exactly determined.

Mr. Albert C. Ashton of the Ashton Valve Co., stated that it did not seem to him that what is most needed to-day is valves of greater capacity, "but rather a better understanding of the proper proportioning of safety valves to boilers, for which no universal rule has been recognized and adopted." He stated that high-lift valves, under some circumstances, may even be considered dangerous, and if high-lift valves were a decided improvement over the best standard makes, manufacturers of safety valves could easily change their design to make nothing but high lift valves; generally speaking, a lift of 1/8 inch is excessive, though valves with a lift a little higher than the standard, say 1/16 inch, would have some advantages.

A presentation of the subject of safety valves, as it appears to the locomotive builder, was contributed by Mr. F. J. Cole of the American Locomotive Company; he referred to the practice both in this country and abroad, and cited several reasons in explanation of the apparent disregard of definite rules governing the application of safety valves to locomotives

Mr. Garland P. Robinson, State Inspector of locomotives, referred to the fact that his experience indicated that no rule is generally followed in determining the size of safety valves for locomotive boilers; he believed that a formula based on the heating surface and providing for 50 per cent of the maximum evaporation of the boiler would give satisfactory results for locomotives. Using the notation above, he gave the formula (applicable to locomotives):

$$D = 0.05 \frac{H}{l \times P}$$

In view of the fact that some of the tests referred to in the discussion have been conducted by manufacturers of valves themselves, Mr. Carhart, of the Crosby Steam Gage & Valve Co., emphasized that "the actual lift or discharge area of valves should be determined and reported upon after impartial tests conducted by competent and disinterested engineers, * * * and not from reports of tests conducted by any one manufacturer without the knowledge of other makers whose valves are tested, and where the one measurement noted has been, in many cases, purposely limited by the manufacturer for special reasons."

* * *

HORSE-POWER REQUIRED FOR MOVING CARS.*

MORRIS A. HALL.

It is a rather complicated problem to determine the power required to move a railroad car of known weight at any known speed over a level track, or up a known grade. A diagram, or graphical chart, however, can be prepared, from which the power required may be obtained practically at a glance if the quantities, speed, weight and grade be known. Such a diagram is presented in the accompanying Supplement. Suppose, for an example, that the car weighs 15 tons, or 30,000 pounds, and assume further that we wish to move this car at a speed of 25 miles per hour over a level track. Find first on the right-hand vertical scale the point marked 15 tons (the weight of the car), and follow the horizontal line from this point to the intersection with the oblique line marked 25 miles per hour and from this intersection follow a vertical line downward intersecting the horse-power scale for level track at 30½ H. P. Suppose that the car must also climb a grade of 3 per cent somewhere on the line. In order to find the horse-power required for this, follow the same vertical line, already found, until it intersects the oblique grade line marked 3 per cent grade, and then follow the horizontal line from this intersection point to the right-hand vertical scale, where we find the required power for climbing the grade to be 93 H. P. As will be seen, the diagram can be used for cars weighing up to 20 tons, for speeds from 3 to 30 miles per hour, and for grades from 1 to 10 per cent.

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* With Data Sheet Supplement.

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS–6.

CONSTRUCTION PERIOD.

WILLIAM P. SARGENT.*

The previous articles of this series have covered the engineering work in connection with the planning and developing of projects of plant improvement from the conception of the idea to the beginning of the actual work of construction. At the beginning of the construction period the engineering control of the project takes on the function of supervision, and if this supervising is not efficient the best and most thorough planning will be fruitless as far as obtaining a high degree of excellence of construction and the completion of the project on the predetermined date is concerned.

Miscellaneous Notes on Construction Work.

Many of the following commentaries may belong more properly to the planning of the work, but they are brought to mind by the consideration of the construction period, and therefore are presented in connection with the discussion of the carrying out of the plans.

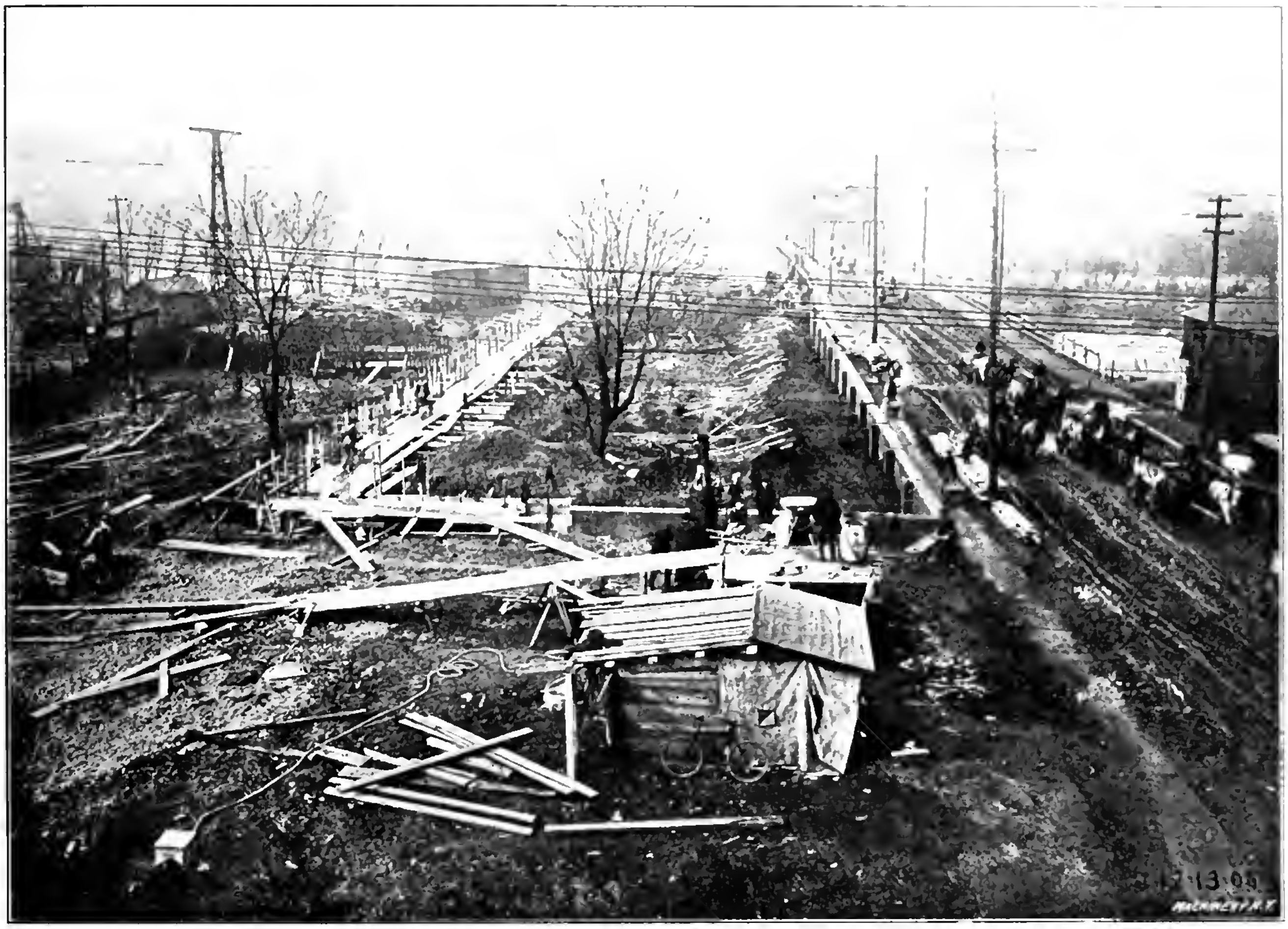

Fig. 37. A Job on which the Contractor put in a Bill for 1,000 Extra Cubic Yards of Excavation The Photograph Helped to settle the Bill for Something like 100 Yards.

The good-will and personal regard of the contractor and his foremen for the engineer in charge of construction work is a stronger factor in securing good work than the strictest supervision and inspection. This holds true in general with the building trades, but one cannot go to an extreme in guarding against unintentional errors and omissions in the laying out of the main working lines of a project and other points that cannot be remedied easily and cheaply. A contractor loses profit and an owner loses time when slips occur in the early part of building operations, so this part of an engineer's care is very important.

Oftentimes such work as trackage, sewers, power-house, water supply, etc., cannot be laid out and contracted for satisfactorily in advance of the awarding of contracts for the buildings. It is then necessary to organize a working force controlled directly by the engineer in charge or by a foreman who receives instructions from, and reports to, the engineer. The writer, in a general way, would advocate that all work should be done by outside contractors, under specifications, whenever possible to plan ahead and give definite directions. If the concern is of such a size as to have at all times on its payroll men of the various building trades, such as masons, carpenters, yardmen and others who will be responsible for the repairs on the new plant in the future, it is advisable to handle all underground work directly. By adding to the plumbing force, for instance, the sewer work can be done cheaper and better in this way, and the head plumber not only has the opportunity to familiarize himself with the drawings, but also sees the work go in, and he cannot afterwards lay the blame for avoidable troubles onto anyone but himself. In the sewer work, for example, changes will often be necessary in the layout almost as soon as work is started, on account of surface drainage or draining excavations. A site is selected because of its being level, but surface water cannot be carried away by means of open ditches without interfering with the rapid transfer of materials, and it pays well to keep the site dry and avoid the seas of mud so often in evidence about new buildings. Then again, tees and other branches can be placed wherever there is the possibility of future need and their location noted on the blueprints, and afterwards on the record drawings, if the work is done by the owners. With a contractor doing work so liable to changes, bills for extras are sure to result, and furthermore the additions and changes will seldom be followed up and recorded on the drawings.

The importance of inserting extra branches at intervals should not be passed over lightly, as the labor required to either cut a hole in tile pipe or set in branches by means of sleeves will pay for these extra branches a dozen times over. Holes can be cut in tile pipe when the pipes are hard rammed full of sand and the pipe is on the ground, but the difficulties arising from the necessity of doing this cutting at the bottom of a trench and with the sewer running nearly full can well be imagined. The branches should be carried up to within two or three feet of the floor level and have

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pl[illegible] It is also a wise precaution to cover these [illegible] with a close woven fabric as soon as possible [illegible] debris from getting in and clogging the [illegible] case it is advisable to use cast-iron soil pipe [illegible] of the buildings, and in the vertical branches [illegible] there is a probability of excavating and damaging [illegible] pipes. All branches for future use should be marked by [illegible] stake and they should be located definitely on the record drawings. If branches must be set in a line of finished tile sewer the split tile mentioned in a previous article of this series should be used, as a section of straight pipe can be broken out and the lower half of the new branch rocked into place and cemented and inspected before closing in with the top half.

The main runs of pipe should invariably be made large enough to provide for the extension of the plant buildings

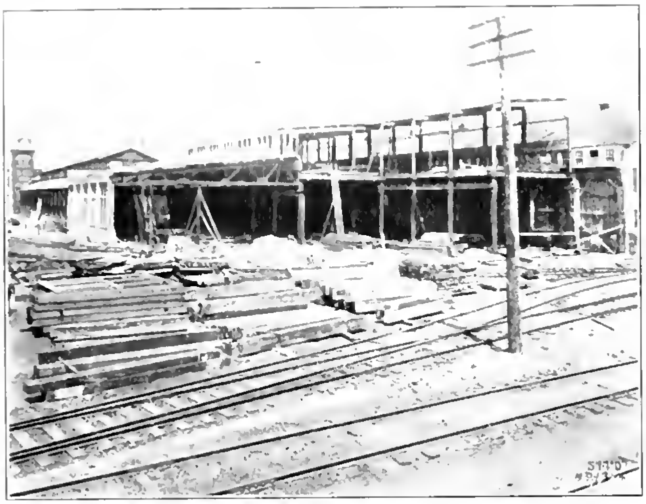

Fig 38. Shop Construction held up in the Condition shown for nearly Two Months because of Lack of Railway Trackage.

The end of every run of pipe, either main or branch, should finish either with a curve of long radius or with a manhole to permit of flushing with a hose or starting obstructions by means of wires.

Grades of Sewers.

There is any amount of information extant concerning the proper amount of fall that should be allowed for sewers, but very little that will help in determining the *very least* that can be used. The problem is often whether the slope that can be easily obtained is sufficient or not. Nearly every engineer has to depart from the recommended practice at times, and precedents are then more valuable than theory. There was a description of a sewerage system in the *Engineering News* of February 6, 1906, in which the slope was given as one-tenth of 1 per cent or approximately 5 feet per mile for an 18-inch sewer; and about 4 feet of head was all obtainable with this slope, and this head had to operate a septic system. A septic system will be a necessary part of nearly every large plant built in the future, as the pollution of streams will not be tolerated. Many of the large railroad shops have septic systems, and one large industrial plant saved over $1,800 per year on its water bill by such an installation. The cost of a septic tank and filters approximates $5.00 per man. The above mentioned article is one of the most concise descriptions of a septic system published.

The predetermined slope of a pipe sewer can easily be obtained in construction by excavating nearly to the desired depth and driving stakes. The tops of the stakes represent the undisturbed bottom of the trench and should be set with an instrument. The bottom can be graded to the stakes, and by digging out for the bells of the pipe, the barrel of the pipe rests on solid ground. *Salt glazed* tile should always be used to secure strength and freedom from porosity.

In making layouts of sewers, a small scale is naturally used and the details of branches, etc., are often too small to be well shown. A method of numbering the branches and [illegible] data of lengths, sizes, location of traps, in marginal [illegible] similarly numbered is recommended. The branches on [illegible] side of the main line should be numbered odd and on the [illegible] side numbered even, beginning at one end of the system. This method of numbering aids in listing material and checking off the work as finished.

Drainage of Pipe Tunnels and Basements.

It is seldom possible to lay drains for underground chambers and tunnels that will clear them of seepage water by a gravity flow. It is hardly possible to thoroughly waterproof the side walls of concrete without excessive cost for excavating to afford room for men to work between the sheeting and the wall after the forms are struck. For these two reasons, sump pits should be installed below the floor level, and steam syphons or other forms of pumps put in to raise the water to the level of the gravity drainage system. There are a number of compounds on the market which are intended to be mixed with the cement to prevent seepage. These have been efficacious in some instances, but failures have occurred that suggest the advisability of providing for the removal of seepage, even if a compound is used.

Whitewashing of the interior wall surfaces should be deferred until either seepage is evident or a certainty of a dry chamber is assured. One very good way to handle seepage is to localize the leakage by drilling holes in the walls at the points of greatest leakage, and by means of small pipes laid in channels cut in the concrete, leading the water to the drain and sump. Porous agricultural tile laid outside the wall near the bottom will often take care of the surface drainage and prevent seepage, and such tile should be laid even when the interior drains and sumps are provided. The roofs of tunnels are generally waterproofed with a multi-ply felt roofing laid with pitch as on buildings.

There is one most important point in planning pipe tunnels that is often neglected—the exact location of branches of piping which cross over and lead into buildings. It is often necessary to carry a branch back of the interior wall line, then up and through a raised chamber, in order not to unduly restrict the free opening of the tunnel. As these recesses cannot be put in after the tunnel is built it is obvious that most careful study and laying-out of the piping should be done before making the final drawings of the tunnel.

Wrought Iron Piping.

The use of galvanized pipe where laid unprotected underground is strongly advocated. The deterioration of black pipe has been noted by nearly every engineer who has watched excavation around old buildings, and the recommendation of galvanized pipe made here is based on the experience of an old engineer in the Middle West, whose work for nearly 40 years had been mainly in connection with pumps and water-works. This same engineer has noted the deterioration of black pipe when used inside of shops for compressed air and states that galvanized pipe has a much longer life than black pipe when used for this purpose.

Fig. 39. An Illustration of the Opportunity for carrying on Work Inside when Masons work on Outside Scaffolds.

Concrete Work.

Great stress is often placed on the testing of cements and concretes irrespective of the nature of the work. It is hardly practical to specify a different mixture for each par-

ticular mass of concrete, so an experienced foreman is apt to judge the concrete by the color and to vary the mixture according to the need for a rich or lean mixture. It would be unwise to arouse the antagonism of the construction foreman by insisting on a rigid compliance with the specifications for the "mix" for concrete to go in the bottom of masses and in unreinforced members on which there is little load.

Let the foreman know that the concrete will be tested with a pick after the forms are struck and the concrete is set and aged, and that defective work must then be replaced. It will not then be necessary to place a watch over the mixer, for if the foreman is competent the quality of the work will be satisfactory even if the contractor does save a few dollars.

There is a great difference of opinion as to the effect of freezing on concrete. Nobody maintains, however, that freezing helps concrete, and concrete which has been frozen and can be broken with the toe of one's shoe is certainly unfit for anything. It is believed generally that concrete can be safely put in at any temperature as long as it is protected from freezing by means of hay, straw, etc., until it has set. The writer is informed by an engineer of the Pennsylvania R. R. that concrete has been put in at zero temperature without any freezing. The following rule is believed to be safe for the permissible minimum temperatures: Concrete may be put in down to 35 degrees with a falling thermometer and at 28 degrees with a rising thermometer.

Many methods and expedients are used in the attempt to obtain a good surface on concrete. Even if the surface is to be bush-hammered afterwards it is the better if made as uniform as possible when being placed. The thin-edged square-end spade so often recommended does not always force the aggregate back sufficiently, and paddles of wood ½ inch or more thick are better. The proper thickness can be found by watching the effect on a section from which a form board can be removed. Of course, tongued and grooved lumber will make a better surface than plain boards. Nothing less than 2-inch plank, with uprights on a 2-foot center, should be used in order to prevent bulging. With the uprights on 2-foot centers, stock lengths of lumber can be used without waste.

Fig. 40. Inside of Shop shown in Fig. 42, during Construction.

It is difficult to obtain a uniform level for the tops of piers and pilasters where columns are to be set. This cannot be done by attempting to flow the concrete to a line. It is better to keep the concrete an inch or more below the line and build up to the line with a rich cement mortar trowelled on. The common way of levelling up columns is to grout in under the column footplates, pushing the grout in with a paddle. This does not, with any degree of certainty, provide an even bearing on the concrete. The best way is to leave 2-inch holes in the footplates and pour the grout in until it shows all around the plate, confining the grout with a dam of clay or putty.

It is obvious that the forms for foundation walls will not be built on the entire outline of the building at once, but that sections of concrete will be put in up to the floor level and the forms then built up for the next section, using the lumber from the completed section as fast as the forms can be struck. This necessitates vertical joints These stop-offs will not do material harm if the old and new sections are bonded securely. Undoubtedly the strongest and best method is to use steel reinforcement, letting the steel run into both sections about 2 feet.

The "V" joint commonly used has but little strength, as dependence is placed upon cohesion alone A square tongue and grooved joint is stronger in both directions. The "V" joint often leaves an unsightly fissure in the face of the wall at the feather edge. If either joint is used to take care of strains in the direction perpendicular to the wall, reinforcement should be invariably used in addition. The surface of all parts of older work should be scratch-brushed before placing fresh concrete. Many contractors content themselves with washing the surface with a little water or throwing on a little dry cement. Reports of recent tests indicate the advisability of cleaning and scratching and brushing with a cement grout.

Fig. 41. Inside of Same Shop as shown in Fig. 40, at a Later Period of Construction.

A frequent cause of differences between the engineer and the contractor is extra concrete and excavation. It is very easy to avoid trouble on this score by having the bottoms level, the footings uniform in thickness and then taking measurements from the top of the wall to the footings after striking the forms. These measurements should be taken by the engineer and a representative of the contractor jointly. Records of these measurements should be made in duplicate and signed by both parties. This precaution will tend towards amicable relations.

Fig. 37 shows a job on which the contractor put in a bill for 1,000 extra yards of excavation. On account of measurements taken as above, and the photograph, this bill was settled for, within five minutes, on a basis of something like 100 yards, and the contractor was satisfied.

Grading and Filling.

For filling in the deeper portions of holes, almost any material will do; but as the floor level is approached care must be exercised to get the material so placed that the voids in the coarser material will be filled by the fine dirt, which is best done by using water from a fire hose. Twenty-five dollars worth of water will accomplish more than a hundred dollars expended for tamping. Ashes, cinders and gravel are all good for filling for the inside of buildings, and in some sections of the country locomotive front-end cinders are used as a substitute for concrete. This does not make such a solid floor as concrete but is all right for subsidiary buildings. The filling inside of buildings which are to have other than dirt floors, should be started as early as possible, so that low spots may be discovered and filled, and thus a firm substructure for the concrete secured. When grading for future trackage, make certain that the surface is kept low, as it is difficult to depress a track. Section men will often raise a relatively long stretch of track rather than depress a short length.

Track Work around Industrial Works.

In the following notes it is assumed that it is permissible in practice in track work for a large private plant to consider the factor of future repairs as very important, and that a first cost is justified which is greater than often expended for private corporation trackage.

Ballast should be at least 8 inches deep under the ties. The ties should be 6 x 8 or 7 x 9 inches, and may be spaced on 21 inch centers to make a solid track. With a regular spacing of 21 inches on straight track, the spacing will be about 19 inches at the mouth of the frog, and about 22 inches at the points of 15-foot switches and decrease to 19 inches at the heels. Tie plates will add about 15 cents per lineal foot of track, but they will lengthen the life of the ties 50 per cent. A 70-pound rail is probably the most economical section to use about a plant building heavy machine tools or large engines, because of the heavy switching. Such a rail will last longer than a 60-pound rail or the "re-lay" rails which are generally used. The first wear of a rail is well worth the added cost over old rails.

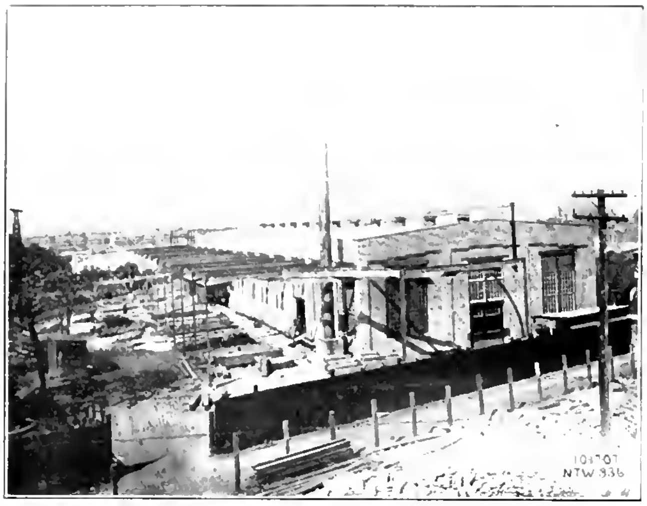

Fig. 42. Outside of Shop Illustrated in Figs. 40 and 41.

Suspended joints should always be used, and angle plates rather than fish-plates. The "pumping" of a tie at a supported joint is certain to cause excessive wear of the rail ends and to make low spots in the track. In laying out tracks remember that railroads are often "sticklers" about any track over which they may be called upon to operate, and even if the works is to do its own switching the curves and grades should be such that a railroad cannot consistently refuse to operate in the event of a private switch engine being laid up for repairs. The Inter-State Commerce Commission has recently established a minimum permissible curvature of 175 feet radius and a standard frog can be obtained for this curve. A 1 per cent grade should not be exceeded on curves if a small engine is to be used. Low switch-stands with targets cost more than the common ground-throw type, but are much better, as dependence is not entirely upon signals given by a brakeman.

The ideal curve for turn-outs or cross-overs would be one that would give a uniformly accelerated motion in the direction of departure from the principal track. If the frog and switch are made with straight rails and start with an angle less than is generally called for by the curve, an approximation to the ideal curve will be secured. This method starts the curve easy and the radius is gradually shortened as the curve advances.

The gage of the track should be standard except on curves, and even for the 175 foot radius curve a widening to 4 feet 9 inches is sufficient. In laying out curves that lead into buildings, see that the curve does not begin for nearly a car-length outside of the door. This permits of narrower doors than if the curve starts at the wall line. For side clearance on straight track keep all obstructions 6 feet 6 inches away from the center of the track. The safest way to look for interferences on curves is to make a dummy of [illegible] foot car to scale, cutting the corners back on one side to the kingbolt centers. Move the dummy around, keeping the kingbolt centers on the track center line and watch the corners and side for interference with buildings or other obstructions. Keep obstacles at least 4 feet away from the side or corner of the car. Very substantial bumpers of a type that is secured to the rail should be put up at the ends of all tracks. A "Y" in some part of the track system is necessary in order that the switch engine can be turned end for end once every week or two. This distributes the wear over the wheel flanges on both sides of the engine.

As much as possible of the track system should be put in in advance of the building operations to expedite the placing and unloading of material. This will be appreciated by the contractors, and as the tracks have to go in some time, it is as well to get the use of them when time can be saved that will help to get the plant running earlier. The track scales should be put in at the start, especially if the steel work is to be paid for on a tonnage basis. The weights of the bills-of-lading may be right; but if the project is of the size of the model plant previously described, the amounts in question are great enough to warrant extra endeavors to provide a means for securing correct weights.

Fig. 38 shows a building which was held up in the condition shown for nearly two months because of the delay in the track work being done by a railroad company.

Erection of Structural Work.

The unloading of the first car of steel work will indicate for the time being whether or not the fabricating company is really making an effort to erect the material on time. If the first car-loads are made up of columns for the first building wanted, well and good; but if they consist of members for buildings not wanted until later, then a "loud holler" must be made. The securing of material in the proper order is a point where the inspector at the shop can be of great value, if employed by the owner, as through his reports the engineer can know of dilatory work and can endeavor to remedy the trouble when it begins. See that the unloading does not result in distortion of the steel work, especially of the compression members. A goodly portion of the shop coat of paint is apt to be rubbed or scratched off in shipment and such spots should be touched up, at least in places that will be inaccessible after erection.

As a rule steel erectors do their work thoroughly and conscientiously, but there are times when they will get an idea that there are too many rivets, and that a few left out will do no harm. Therefore it is well to look at the places requiring rivets that are hard to get at and make sure that all are in.

Another important point in erection is the final tightening of bracing in the plane of the upper chords of the roof trusses. If not done carefully, distortion of the truss will result, due to the excessive unbalanced tension on the diagonal ties. That the abutting surfaces of the columns are in contact over the full surface at the splices is also important. Full rivet heads should be insisted upon, even though the contention is often made "that a poor rivet is better than a bolt, and a bolt would do." The practice of battering the ends of bolts to prevent nuts loosening at bolted connections is to be discouraged, as it is uncertain in fulfilling its object. The form of lock washers used in erecting traveling cranes is more certain for this purpose.

Work of Various Building Trades.

It is difficult to obtain good work and speed at the same time, and it is useless to expect better work than is the ruling custom in the locality in which the buildings are being erected. There is a tendency in some sections to think that anything is good enough for a shop building. This results from the demand for a minimum of cost irrespective of quality of work. Often one will find mason contractors who think a ¾ inch mortar joint is all right, and whose ideas of a shoved joint are such as to defeat the desired aim of securing a full joint and a solid wall. The bonding of the inner and outer courses should be good, and anchors for tying the brick work to the structural framing should be placed wherever there is a chance of the brick work breaking away at points where the parts of the work are intended to

be mutually supporting. Many hard-burned bricks absorb water slowly, and if such is the case the joints should not be struck until settlement has taken place.

The time taken to lay brick for any building is little, in relation to the entire time consumed in building, but this period can be profitably occupied in doing foundation and underground work inside of the building. To this end the masons must work from outside scaffoldings on single story shop buildings. Many contractors will object to doing this, claiming difficulty in keeping the walls clean and in lining up the outside courses. Their objections are not weighty enough to balance the advantage to the owner, of having the space within the walls available for doing such work as may save much valuable time in the future. Fig 39 shows the opportunity for pushing work when the masons work from outside scaffolds.

Plumbers are not prone to work accurately to drawings in the location of piping, and their work should be watched as to clearances for cranes, sliding and lift doors and any other subsequent work.

Most foremen of the building trades have risen to their positions primarily for their skill, and they are generally more proud of their craftsmanship than they are of their executive ability. The feeling that their skill is recognized and credited by the engineer will lead the foremen to use extra care to prevent things from slipping through that would reflect on them personally and even to suggest slight changes that would be better than the design calls for. This cooperation of the contracting foremen can often be obtained by using tact, and its value is immeasurable.

Methods of Following and Expediting Progress.

The following method of recording the progress of building operations is based on the premise—that of a piece of work requiring ten weeks to complete 70 per cent of it should be done in seven weeks, or a larger force should be put on to make up the time lost. It may not be out of place to state that the keeping of costs on shop work by the use of "average hour rates" rather than distributing every minute of every man's time, is recommended by one of the leading practical supervisors of cost keeping in the metal-working industry.

The application to construction work is very simple, as the different hour rates are fewer than in shop work. The first thing required is the total number of hours or days necessary to complete the work. This total for each branch of the work is obtained from the engineer's estimate of cost, either by summating the number of hours there given in detail or by dividing the cost (pay-roll cost only, refer to fifth article of the series, January issue) by the average hourly rate for that branch of the work, and then by the number of hours to a working day, then by the number of working days in the available time. Thus the average number of men required is obtained. The time actually put in on the work is then easily obtained by counting the number of men at work each morning and afternoon. This can be done without arousing any suspicion that the work is being checked Of course, allowance should be made for the days lost on account of the season of the year, bad weather and holidays The available time and the dates from which records should start are shown by the time charts described in the fourth article, December issue, page 253. The progress can be plotted graphically against a predetermined curve on a chart which shows the dates on the horizontal line, and the cumulative number of man-days on the vertical scale. This method involves the least amount of clerical work and shows very plainly whether or not the work is progressing rapidly enough. The vertical scale can also be marked for percentages, and the chart will give the percentage of completion which should be reached on any date, and when filled in, the curve of actual days worked to date will give the percentage which is actually accomplished at that date. As it is necessary to record the number of men working each day, the desired progress can also be shown by the table indicated by the following headings:

Fig. 43. An Illustration showing the Manifold Duties of the Engineer in Charge of the Large Project of Construction Work.

Date.	Men at Work.	Cumulative Days.	Required Days.	Required Per Cent	Actual Per Cent

This method may not be thought sufficiently accurate for cost keeping for shop work, but it certainly is for construction work,, and is far more accurate than the general estimates of percentage of completion, and has the undoubted value of being based on something more than observation and is strong as a support of a claim that the work is behind, if it becomes necessary to make such a claim to the contractor.

The uncertain factor, the figured labor cost as taken from the estimate, should be checked, as it is only necessary to verify the unit of time required for a unit of work. If it is found that this time varies from the estimated time it is easy to modify the curve on the chart. This chance for verification makes it possible to feel more certain that a large project is going right, or to know just how bad things are if they are not going right.

It is hardly necessary to mention the importance of photographs of construction work as a factor in preventing disputes when settling for extras, but the great value of photographs of details, when other work is to be designed or estimated upon, is only realized by engineers who have these record albums in connection with the complete data of estimated and actual costs and other conditions of the problems. Figs. 40, 41 and 42 show stages of a piece of construction work and the details are certainly the equivalent of many pages of a note-book.

Installing and Moving.

It is important that foundations for new apparatus and machines from the old shops shall be ready when the machines arrive on the ground and that facilities are provided for handling and placing the machines without delay in order that the starting up may be systematic and proceed without confusion. Foundation plans for the new machines are easily available, and the time taken to repair old machines before moving should be made use of in obtaining the location of anchor bolts and whatever measurements are required for pits, etc., which cannot be obtained before. The completion of the foundations must also be rushed on receipt of this information.

This is one of the busiest periods in the work of plant extension, as all the many minor items forgotten or deferred must now be met. The machines, as soon as on foundations, must be leveled and made ready for use. The starting up of the machines, the constant operation of cranes and the demands for lights make it absolutely necessary that the power plant be in good running order, and that such changes be made as develop from watching the operation of new apparatus.

On the presumption that the engineer in charge of the construction of a metal-working plant has to do with the

selections of new equipment both in way of machine tools and equipment for handling and transporting of materials, the erecting and running of new machinery should not be left to the shop people. Especially in shops where the heads of departments have worked up from the ranks, there is often a reluctancy to give new machinery a fair chance or to strive for the most that the machinery is capable of. Therefore, the engineer will work to the best interest of his employers and himself if he renders every assistance to any erecting men or demonstrators from the outside, and follows up and records the performance of machines when they are in the hands of skilled operators. The little "kinks" of handling and time-saving used by demonstrators should be noted, as later on the shop men may so handle machines that the performance is not duplicated, and if the engineer has advocated the machine without the earnest acquiescence of the shop foremen, it will be "up to him" to save an efficient machine from being condemned.

Scope of Construction Engineering.

The reason that the author has placed so much stress on the responsibility of the engineer in charge of a large project of construction work is shown in a way by the range of work going on in the scope of Fig. 43. Below the surface of the ground there is tunneling, plumbing and power piping being carried on. The foundry shown at the right is being worked into running order; the foundations are put in for the boilers at the power house of which the mason work is in progress. In the foreground: excavation, concreting, the placing of capstones and the beginning of the steel erection is in evidence. The planning and contracting for the work shown in this one view was done within six months and involved the expenditure of nearly $400,000. If one will but consider the large number of personalities with whom the engineer must deal, and the mass of details for which he must stand sponsor on a job of this size, the difficulty of securing results that are satisfactory to even a *few* people will be understood. The subject is so broad that to treat it in a general way can only serve to bring out a portion of the many things which have to be considered in this class of engineering.

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CRANE HOOKS.*†

H. J. MASTENBROOK.‡

The tables of dimensions and properties of crane hooks found in hand-books usually apply only to hooks of ten tons capacity and under. They are based largely on the results of practice, and are forged from a rod of uniform cross section for reasons of economy in manufacture. In designing a hook of large capacity the matter of weight is of much more importance than cheapness of production; it is therefore important to distribute the metal in the most economical manner, and obtain the necessary strength with a minimum weight. The shape of the cross section of a hook is such that it does not lend itself readily to exact mathematical treatment. However, approximations may be made that are fairly accurate and which experience has shown to be safe.

Let us first consider briefly the development of a general formula. In the formulas:

A = area of section in square inches,
f = allowable fiber stress in pounds per square inch,
P = load in pounds,
p_1 = stress due to pull in pounds per square inch,
p_2 = stress due to bending in pounds per square inch,
I = moment of inertia of cross section,
R^2 = square of the radius of gyration in inches.

See also the accompanying illustration for the notation used. Then

$$p_1 = \frac{P}{A}$$

$$p_2 = \frac{P y_1 y_0}{I}.$$

For safety $p_1 + p_2$ must equal f; therefore:

$$f = \frac{P}{A} + \frac{P y_1 y_0}{I}$$

which may be reduced to the following form:

$$\frac{P}{f} = \frac{A}{1 + \frac{y_1 y_0}{R^2}}.$$

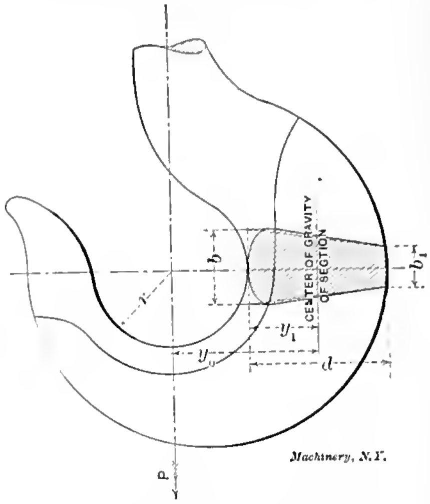
If, instead of the actual section of the hook, we consider the trapezoid as shown by the dotted lines, we then have the following values for the various terms in the formula:

$$A = \frac{b + b_1}{2} \times d,$$

$$y_1 = \frac{b + 2b_1}{b + b_1} \times \frac{d}{3},$$

$$y_0 = \frac{b + 2b_1}{b + b_1} \times \frac{d}{3} + r$$

$$R^2 = \frac{b^2 + 4bb_1 + b_1^2}{18(b^2 + 2bb_1 + b_1^2)} \times d^2.$$



Machinery, N.Y.

Notation for Crane Hook Formulas.

Substituting in the above formulas $b = 0.65\ d$; and $b_1 = 0.3\ d$, we have:

$A = 0.475\ d^2$,
$y_1 = 0.4386\ d$,
$y_0 = 0.4386\ d + r$,
$R^2 = 0.0795\ d^2$.

Substituting these values in the general formula reduces it to

$$\frac{P}{f} = \frac{d^3}{7.2d + 11.615r} = \text{constant in table in Supplement.}$$

To facilitate the work of design, tables giving values of $\frac{P}{f}$ for various assumed values of d and r may be calculated, and such tables are given in the accompanying Supplement. Hooks designed by these tables have been very thoroughly tested in practice and have given entire satisfaction. For ordinary service, a fiber strain of from 16,000 to 25,000 pounds may be used with safety.

When using the table in the Supplement for designing crane hooks, the load P in pounds which the hook will be required to carry is first determined. Then the allowable fiber stress f is assumed, and the quotient $\frac{P}{f}$ obtained. This quotient is found in the body of the table under the value of the radius r required in the hook. When the nearest value to $\frac{P}{f}$ in the table has been located in the vertical column under the radius, follow the line horizontally to the left-hand column which gives the dimension d directly. All the other dimensions are proportioned from the dimension d, as shown in the engraving, Fig. 2, in the Supplement.

As an example, assume that a crane hook for a 50-ton crane is to be designed, that the radius r is required to be 3 inches, and that the allowable unit fiber stress is 20,000 pounds. Expressed in pounds, P = 100,000 pounds. This divided by 20,000 gives us the quotient 5, which is found in the table in the vertical column under 3 inch radius. It will be seen that the nearest value to 5 is 4.75, and following the horizontal line in which 4.75 is found, to the left-hand column for d, we find d = 7.5 inches. All the other dimensions can now be found by inserting this value of d in the formulas in Fig. 2 in the Supplement.

* * *

The movement for increased facilities for technical education is clearly making progress. Even Palestine is to have an institute of technology at Haifa, Palestine. Mr. Jacob H. Schiff of New York, has contributed $100,000 towards it.

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[*] See also MACHINERY's Data Sheet No. 33, June, 1904: Proportions of Hooks.
[†] With Data Sheet Supplement.
[‡] Address: 212 Franklin Ave., Bay City, Mich.

AUTOGENOUS WELDING AS A MEANS OF REPAIRING CYLINDERS.*

HENRY CAVE.†

Breakages in automobile cylinders can be divided into three main classes which cover at least ninety per cent of the cases. The majority of these breakages can be satisfactorily repaired by means of the oxy-acetylene flame as carried out by the Autogenous Welding Equipment Co., Springfield, Mass., with their Davis-Bournonville apparatus, the cylinder being as good as new, and better in some cases. Autogenous welding, as the process is called, consists of fusing the metal around the break by means of an acetylene flame, the heat of which is concentrated to a very small area by being burned with pure oxygen in a torch giving a flame temperature of over six thousand degrees F. Additional metal is added where necessary from a rod of the same material, and the process is practically recasting the part locally.

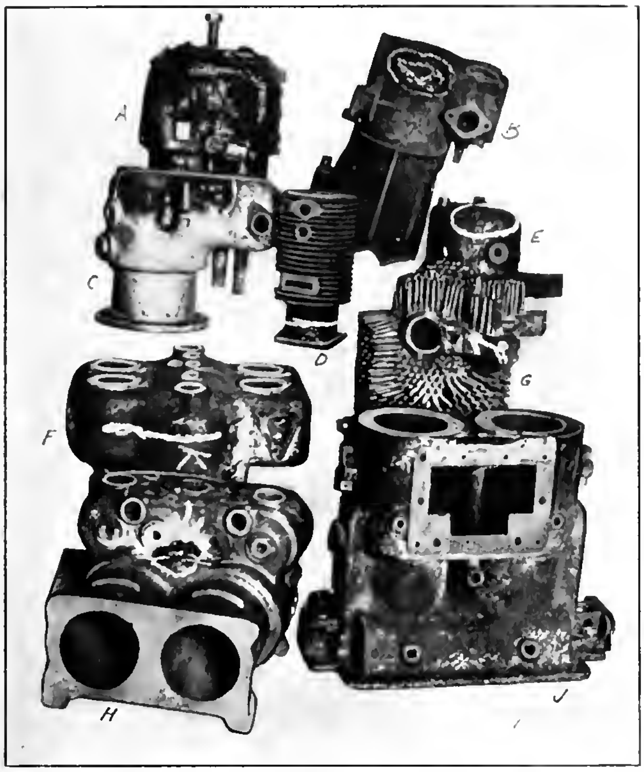

Fig. 1. Group of Broken Automobile Cylinders that were repaired by Autogenous Welding.

Autogenous welding is proving a great boon to those who are unfortunate enough to have their automobile cylinders broken, as they can be satisfactorily welded and in the majority of cases, with a little trimming off, the repairs will not show. This is a particularly valuable feature as some owners wish to sell their cars without the repairs being noticed. Cylinders with cracks are sometimes brazed, but owing to the necessity of heating the whole cylinder to a good red heat to even up the contraction strains, so as not to crack when cooling, the bore of the cylinder is generally warped, and the job requires a lot of finishing as the spelter and flux spread considerably and are hard to remove. Also, owing to the dirt and rust in the crack it is difficult to get the brazing below the surface; the high temperature necessary will sometimes crack the cylinder elsewhere.

Water Jackets Broken by Freezing.

The largest class of cylinder breakages—mainly due to carelessness or misfortune, probably in most cases the former—is caused by allowing the water jacket to freeze, resulting in the breaking of the water jacket wall. This cannot always be termed carelessness, as I have known an automobile to have all its water jackets cracked as early as the middle of October when the owner had no thought of such a thing being possible. I have also known of cars being "hung up" on the road in cold weather, the driver opening the drain cocks before he left to summon help and upon his return finding the water frozen with the usual result. This accident probably is due to too small drain cocks. Also, it has frequently happened that when shipping a car by rail in winter the drain cocks were opened, but due to some pocket in the water system (in some cases very small ones) which did not drain, the cylinders have become fit subjects for the autogenous welder.

Curiously enough the majority of cylinders cast from the same patterns will break in just the same place when frozen. In a number of cases the break causes a piece of the wall of the water jacket to be entirely detached, and the breaks occur so nearly alike, in similar cylinders, that it would be possible to take the detached piece from one and weld it into another, even the smaller irregularities coinciding.

When a break of this nature is autogenously welded, by means of the oxy-acetylene flame, the crack or edge of the broken part is prepared so as to leave a groove nearly through the metal. The whole part is then uniformly heated to about five hundred degrees F. This temperature is not high enough to warp the bore, as has been repeatedly proven by careful measurements before and after treatment. The sides of the groove are fused together and filled from a rod of cast iron. The resulting weld is very neat in appearance; it generally requires no finishing and is as strong as the original wall. As a very small number of heat units are absorbed by the part, owing to the intense heat of the flame fusing the metal before the heat has time to spread, there is seldom any trouble with cracks when the metal contracts in cooling.

Cylinders *A*, *F*, *H* and *J*, Fig. 1, were welded in this manner. The weld on *F* was along the chalk line, and was ground off so that all signs of it were effaced. A piece of the water jacket had been knocked out of cylinder *H* when the casting was being smoothed up ready for painting at the factory; the successful welding, however, saved the cylinder. A crack along the top corner of *J* is shown welded. *A* and *B*, Fig. 2, show common types of breakages which are being satisfactorily welded every day. The crack in *A* is seventeen inches in length. Both cylinders are grooved out ready for welding.

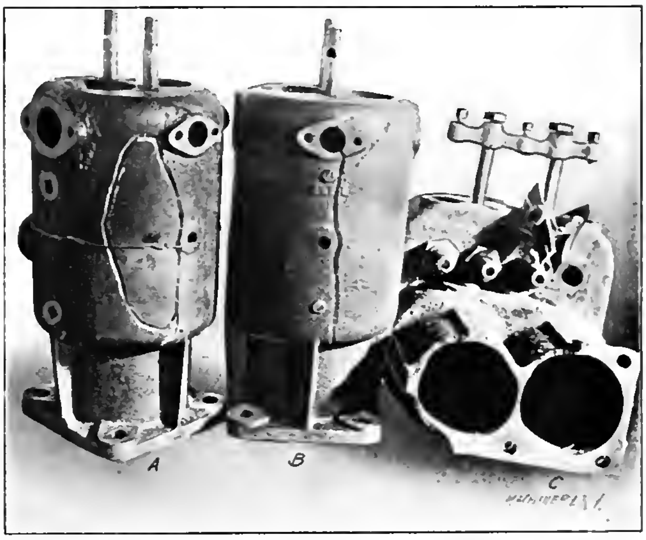

Fig. 2. Two Cylinders with Cracked Water Jackets prepared for Welding
Twin Cylinders with Broken Flanges to be Welded

Cylinder Wall Broken.

The next class of breakages, in order of frequency of occurrence, is that in which the wall of the cylinder, combustion or valve chamber, is broken or cracked. These breaks are, in most cases, due to freezing, but a certain number of them are due to the designer making a large flat surface without adequate ribbing to support the pressure of the explosion.

Another cause is the breakage of the connecting-rod, allowing the piston to strike the top of the cylinder. Serious damage from this cause occurs most frequently in two-cycle engines as the deflector on the piston readily punches a hole in the combustion chamber wall. Fig. 3 shows a cylinder

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* For previous articles on oxy-acetylene flame autogenous welding see "The Application of Autogenous Welding to Automobile Repairs" by Henry Cave, December, 1908, and other articles there referred to.

† President of the Autogenous Welding Equipment Co., 92 Hayden Ave., Springfield, Mass.

h[illegible] and Fig. 4 shows the outside after welding. [illegible] break also often occurs due to foreign s[illegible] s the head of a broken valve getting between [illegible] the cylinder head.

[illegible] of breakages is the most difficult to repair, as [illegible] necessary in most cases to cut out a section of the [illegible] to be able to work on the inner wall, the only deviation occurring when the break happens to be opposite a large hand hole. This operation has a singular resemblance to the well-known trepanning operation performed upon the human skull.

It can be readily seen that it is practically impossible to make a repair when the break occurs between two cylinders or behind the valve chamber, as these parts cannot be reached with the small flame.

If the crack occurs in the bore it is necessary to carefully weld to within a sixteenth inch of the bore, or the finished surface will be spoiled; the crack left in this way is of small importance, as sufficient metal can be built on the outside so that there is no doubt about the strength. After welding the break the section of the water jacket which was removed is welded back in place.

As it often is impossible to determine the length or exact locality of the cracks before cutting away the jacket and is desirable to remove as small a section as possible, it often is found necessary to cut additional pieces out, thus necessitating welding a number of small pieces back in place when finishing the job. To restore these pieces sometimes is impracticable, and a sheet steel substitute must be hammered out and welded in place. With care this piece can be shaped so as to coincide with the piece removed, and cannot be detected when welded in place. A case of this kind is shown in *B*, Fig. 1. The part shown cut away was neatly replaced by sheet steel, as shown at *A*, Fig. 5.

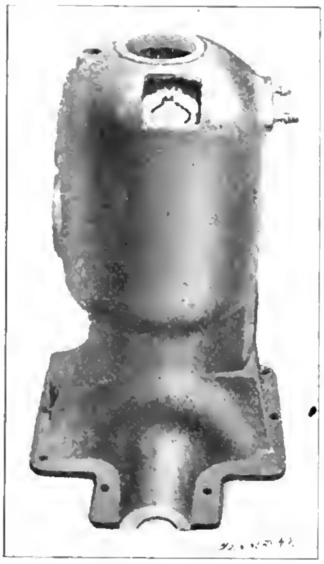


Fig. 3. Cylinder with Section of Water Jacket removed to repair Crack in Inner Wall

Fig. 4. Cylinder shown in Fig. 3, after Welding

The water in freezing will often crack both the water jacket and cylinder wall. The former being readily seen is generally thought to be the full extent of the damage, particularly as it is practically impossible to make a test until the crack is repaired. The work may then have to be cut out to find further defects. This was the case in the cylinder shown at *A*, Fig. 1, the right angle crack being first welded; the break extending from below the hole shown cut out across the other side was welded and the cover replaced. A similar break then being discovered in the other cylinder, the relief cock boss for both cylinders was entirely detached and welded back in place.

The cover plate on the cylinder shown in Fig. 5 was also broken in freezing, at the same time as the cylinder wall was broken, and is shown welded.

Fig. 6 shows a cylinder having a crack eight inches long, located at the corner of the combustion head, that was welded. The part cut out of the water jacket is also shown. It [illegible] noticed that this operation required cutting through a supporting lug. The water jacket part successfully welded back in place is shown at *C*, Fig. 1.

The cylinder shown at *E*, Fig. 1, had a hole to be welded to accomplish which it was thought necessary to remove the section shown chalked. A much larger section, however, had to be cut out so as to take care of a crack running down the side; the two pieces removed were welded together before they were replaced.

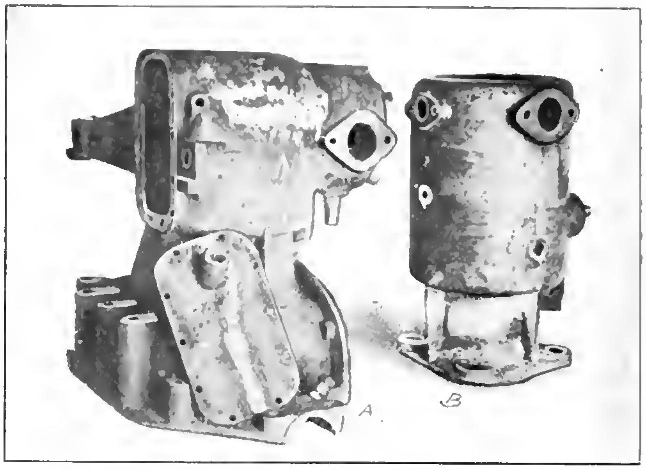


Fig. 5. Cylinder A, (Fig. 1, B) repaired by inserting a Steel Piece, bent to Shape, and autogenously welded in Place.

Broken Flanges.

The next order of breakages in point of number are those in which all, or a portion of the flange, which holds the cylinder to the crank case is broken away, due either to insufficient metal to withstand the strain or, to carelessness in assembling.

These breakages occur in two ways; the wall of the cylinder may be broken away or part of the flange may be cracked off. In the latter case it is an easy matter to make the repair, but when the break runs through into the bore of the cylinder considerable care is required. First it is necessary to consider whether it is desirable to weld in the bore which would then require machining or at any rate filing out, or only groove and weld from the outside to within a sixteenth inch of the bore, sufficient metal being added to the outside to insure strength. The latter method, of course, leaves the crack on the inside, which can, however, be smoothed down and is not objectionable for a repair job; not interfering with the satisfactory operation of the motor in any way.

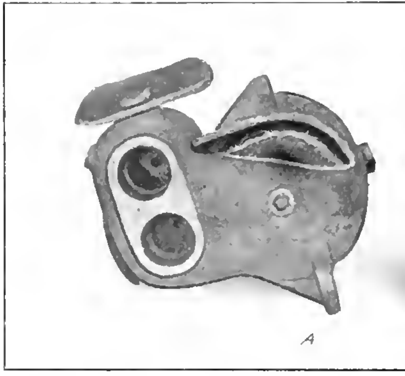


Fig. 6. Cylinder Cracked in Inner Wall, showing Large Section of Outer Wall removed to weld the Crack.

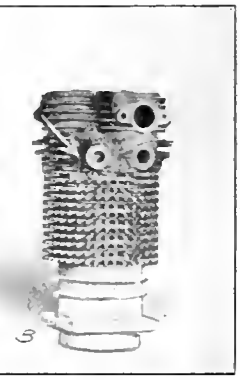


Fig. 7. Air-cooled Cylinder on which Boss for Ignition Plug was autogenously welded.

In addition to these three classes, there is a large variety of other breakages, no two of which are alike, that can be repaired successfully by the oxy-acetylene torch, such as broken inlet and exhaust flanges, holes knocked through the barrel of the cylinder by broken connecting-rods, welding of broken supporting brackets, as shown at *G*, Fig. 1, the bracket or lug shown having been entirely detached.

In addition to this, considerable welding can be carried out for the manufacturer, such as the welding on of additional bosses for dual ignition systems, as shown in Fig. 7, building up bosses that did not "fill" in castings, welding porous spots which show up after machining or adding metal anywhere it may be required.

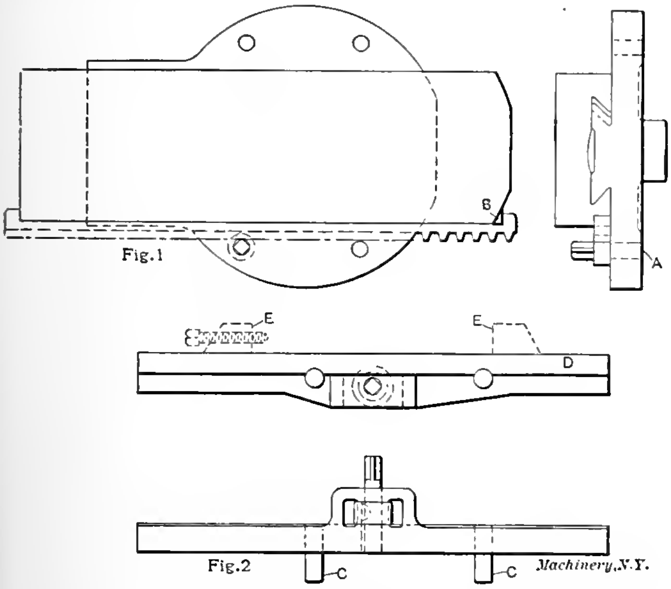
LABOR-SAVING DEVICES FOR SCRAPING OPERATIONS.*

ALFRED SPANGENBERG.†

Alfred Spangenberg.‡

There are a number of elements entering into the cost of scraping operations, other than that of scraping proper, which are always of sufficient importance to merit the closest consideration. In fact, very often it is the lack of attention to these other factors that accounts for much lost time. This is particularly the case in such laborious operations as "straightening out." This operation consists in moving the sliding machine member with the packing set up tightly, over the fixed member, in order to find the bearing on the packing, and finally to feel the "high spots." It is obvious that the packing must be adjusted to make the sliding member pull hard, otherwise it would be impossible to detect any variation in pressure due to inequalities in the machining.

Even on comparatively light work this pulling and pushing, if done directly by hand, involves more labor than is required in the actual operation of scraping. In work of this character, where brawn and muscle are prime requisites, we are dealing with the human elements which may cause a slowing up of production. The principal point to be observed is that a workman has a certain amount of physical endurance, and if the greater part of his energy is concentrated on the productive operation of scraping, a material increase in production will result; because of this fact, it becomes of extreme importance that means be provided for making the task of pulling easier.



Figs. 1 and 2. Device for Pulling Planer Slide back and forth, and Support for Rack and Pinion.

The classifications of work determining the selection of a proper type of pulling device are: (*a*) Planer slides, lathe rest slides and work of a similar character; these are usually pulled directly by hand. For this work a rack and pinion operated by a ratchet wrench is the most convenient type of pulling device; the tight and loose places in the work being easily detected. (*b*) Boring mill rams, shaper rams, milling machine tables and similar work, which is comparatively short and too heavy to be pulled by a ratchet wrench. The type of device suitable for this class of work is a rack and pinion operated by power. The pinion being driven through a frictional device, the slipping of the driven friction member indicates the "high spots" in the work. (*c*) Planer crossrails, lathe beds and work having large dimensions, and where the pull required is long. For this class of work the pulling device takes the form of a power-driven wire rope drum. A tension indicator interposed between the work and the wire rope indicates any variation in pulling force required to move the work.

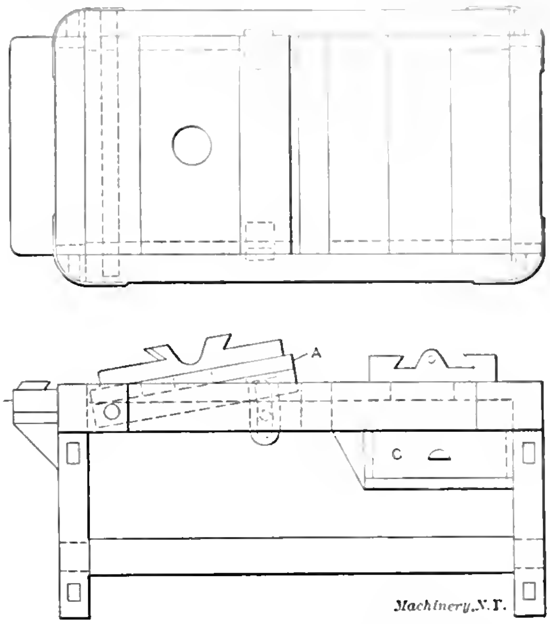


Fig. 3. Bench for Holding Slides and Swivels

Concrete examples of the conditions stated in class (*a*) are illustrated in Figs 1, 4. and 5. Fig. 1 shows the application to a planer slide and swivel, of a rack and pinion operated by a ratchet wrench. In this case, the clamping bolt hole *A* in the swivel is made use of as a bearing for the pinion. A lug is cast on the slide at *B* to provide a square seat for the projection on the rack. The rack is a loose fit endwise on the slide and is easily removed.

When the design of the swivel is such that the clamping bolt hole *A* is too near the slide to be used as a bearing for the pinion, the device shown in Fig. 2 is substituted. The pins *C* fit into the holes in the swivel and hold the device from moving. The surface *D* supports the rack and keeps it in place when the slide is in the extreme positions. The lugs *E*, indicated by the dotted lines, show how the device can be attached to a swivel in which the clamping bolt holes *A* (Fig. 1) are not available for supporting the device.

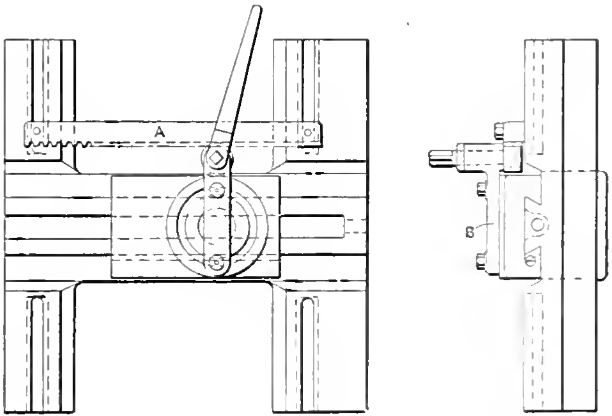


Fig. 4. Method of Attaching Rack and Pinion to a Lathe Rest.

The special bench represented in Fig. 3, while not strictly a pulling device, is shown because it is very useful for holding

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* See also MACHINERY, February, 1909: Application of Lifting Devices to Assembling Work.

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‡ Alfred Spangenberg was born in Brooklyn, N. Y., in 1876, and received a high school education, after which he completed a correspondence course in mechanical engineering. He served a four years' apprenticeship with the Pond Machine Tool Co., three years of which were in the machine shop and one year in the drawing office. He has been employed by the Hercules Seamless Drawn Tube Co., Garwood, N. J.; National Meter Co., Brooklyn, N. Y.; and the Pond works of the Niles-Bement-Pond Co., Plainfield, N. J., where he is now employed as foreman of the turret lathe erecting department. Mr. Spangenberg has made a specialty of assembling work, and his article on the subject published in the February issue of MACHINERY illustrated a number of practical shop devices for scraping and fitting, which are of his own design.

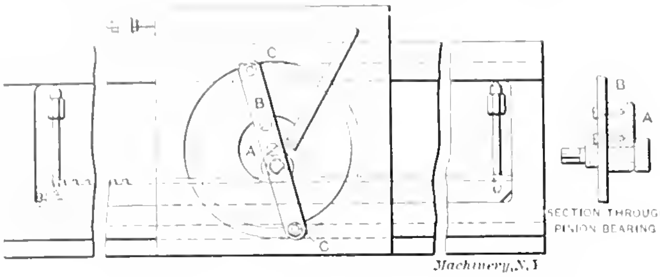

Fig. 5. Rack and Pinion for Pulling a Planer Slide

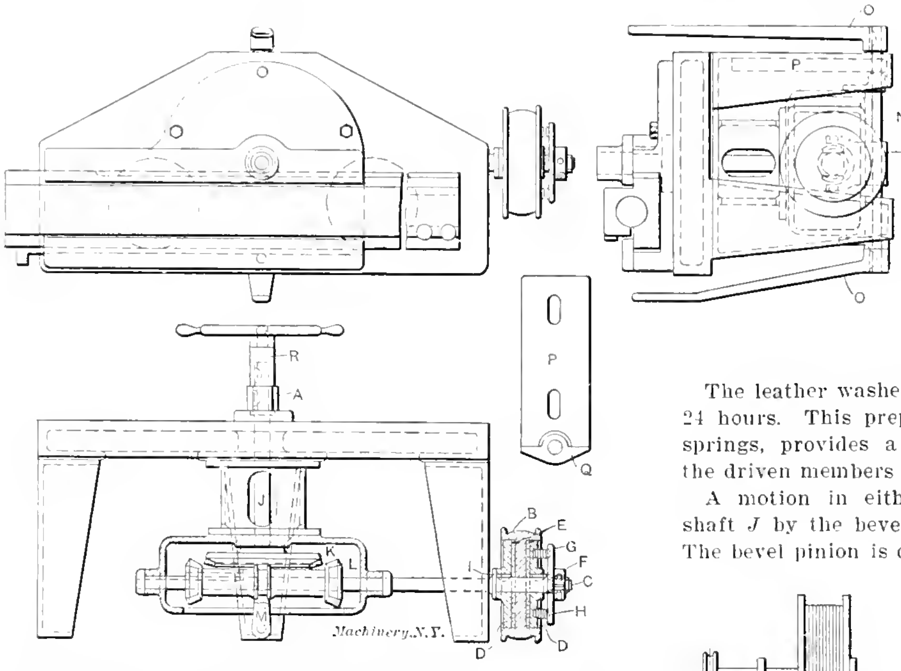

Fig. 6. Machine for Imparting Motion to Boring Mill Rams while Scraping.

slides and swivels and work of a similar character, during the operations of pulling and scraping. The top half of the bench shown tilted is for holding the swivel on an angle, the object being to easily keep the slide against the fitting angle of the swivel while finding the bearing before the packing is fitted. When the packing is being fitted, and during the operation of "straightening out," this swinging top *A* is kept level. The magnetic chuck *B* provides a very convenient means for holding the packing while it is being scraped. A drawer *C* is for keeping the scrapers, oil stone, etc. The bench is made of wood and iron and bound at the corners.

Fig. 4 clearly indicates the method of attaching a rack and pinion to a lathe rest and shoe. The rack *A* is bolted to the rest by means of the T-slots. The pinion bearing casting *B* extends across the top of the shoe and is clamped by two bolts in the circular T-slot. The rack is quickly made parallel with the ways of the rest by placing the shoe, with the pinion clamped to it, in one extreme position and clamping the adjacent end of the rack in proper mesh with the pinion; then repeating the operation with the shoe in the other extreme position.

The method of attaching a rack and pinion to a small planer cross-rail and saddle is shown in Fig. 5; it is practicable to apply this method for pulling the saddles of cross-rails up to sizes of 48 inches. Referring to the illustration, the rack rests on the rough inside surface of the cross-rail, and is held in position by the screw, studs and nuts as indicated. The adjustment of the pinion into proper mesh with the rack is accomplished by making the pinion bearing *A* in the form of an eccentric bushing fitting into the hole in the saddle. The eccentric bushing is clamped by the strap *B* and bolts *C*.

The principles embodied in the design of the pulling machine illustrated in Fig. 6 are adaptable to the work mentioned in class (*b*). This machine is made for pulling boring mill rams; the simplicity of the design is immediately apparent from a study of the three views shown in the sketch. The top and end views show a right-hand ram and swivel in position on the table of the machine. This table is supported on three legs to avoid any tendency to "wind," and the design is adapted to hold either right- or left-hand swivels.

The machine illustrated is belt-driven, although a motor drive could be easily substituted. The mechanism for driving the pinion *A*, which meshes with the teeth of the ram, is clearly shown in the side view. Referring to the sectional view of the friction pulley, the driving member is the flanged pulley casting *B*, having a solid web. This member is a running fit on the shaft *C* and friction disks *D*. The friction disks are the driven members, and are keyed to the shaft *C*. Between these disks and the pulley casting are two leather washers *E*. The amount of friction required is adjusted by means of the split nut *F*, which moves the spring disk member *G* (keyed to the shaft) and compresses the twelve springs *H*. This regulates the pressure on the friction disks, leather washers, and pulley; the thrust is taken by the nut *F* and collar *I* on the shaft.

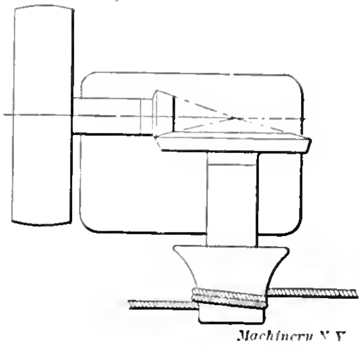

Fig. 7. Winch Superseded by Pulling Machines in Figs. 6 and 8.

The leather washers are prepared by being soaked in oil for 24 hours. This preparation, together with the action of the springs, provides a very uniform and positive slippage of the driven members when the load is excessive.

A motion in either direction is imparted to the pinion shaft *J* by the bevel gear *K* and the double bevel pinion *L*. The bevel pinion is operated by the yoke *M*, shaft *N* and operating levers *O*. The detail sketch of the weight *P* shows its action on the double rocker arm *Q*, which is pinned to the lever shaft *N*. It is obvious that this device keeps the double bevel pinion in a central position when the hand levers are not being operated. The hand-wheel sleeve *R* is a sliding fit on the pinion shaft and its key.

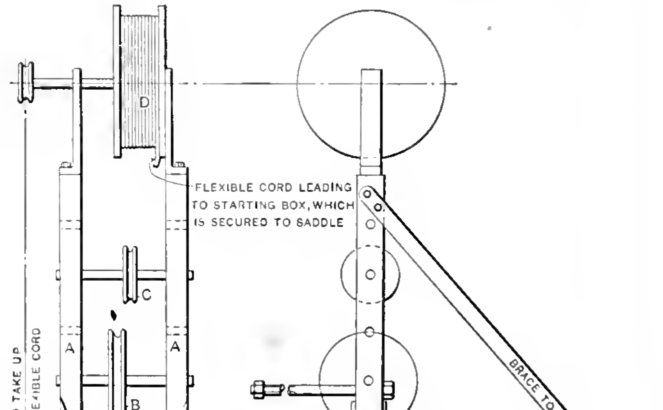

Fig. 8. Pulling Device for Cross-rail Saddles.

In operation, the swivel is centered by its hole fitting the hub cast on the table, and clamped by the bolts as indicated. When the packing and gibs are being fitted, the hand-wheel is left off the machine, and the ram only moved back and forth for a short distance near the center of its travel. After the operation of "straightening out" the ram is completed, the hand-wheel is used to pull the ram by hand (once or twice) to make sure the ram pulls evenly from end to end of its travel. The friction is adjusted so it will just pull the ram when the packing and gibs are set to a rather tight running fit. The "high spots" in the ram are indicated by the friction slipping. The machine is geared to move the ram at about the rate of 15 feet per minute. A modification of this machine is adaptable for pulling any work of comparatively short dimensions, by coupling the sliding work member to a rack supported in suitable guides and driven by a mechanism similar to that shown in Fig. 6.

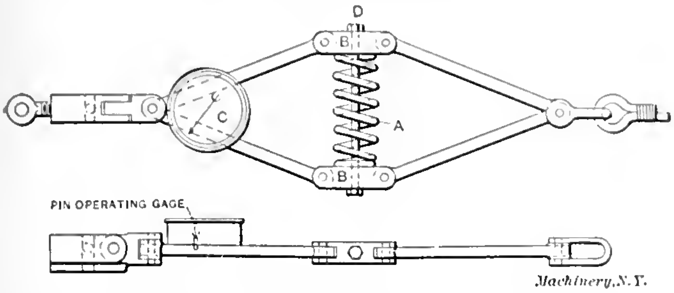

Fig. 9. Indicating Mechanism for Pulling Device.

The type of pulling machine illustrated in Fig. 8 is particularly well adapted to the work mentioned in class (*c*). The general features of the machine comprise a heavy cast-iron base carrying the motor, wire rope drum and driving mechanism. Bolted to the base are two upright steel bars *A*, which are made rigid by the braces as indicated. These bars support the wire rope idler sheaves *B* and *C* and the electric conductor cord drum *D*. The holes in the bars *A* are for carrying the wire rope sheaves at a height to suit the work, it being desirable to have the rope attached to the gage, measuring the pull, as nearly level as possible.

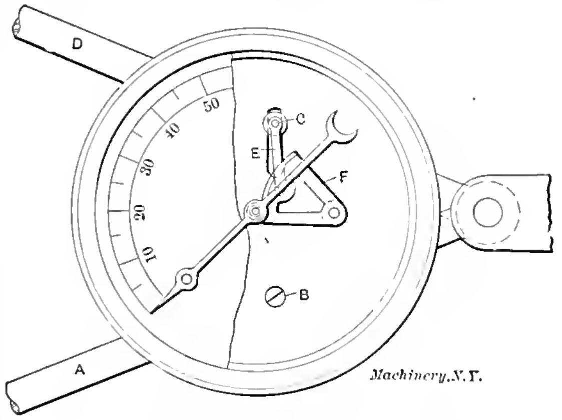

Fig. 10. Detail of Gage shown in Fig. 9.

It will be seen that the machine is self-contained as far as the application of power is concerned. The spur pinion on the motor shaft meshes with the gear on the worm shaft. Between the bearings for this shaft is the worm; this worm drives a worm gear on a cross-shaft. On the cross-shaft are also a sliding clutch and wire rope drum. This drum has clutch teeth cast on one end and is driven by the sliding clutch. The lever *E* is for operating the sliding clutch. The advantage of this clutch is to facilitate the setting of a tension indicator and wire rope onto the work.

The tension indicator illustrated in Fig. 9 and used in connection with the pulling machine just described is essentially a double toggle joint. A force pulling on the wire rope, with the indicator attached to the work, compresses the spring *A* between the two short links *B*. The amount of compression is indicated by the index hand on the dial of the gage *C*. The function of the stud *D* is to limit the outward travel of the lever arms and thus reduce their movement by keeping the spring under a slight compression when there is no load, *i. e.*, there is no movement of the lever arms until the pull is sufficient to move the work. This avoids the tendency of the gage to jump or vibrate.

The construction of the gage is clearly indicated in Fig 10. The body of the gage is pivoted to the lever arm *A* by the screw *B*. A stud *C* screwed into the lever arm *D* passes through a slot in the body of the gage. A shoulder on this stud and the screw *B* keep the gage in place. The link *E* connects the stud *C* with the sector *F*. The teeth on this sector mesh with the pinion on the index hand shaft. There is no stop pin at 0 for the index hand, the return to 0 being controlled by the stud *D*, Fig. 9.

Referring now to Fig. 9, it is evident that since the relative movement of any two levers of the toggle joint is not in direct proportion to the amount of tension applied to the device, compensation should be made in the dial graduations. This refinement is not necessary, however, as the requirements simply are that the gage indicate *variations* in tension and not the *amount* of variation measured in any definite quantity.

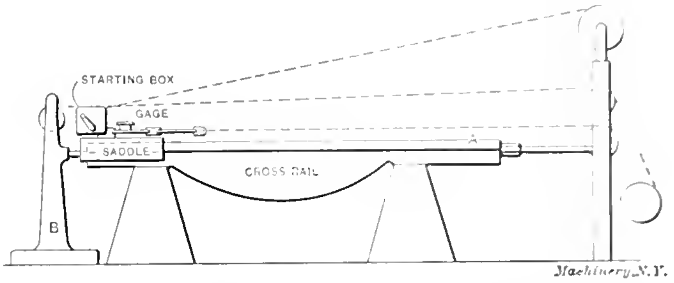

Fig. 11. Pulling Machine, Fig. 8, and Tension Indicator, Fig. 9, in Position for Moving a Cross-rail Saddle along its Ways

Fig. 11 shows the pulling machine and tension indicator in position for pulling a planer cross-rail saddle. The cross-rail is shown lying face up on suitable iron parallels. This is the position for fitting the packings and "straightening out" the angle. When the surface *A* is being scraped, the cross-rail is turned right-side up. In this case the idler sheave shafts are moved up in their supports so as to keep the wire ropes level. The pulling machine is not fastened to the floor; its weight and the braces keep it in position. The same conditions exist in the case of the idler pulley stand *B*.

The wire rope for pulling the saddle back to the starting point is fastened to the eyebolt shown in Fig. 9. The swivel block of the indicator is bolted to the T-slot in the saddle. When the saddle is pulled backwards the packing is left loose.

The starting box and reversing switch for the motor are on a board which is fastened to the saddle. The weight and cord attached to the sheave on the drum shaft, Fig. 8, take up the slack in the electric cable as the saddle moves forward. The rate of traverse is about 10 feet per minute.

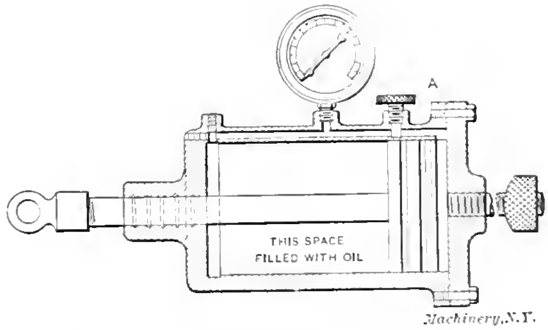

Fig. 12. Tension Indicator which proved a Failure.

In operation, the saddle is moved for a short distance near the center of the cross-rail to fit the packings. During the operation of "straightening out" the cross-rail, the saddle is brought to the position shown in the sketch, the packing is adjusted and the operator starts the motor. By watching the gage, the operator marks on the cross-rail with a piece of chalk the tight places. When the surfaces being tested are parallel with those that have previously been surfaced with a straight-edge, the index hand on the gage will remain fixed from end to end of the cross-rail. The packings are, of course, tightened one at a time.

It will be observed that the gage shown in detail in Fig. 10 consists of parts from a standard pressure gage. The reason for using this was a special one in this case.

When the pulling machine shown in Fig. 7 was designed by the writer a hydraulic tension indicator, illustrated in Fig. 12, was made. The general principles of this indicator are immediately apparent from a study of the line engraving.

Although the piston was grooved, and the cylinder and piston ground to insure their being a good fit, trouble was experienced from the oil leaking past the piston. Provision was made for returning the oil to the front of the piston by opening the valve *A* and pushing the piston-rod back. The principal cause of its failure, however, was the fact that the gage was too sluggish in its action. The sliding members to which the indicator was attached, had to travel quite some distance before the gage indicated the actual tension.

The indicator above referred to was then designed by the writer, using parts from the pressure gage. This type proved to be very simple and efficient.

The engraving, Fig. 7, represents a power-driven winch that was superseded by the pulling machine described in this article. The advantages possessed by the latter type are at once apparent; they are time and labor savers. The principal point to be gained by their employment, however, is the fact that far more accurate results are obtained.

* * *

BROACHING AUTOMOBILE PARTS.

ETHAN VIALL.*

There is a decided prejudice in some shops against the broaching of keyways, but where the broaches are properly made, the quickness, ease, and accuracy with which keyways may be cut in almost any metal, is astonishing to those accustomed only to the work of the ordinary keyseating machine. The principal difficulties encountered by those who have only experimented a little with broaches, have arisen from the fact that, as a rule, too few teeth have been cut in them, thus compelling six or seven teeth to do the work at one pass, that would require twenty-five or thirty strokes of the cutter on the keyseating machine. Where too few cutting teeth are used there is not only the strain of the heavy bite, but the cut metal fills up between the teeth and either scores the slot or breaks the broach. In addition to an ample number of well-spaced cutting teeth, a number of full-sized teeth should be left on the broach to insure accuracy, and long life to the tool, for where only one or two sizing teeth are used, they soon wear away under the excessive task and the resulting keyway is undersize and causes trouble. Not only must good judgment be used in the making of keyway broaches, but in all of the other forms as well. Of course there are some classes of broaching work where it is only possible to use a few teeth in the broach, but as a general rule plenty of cutting and sizing teeth, as well as ample chip space, should be put in if the nature of the work and the stroke of the machine will permit.

The hardening of the broaches also calls for the exercise of a great deal of judgment and "horse sense," for with these as with other cutting tools, a careless or ignorant hardener can spoil the work of the most competent designer or painstaking toolmaker.

In many cases the character of the work necessitates the broach being pushed through the metal, but for regular keyways, and wherever possible on other work, the broaching should be done with a drawing cut, the broach being supported by a guide or bushing. Draw-cut broaches that are used to cut double keyways, should have a guiding rib extending their entire length, which accurately fits the slot in the guide bushing. This form of flat broach, stiffened and guided by a rib and running through a slotted bushing, is preferable in many ways to the round-bodied self-supporting form, where close accurate work is desired.

In the construction of automobiles, where the Woodruff system of keying is almost universal, the broaching process is particularly adapted to the work, and at the factory of the E. R. Thomas Motor Co., Buffalo, N. Y., not only are all keyways broached that are usually cut on the keyseater, but this method is used for a number of other classes of work that are generally done in a more round-about way. Much of the broaching work is in direct charge of C. B. Buxton, the assistant superintendent, and his practical experience and ideas, together with those of the tool-designer, Lucien Haas, have done much to simplify the difficulties encountered from time to time, thus placing their broaching practice ahead of a majority of the other shops in this respect.

A good idea of the class and variety of the broaching work done at the Thomas plant may be obtained from Fig. 1, while a few of the broaches are shown in Fig. 2. The broaches *A* and *D* are for cutting double keyways, and the guiding rib is very plainly shown; *C* is a broach for cutting a single keyway, and works in a slotted bushing; *B* is a self-guiding broach for cutting the spring notches in the segments of what is known as the Westinghouse piston ring. All of the larger broaches are of the draw-cut type, while the small ones are pushed through the metal. It will be noted by carefully examining the broaches shown, that the notches between the teeth are not sharp at the bottom, thus lessening the tendency to crack at these places.

The draw-cut work is done on the type of machine shown in the illustration, Fig. 3, where the method of holding the work is well illustrated. The piece being broached has a taper hole, and it is set in the jig at an angle in order to make the keyway parallel with the side of the hole. As the small end of a draw-cut broach must be thrust through the hole in the work and then fastened to the draw-head of the machine, some quick method of locking the broach to the draw-head must be used. For the broach shown at *B*, Fig. 2, a socket and pin are used on the draw-head, but for the broaches shown at *A*, *C* and *D*, a lock shown at *E*, Fig. 4, is used. This lock consists of two parts as shown, which are placed together with the broach and the grooved end of the draw-head between them. The collar *F*, which hangs loosely on the spindle, is then slipped over the parts *E*, thus locking them securely in place, yet allowing a certain amount of floating action. At *G* is shown another style of draw-head lock. The broach end is round and notched on each side, while the shape of the slot in the lock-slide is seen at a glance. The slide is lowered until the end of the broach can be slipped through the round hole *J* at the bottom of the slot, and the broach is then pushed in until the slide drops down into the notches locking the broach to the draw-head. At *H* is shown a guide-bushing for a double keyway broach, while at *I* is a jig for holding small cams while broaching out the keyway, the end of the guide-bushing being shown in the hole.

A turret arrangement for use in broaching to a shoulder is shown in Fig. 5. This device is extremely useful and efficient for doing this class of work. The broaching tools in the turret are not indexed in any way, but are swung around by hand and the pilot inserted in the hole in the fitting which is firmly held in a jig as shown.

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* Associate Editor of MACHINERY.

* * *

HINT FOR LEARNERS OF LETTERING.

An approved method of learning to letter drawings neatly is somewhat like that of learning to walk—a child creeps before it stands, and the learner of lettering soon finds out that he can imitate the approved free-hand style commonly used for legends on drawings much easier if he makes a broad flat letter in the beginning, thus:

When learning to letter make the letters
broad and flat, thus:

This style of lettering represents the creeping period, but after much practice the learner is able to give his letters more height and less base until finally his lettering looks something like this:

As proficiency is acquired make the letters narrower, space
closer and give more height.

Young draftsmen who are troubled by inability to letter neatly and rapidly may find a valuable hint in the above.

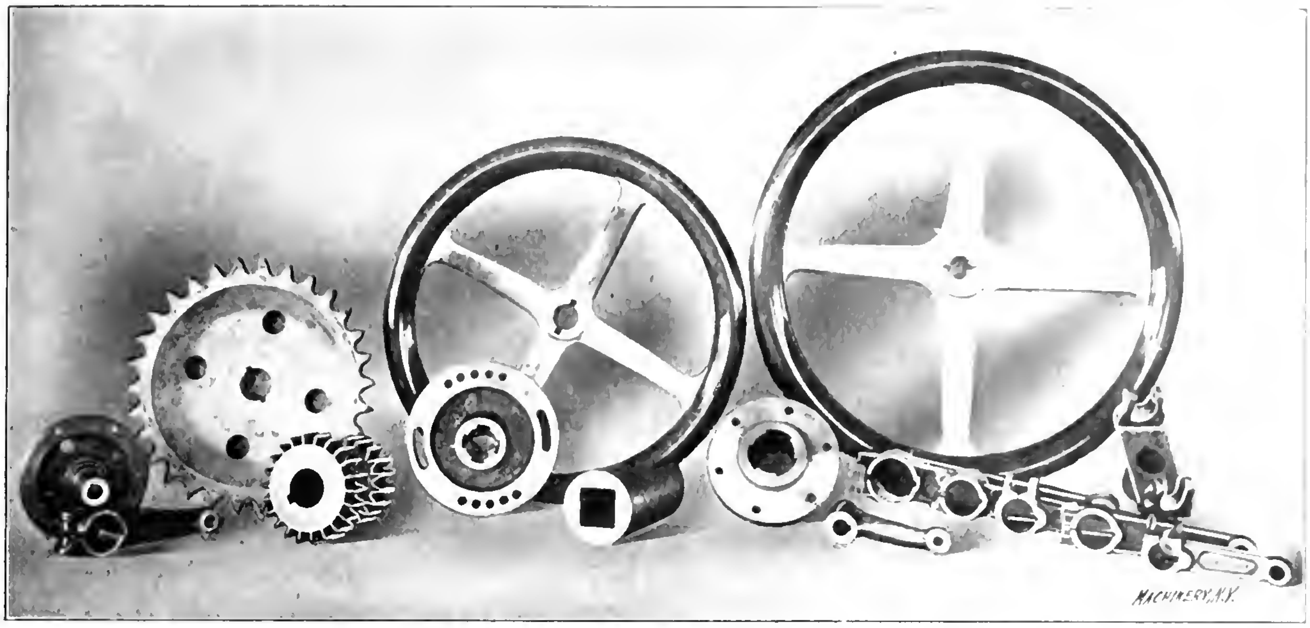


Fig. 1. Examples of Broaching Work done at the Factory of the E. R. Thomas Motor Co.

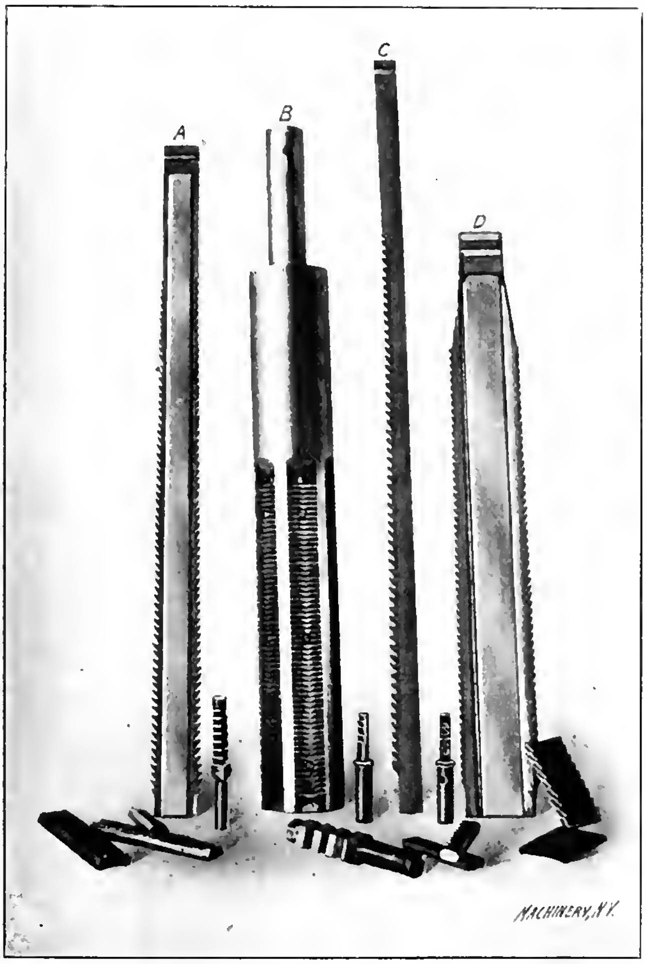


Fig. 2. Some of the Broaches used for Broaching Motor Parts.

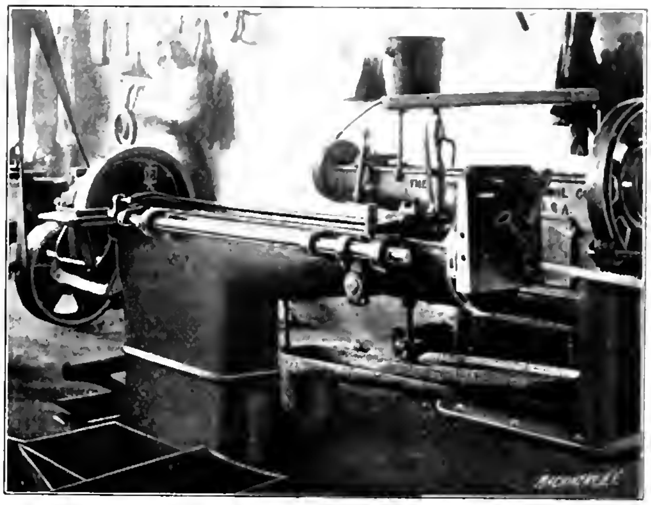


Fig. 3. Draw-cut Broaching Machine, showing Single Keyway Broach and a Jig for Holding Front Axle Part.

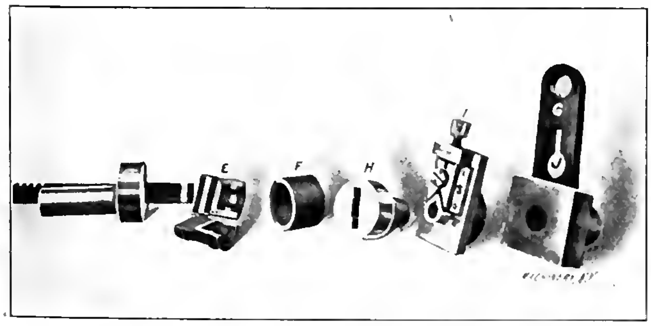


Fig. 4. Draw-head Locks, Guide-bushings and Cam Jig used on the La Pointe Broaching Machine, Fig. 3.

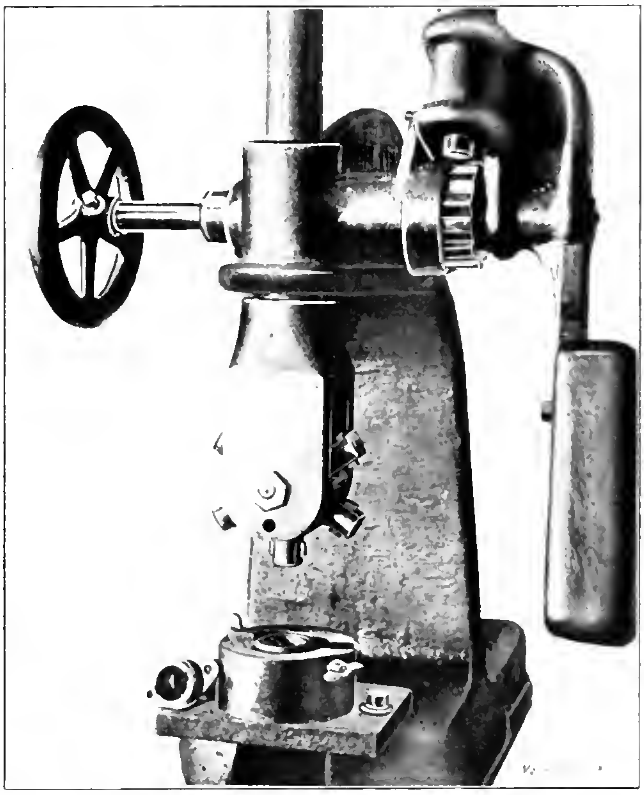


Fig. 5. Revolving Broach used in an Arbor Press for Broaching to a Shoulder.

JIGS AND FIXTURES—13.

PLANING AND MILLING FIXTURES.

EINAR MORIN *

Fixtures for planing and milling are as essential for interchangeable manufacturing as are drilling and boring jigs. Fixtures of this kind serve primarily the purpose of locating and holding the work, but they are often provided with setting pieces or templets which are made either in one part with the fixture or separate; the cutting tools are set to these setting pieces so that the work is always machined in a cerain relation to the locating means on the fixture itself.

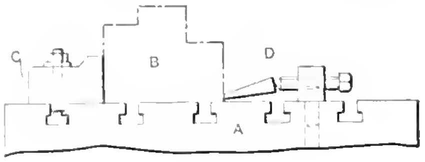


Fig.167

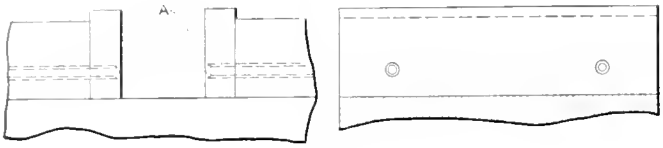


Fig.168

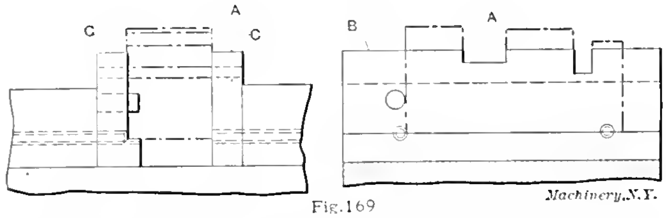
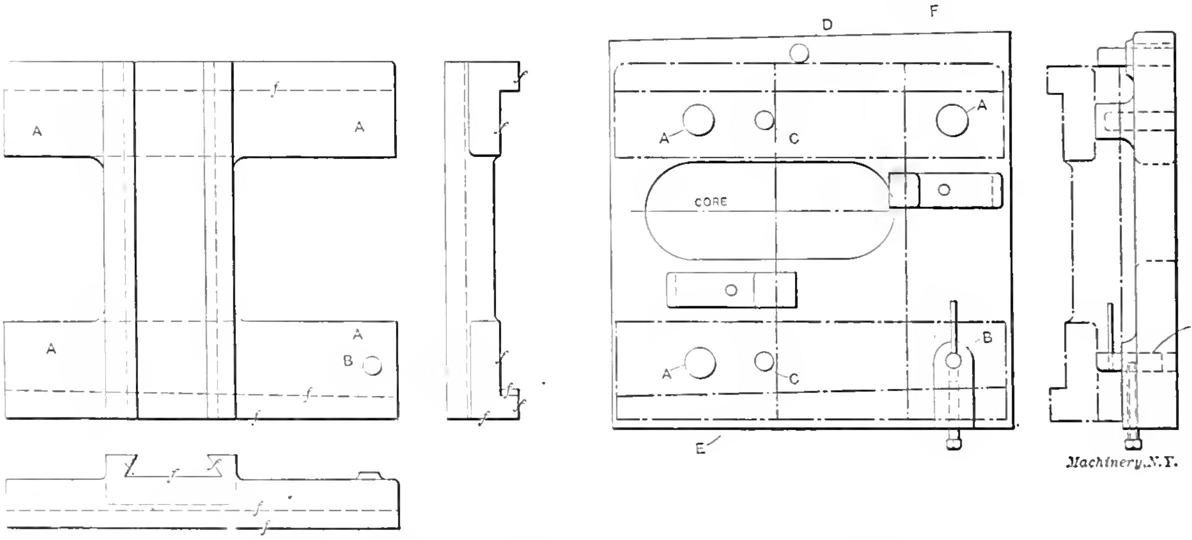


Fig.169

Fig 167 Principles of Fixtures exhibited by Common Method of Clamping Work on the Planer Fig 168. The Common Milling Machine Vise, an Example of Adjustable Fixture of Wide Range. Fig. 169. Vise with False Jaws shaped to the Form of the Work by the Cutting Tools Themselves.

When more than one milling operation is to be performed on the same piece, it is often possible to use the same fixture for the various operations, but it may be, in some cases, of advantage to make up a fixture for each different operation. The designer must in this case be guided by the number of pieces that are to be machined, and the advantages as regards rapidity of handling and operation that may be gained by having special fixtures for every operation, even though the operations may be such as to permit the same fixture to be used, with or without slight changes.



Figs. 170 and 171 Lathe Carriage and Fixture for Rough Planing Ways.

The strength of fixtures should be governed by the kind of operation to be carried out on the work while in the fixture, whether planing, milling, slotting, etc., and how much stock is to be removed. A milling fixture, as a rule, must be made stronger than a planing fixture, because a milling cutter, as a rule, takes a heavier cut than a planing tool.

The principles which have been previously explained in this series for drill jigs govern the locating means of milling fixtures, and the clamping devices of the same general type as described and illustrated in the July and August, 1908, issues of MACHINERY, are used, except that they are usually made heavier than when used for drill jigs and planing fixtures. On account of the irregular form of the work and the necessity for clearing the cutting tools, the clamps of milling and planing fixtures must often have irregular shapes.

An important factor, on which too much stress cannot be placed, is the necessity of having sufficient clearance for the cutting tools so that they do not interfere with some part of the fixture and clamping devices, and also that the fixtures, when located on the platen or machine table do not interfere with any part of the machine, when the table is fed one way or another. As a rule, milling and planing fixtures are provided with a tongue or key in the base, for locating them on the machine table. Suitable lugs should also be provided for clamping the fixture to the platen.

One of the very simplest types of fixture is illustrated in Fig. 167; work being planed is very commonly located and held by the means indicated, and for taking light cuts in the milling machine such an appliance may also be used. In this case, the planer platen *A* forms part of the fixture, and the work *B*, located on the platen, is held up against the bar *C*, which is held down by bolts, and located by a tongue as shown. The lugs and lug-screws shown with the spurs *D* hold the work up against the bar, and press it flat against the table. Instead of using the loose spurs *D* between the screws and the work, it is sometimes possible to let the screws bear directly on the work, in which case the screws should pass through the lugs at an angle with the top of the table, as shown in Fig. 175. The arrangement in Fig. 167 may or may not properly be considered a fixture, but it illustrates the principles of a fixture, as it locates and clamps the work in the simplest manner.

The most commonly used fixture for planing, shaping and milling is the vise. Standard vises are indispensable in planer or milling machine work, and by slight changes they can be used for a large variety of smaller pieces. In Fig. 168 are shown the regular vise jaws *A* of a standard vise. These jaws are often replaced by false jaws, which may be fitted with locating pins and seats, and held to the vise the same as the regular jaws. They are usually left soft, and often the milling cutter is permitted to cut out the jaw to the same shape as required for the work, as shown in Fig. 169. Vises with false vise jaws are especially adapted for milling operations, but vises are not usually employed for long work, special fixtures then being commonly made. While it is difficult to lay down any specific principles for the designing of milling and planing fixtures, it may be said that for most kinds of plain work, finished in the planer, the fixture shown in Fig. 167 is quite satisfactory. When pieces of a more complicated nature are to be machined, particularly in the milling machine, more complicated fixtures will be required.

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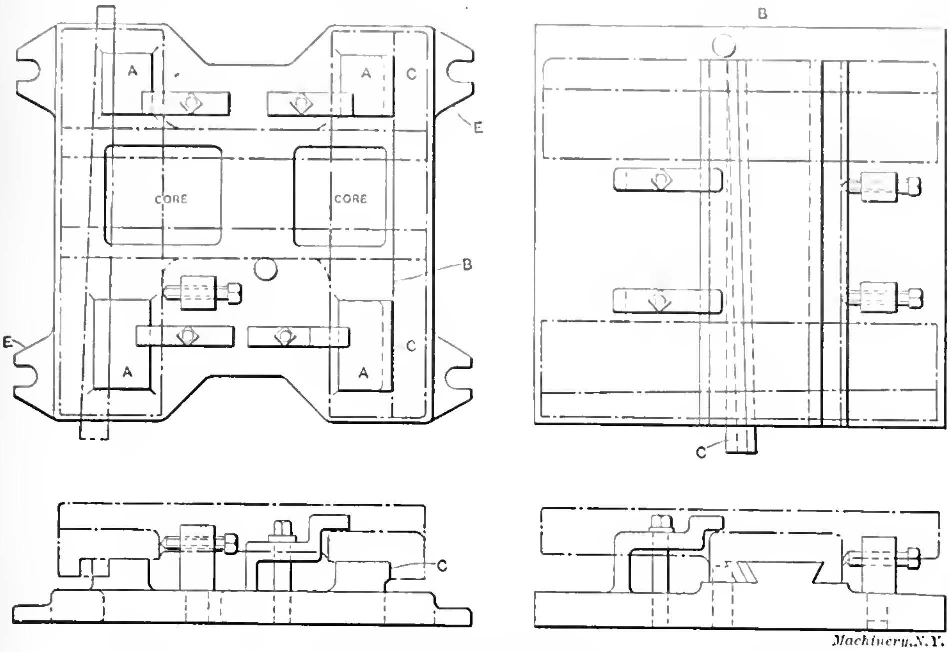
Assume that a set of planing fixtures for the piece shown in Fig. 170 is required. The work is a slide or carriage for a lathe. The finishing marks given on a number of the surfaces indicate where the work is to be finished. The piece comes rough from the foundry. In the first place, it must be considered which sides to locate from, and how to locate and hold the work without springing it, and in what order the operations should be performed to best advantage. Fig. 171 shows a fixture for roughing out the ways on the bottom. The slide is located on three fixed locating points *A* and the sliding point *B*. This latter is adjustable in order to enable cutting the metal in the slide as nearly as possible to uniform thickness. Sometimes, if the parts *A*, Fig. 170, bevel towards the ends, lugs *B* may be added; these can then be finished and used for locating purposes. The carriage, as shown in Fig. 171, is further located against the pins *C* in order to insure that the cross slide of the carriage will be square with the bottom ways. The slide is brought up sidewise against the pin *D*, and then clamped down in convenient places, the clamps being placed as near the bearing points as possible to avoid springing. The reason for not having the locating point *D* on the opposite side, is that this side must be finished at the same setting; this side, being the front side of the carriage, is finished for receiving an apron.



Figs. 172 and 173. Fixtures for Planing the Dove-tail Slide and for Finish Planing the Ways of Carriage in Fig. 170.

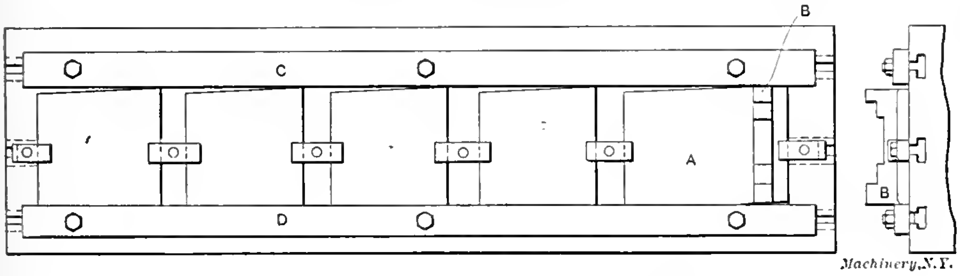


Fig. 174. "String" of Fixtures on the Platen of a Planer.

The sides *E* and *F* of the fixture may be finished in a certain relation to the locating points and each other, and the side *E* be made perfectly square with the locating points so that when it is brought up against a parallel on the machine table, the ways of the machined piece will be square with the ends. The side *F* may be finished on the same taper as required in one way of the work for a taper gib.

The fixture for the next operation is shown in Fig. 172. This fixture is made to receive the carriage and locates it by the now rough-finished ways; in this fixture the cross-slide dove-tail in the work is planed. The slide rests on four finished pads *A*, and the straight side *B* of the ways in the slide is brought up against the finished surfaces *C*. If no other part is available for clamping the fixture on the machine table, lugs *E* are added. If there are no tapering surfaces, the fixture can be located on the machine table by a tongue, as already mentioned, or by placing a finished side against a parallel. The slide or dove-tail is now roughed out and it is usually sufficiently accurate practice to finish it in the same setting, especially as slides must anyway be scraped and fitted to suit the machine on which they are to be used.

The next operation would be performed in the fixture illustrated in Fig. 173. The carriage is here located by the dove-tail and by the pin *B*, and held by a gib *C*, or by straps and screws, as shown. It will be noticed that with the given design, the straps and screws must be removed each time a new piece is inserted, which is an undesirable feature of the fixture. If parts *A* in Fig. 170 project out too far, so that a light finishing cut would cause springing, they are supported by sliding points or other adjustable locating means.

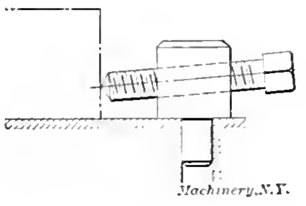
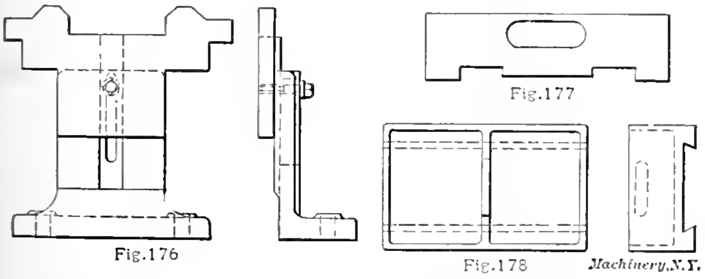


Fig. 175. Clamping Work by Means of Pointed Screw.

If the dove-tail in the slide had simply been rough-finished in the fixture, Fig. 172, the finishing operation of the bottom ways could have been done as just described in the fixture in Fig. 173, and then, after having finished the bottom ways in this fixture, the work could again have been located in the fixture, Fig. 172, and the dove-tail finished; this procedure may insure more accurate work in some cases.



Figs. 176 to 178. Gages for Setting Tools and Testing Work.

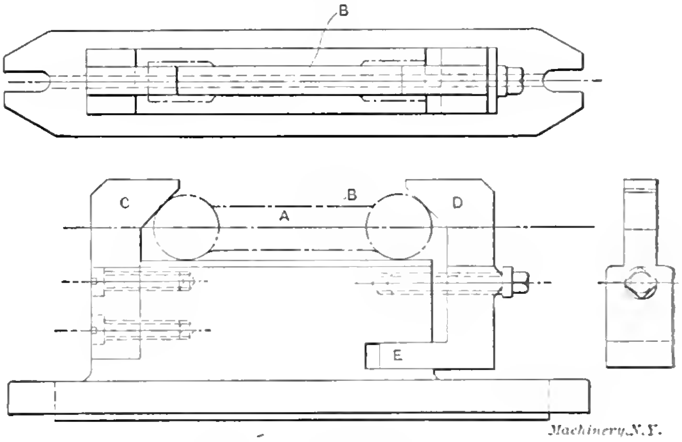


Fig. 179. A Typical Milling Fixture.

In the case just described, the work requires three different fixtures, to be completed. How many fixtures to use in each

case is entirely dependent upon the nature of the work. When there is a large amount of work of the same kind to be done, several fixtures of the same type are made up for the same piece, and when in use these fixtures are placed in a "string" on the table of the machine, as shown in Fig. 174. Each strap holds down two of the jigs, one on each side of the bolt through the strap. The first one of the fixtures, *A*, is provided with a templet *B*, to which the tool may be set. The fixtures are located against the bars *C* and *D*, alternatingly, depending upon whether the straight or tapered side of the slide planed in these fixtures is being finished.

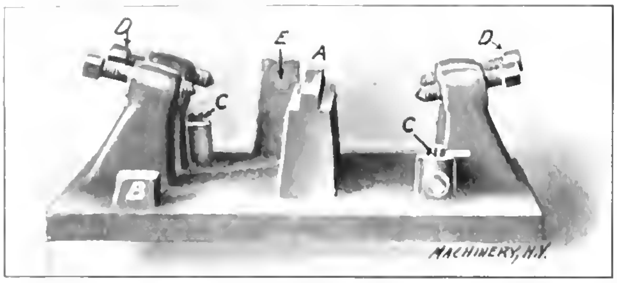


Fig. 180. Simple Type of Milling Fixture.

Templets are often made up separately and are used to determine the machining of both larger and smaller work. A templet may even be made adjustable, as shown in Fig. 176. This templet may be fastened to the machine table either in front or behind the work and the tool set to it, and is used when planing machine beds. Other templets or gages are made for testing the planing. They may not properly be considered as parts of the fixtures, but are usually designed and made at the same time as the fixtures are completed. These gages are made from sheet iron, and the profile or cross-section of the work to be planed or milled is cut into the templet, as shown in Fig. 177. Other testing pieces may be made up more elaborately, as shown in Fig. 178. These latter are also used for testing when scraping and fitting the work. One templet may be made for rough planing or milling and one for the finishing cut.

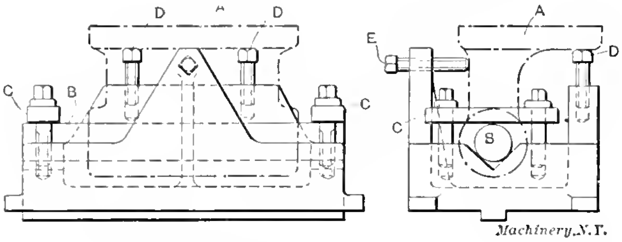
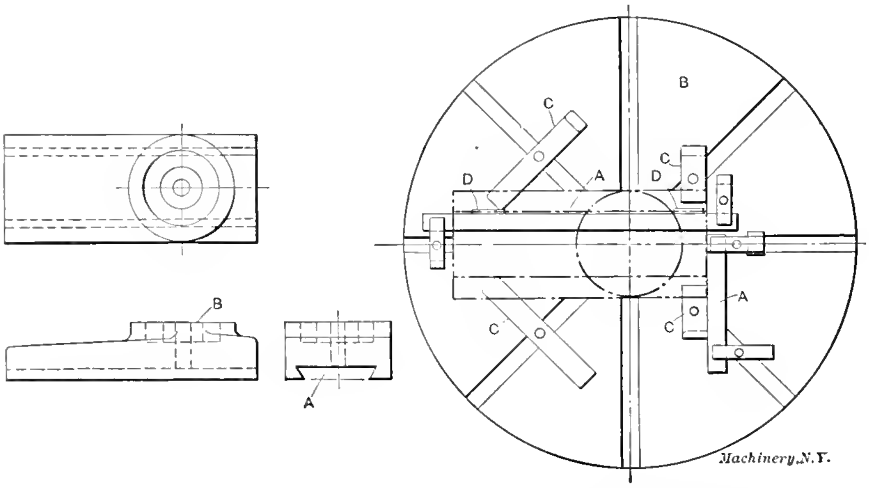


Fig. 181. Milling Fixture in which Work is Located from a Previously Bored Hole.



Figs. 182 and 183. Work to be Recessed and Faced and Method of Doing it in a Lathe.

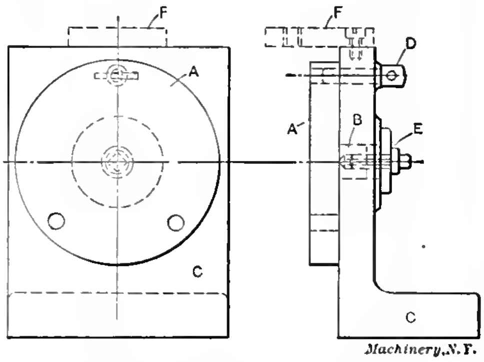


Fig. 184. Simple Type of Indexing Fixture.

A milling fixture of a type commonly used is illustrated in Fig. 179. The work *A* is supposed to be milled on both sides simultaneously. It is located on the fixture base *B*, and is held up against the half V-shaped piece *C*, which is stationary and held to the base by screws; the clamping is done by a clamp *D* which is guided at *F* as indicated, so that it has a tendency to hold the work down well. Both the clamp and the corresponding piece *C* are thinner than the work, so as to allow the straddle milling cutters to pass over the fixture without interference.

In Fig. 180 is illustrated a simple fixture which may be used for both milling and planing. Two pieces are machined at the same setting in this fixture, and are located against the finished seats *A* and *B*, which latter acts both as a seat and as a stop. Another seat like *B* on the opposite side is not visible in the illustration. As the work to be done is of a rough character, sliding points provided at *C* give an adjustable support. The work is clamped by the pointed screws *D*. The tool is set by the lug *E*, which is cast solid with the fixture and which has a top finished to the required height.

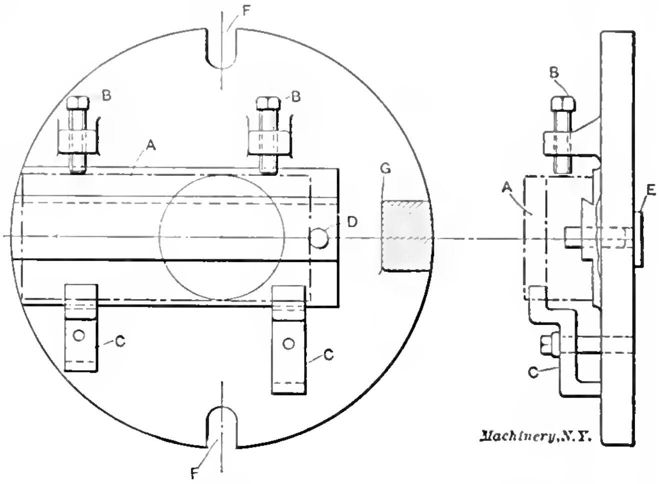


Fig. 185. Fixture for Recessing Work shown in Fig. 182.

It is often advantageous to perform milling operations after the boring and drilling has been done on the work, and then some finished hole may be used for locating the work. An example of this is shown in Fig. 181 where the work *A* is located by an arbor *B* passing through the finish-bored hole in the work, and resting on two V-blocks planed out in the fixture as shown. Two straps *C* hold the arbor down in the V-blocks. The work is further located against the screws *D*, which are adjustable so that the work may be held level. The clamping screw *E* holds the work against the screws *D*.

It is sometimes advantageous to make fixtures for holding work in the lathe. Suppose that a piece to be finished has the appearance shown in Fig. 182. The dove-tail *A* is finished, and the circular seat *B* is to be turned afterwards so that the center of the seat will come in a certain relation to the dove-tail and a certain distance from the end. This operation can be carried out as shown in Fig. 183, by placing parallels *A* on the face-plate *B* of the lathe. These parallels will serve as locating means, and straps *C* hold down the work. If it is required that the seat be in exact relation to the dove-tail, two rollers *D* may be used onto which the slide is hooked; the angle of the dove-tail and the diameter of the rollers are calculated so that the work can be very carefully located.

The work may be turned out properly by this means by a careful man, but there are always chances of moving the parallels and it is a slow operation. If a simple fixture like

the one illustrated in Fig. 185 is used, an apprentice can do the work correctly, provided he knows how to run a lathe. The work *A* is located by a dove-tail in a similar manner as it later on will be located on the machine on which it is to be used. It is held against the dove-tail in the fixture by screws *B* and clamped down on its seat by straps *C*. The pin *D* locates the work in the other direction, and the fixture itself is located on the face-plate by the boss *E*; as this boss has a perfect fit in a recess turned out in the face-plate, it must, by necessity, run true. Slots may be provided for locating the fixture on the face-plate and driving keys inserted. A sufficiently large lug *G* may be provided for counter-balancing.

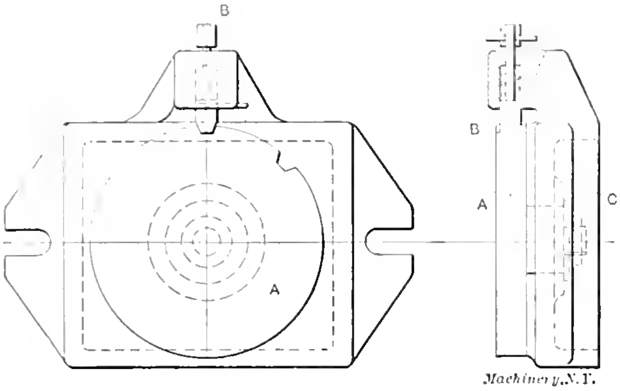


Fig. 186. Another Type of Indexing Fixture.

It is always of advantage to try to locate work in fixtures in the same manner as it is located on the machine where it is to be used.

Indexing Fixtures.

A number of fixtures for performing various operations are fitted with indexing devices, so that accurate machining at predetermined places in the work may be carried out in the shortest possible time. A simple indexing fixture is shown in Fig. 184. The work is mounted on a disk *A*, which turns in the bearing hole *B* bored out in the knee or angle iron *C*, which is located and fastened on the machine table. The disk *A* is indexed, and held in the right position by a pin *D*, which fits into a finished hole in the angle iron and also into one of the holes in the disk. The disk *A* is clamped against the knee *C* by a screw and washer *E* while taking the cut. When the main parts of this fixture are made of cast iron it is sometimes the practice to put lining bushings of tool steel in the indexing holes to prevent them from being worn out too rapidly by the continuous removal and insertion of plug *D*. This is a very simple indexing fixture, but a great deal of work can be finished with no more elaborate arrangements. By adding a plate *F*, screwed to the top of the knee, and fitted with a drill bushing as indicated, drilling operations may be performed in the same device.

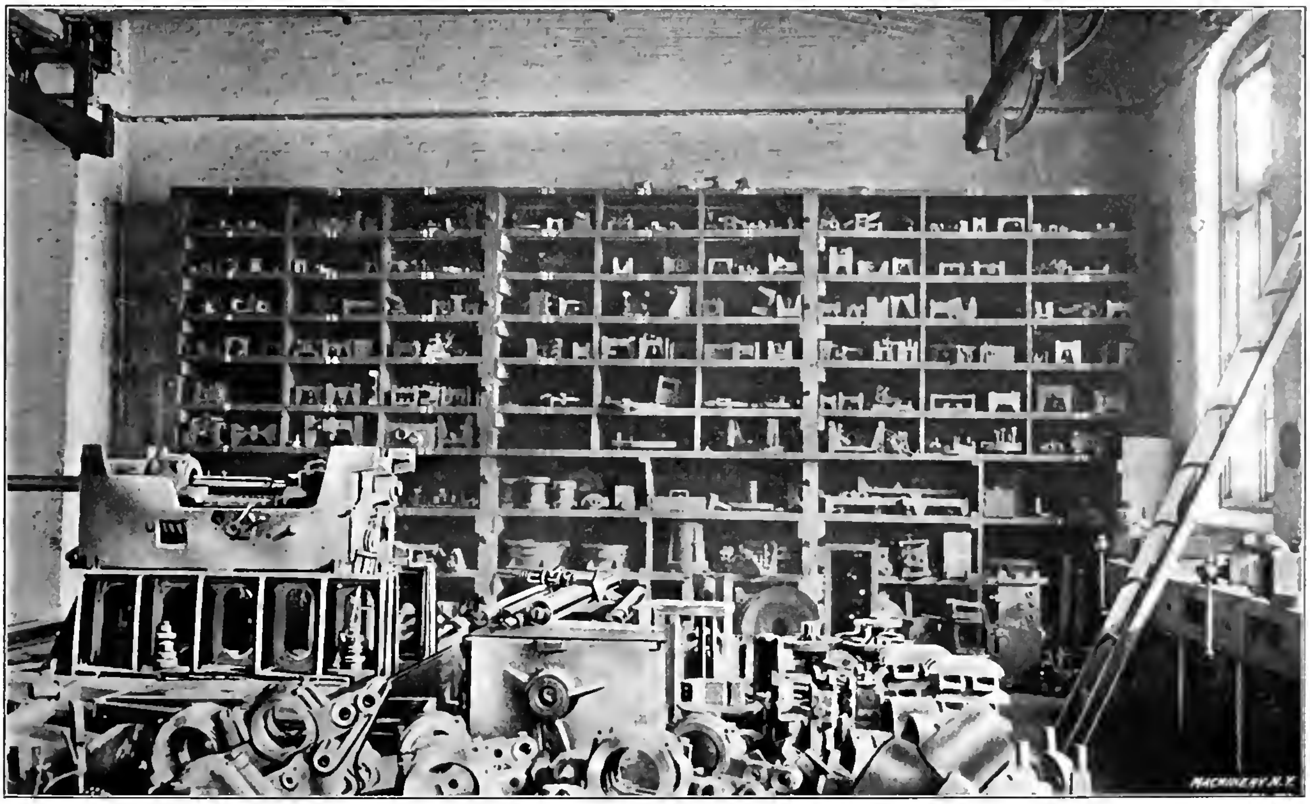


Fig. 188. An Example of Neatly and Conveniently Stored Jigs and Fixtures.

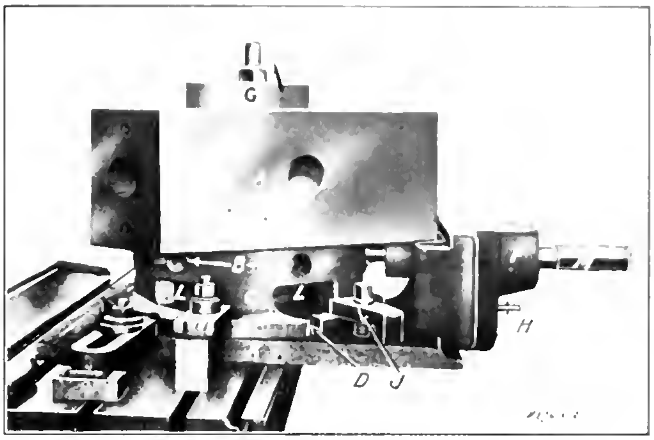


Fig. 187. A Combination Boring, Planing and Milling Fixture

In Fig. 186 is shown a similar indexing fixture somewhat modified. The work is located and held on the rotating disk *A*, which is fitted in place in the bracket or body *C*, so as to have no play. The round plunger *B* is beveled on the end, and fits the slots in the circumference of the disk. A spiral spring pushes the plunger into place. The plunger is guided by a pin in an oblong slot, so as not to turn around. Sometimes the plunger may be made square or with a rectangular section, and fit a slot which may be shaped to this form. This latter method is more expensive and does not give better satisfaction than the plunger with the round body.

A large variation of methods for indexing are in use, employing pawls, levers, springs and safety locking devices, which sometimes may be necessary. Indexing fixtures, however, designed according to the simple principles laid down above, will give as good service as many complicated arrangements. These indexing devices are used in cases where the standard indexing heads would not be suitable, and for many classes of work are equally efficient.

In Fig. 18[illegible], is shown a fixture which serves several purposes. The work, a turret A, has holes B bored out, the sides planed and the T-slots milled on the sides, all operations being performed by using the same fixture. When boring out the holes, the turret is mounted on the circular way of the revolving part C of the fixture. The work is located in right relation to the indexing notches D by a taper gib placed in the cut-out portion of the upper part of lug F; this gib locates the side of the turret square to the bushing hole passing through the lug. This taper gib is removed after the turret is clamped down securely by the strap G on the top of it, to allow indexing by the pawl H which fits into the notches D. As will be seen in the illustration, straps J hold the rotating part C securely to the face-plate K to prevent vibration during the boring operation. The lug F which holds the guiding bushings for the boring bars and also the indexing pawl, is cast in one piece with the face-plate. The casting is cored out at L for the purpose of removing the chips as well as making the indexing plate lighter without weakening it too much. When the fixture is used for planing or milling the turret, a special plug M is used, which fits the guiding bushings and the finished holes in the turret to insure perfect alignment.

Conclusion.

In a large shop with a great number of jigs and fixtures, it is quite difficult to keep them in proper order, and to have them so indexed and classified as to be able to find the required fixture at a moment's notice. It is unquestionably the best way to permit each department to have a storing place for all its own jigs and fixtures, more especially so if there is a store-room for other tools in each department. The jigs or fixtures are given out to the operators in exchange for checks, and before they are returned they should be carefully cleaned and the finished surfaces greased to prevent rusting. Before returning the check to the workman, the tool-room clerk should look over the fixture to see that no loose parts are missing, and no parts broken, and also that all loose pieces are tied together and attached to the jig body. An excellent method for storing jigs and fixtures is shown in Fig. 188. The tools are placed on shelves partitioned off and numbered and an index is kept showing at a glance the location of the tools for different operations. A copy of the index should be in the possession of the foreman, and also of the tool-room clerk, and should give the piece number of the work to be done in the jig, the number of the jig itself, and its place in the racks.

It will be seen from the half-tone that the lighter jigs are placed on the top shelves and the heavier further down. This not only permits a lighter construction of the storing shelves, but also makes it more convenient for the attendant to put the jigs and fixtures in place. If possible, jigs used for the same machine, or the same type of machines, should be in the same section of the rack, as this, to a certain extent, facilitates the getting out of jigs for the same work. When a jig or fixture needs repairing, it should be sent at once to the tool-making department, even if it is not to be used immediately.

In some trade journals there has been a great deal of paper wasted discussing what position a tool and jig designer really occupies; whether he should be considered a designer with a designer's salary, or simply a draftsman; and of other topics of similar nature. The fact remains, however, that a progressive manufacturing plant, in order to have suitable and efficient tools devised, requires a man who possesses in the first place good shop experience, in the second place sound practical judgment, and in the third place, a fundamental knowledge of theoretical mechanical principles.

* * *

The first aeronautical exhibition of any real importance has just been held in Paris. All the French models of aeroplanes were shown, including the new Santos Dumont flying machine, which is of rather interesting construction, and of particularly small dimensions. It is proposed to hold a large aeronautical exhibition in Frankfort a. M., Germany, next year.

PUNCH AND DIE FOR CORRUGATING THIN COPPER SHEETS.

A. L. MONRAD.*

The accompanying illustrations show a punch and die designed for forming copper corrugations from 0.010-inch copper sheets. The corrugations are bent in on the sides, and when completed present an appearance as shown in Fig. 1. They are then cut apart in suitable lengths and placed on top of each other, soldered together, and used for automobile cylinder cooling arrangements. These corrugations are formed by passing a copper sheet 3¾ inches wide between the punch and the die, shown in Fig. 2, feeding the strip of copper sheet along one step or corrugation for each stroke of the press. It will be noticed from the end view in Fig. 2 that it takes five strokes to complete the operations on one corrugation, although, as five operations are really performed simultaneously, one corrugation is completed for each stroke. The first stroke "breaks down" the metal, forming a half-circular corrugation. At the second stroke the section of the corrugation is formed to perfect shape, and at the same time small tools provided cut the metal at the corners of the corrugation in order to permit the edges to be bent down later on, as shown in Fig. 1. In the third operation the ends or sides are bent over to a 45-degree angle. In the fourth operation they are bent to a 90-degree angle, a small bevel of 45 degrees, however, still being left at the inside of the bent-over end. Finally, in the fifth operation, the sides are bent up to a sharp corner. Between each of these steps the metal must be released or stripped from the punch and die and fed along one step. The stripping is accomplished by means of compressed air acting on small plungers K, which strip the metal from the punch and the die at the same moment, as soon as the punch begins to ascend. The feed is accomplished by an automatic arrangement actuated by a cam, as shown in Figs. 3 and 4. This mechanism is put in action by the descent of the ram, and locates the copper strip in an exact and perfect position. The details of the stripper and feed arrangements will be explained more thoroughly later on.

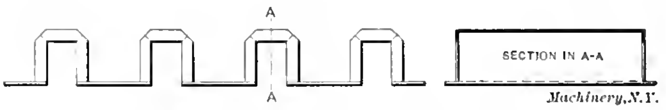


Fig. 1. Copper Corrugation to be made.

In order to prevent the punch and die from changing in hardening, it was deemed advisable to make those portions which are active in shaping the copper strips in separate parts. The manner in which these parts are inserted in the punch and die blocks is plainly shown in the end view in Fig. 2. The blocks or holders are left soft, and the hardened formers can be replaced when worn or broken, simply by driving them in place. On account of the great number of copper corrugations required, the chief feature sought in the design of the tool illustrated was to minimize the handling of the parts made, and eliminate separate operations, and for this reason an expensive tool was permissible, if efficient.

Construction of Forming and Shaping Mechanism.

In Fig. 2 is shown the front and end view of the punch and die, together with the mechanism for bending up the sides of the copper sheet, and the pneumatic stripper. The copper was ordered of the required width, and in rolls containing 200 feet of metal. These rolls were provided with large washers on each side to guide the metal, and the roll was placed in a bracket, fastened to the floor, with a steel rod through the hole in the center, on which the roll would revolve, as the copper was fed through the die. After the metal has passed through the die, it slides on a bench located at the back of the press. Gage marks are provided in the bench, and a stationary lever shear is located with its cutting surface level with the bench. The corrugated strip passes over the cutting edge of the shear, and the operator cuts off the metal to the required lengths, according to the gage marks.

The press is running continuously the whole day, at a rate of 100 strokes per minute, without any attention, the only

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thing required of the operator being to place a new copper roll on the shaft in the bracket as soon as the previous roll is used up. The metal has to be fed in by hand when starting a new roll, until a few corrugations have passed through the press. After that, the automatic feed will take care of the feeding along of the stock. While in the drawing, Fig. 2, the punch is shown considerably above the die in order to be able to show each of the parts clearly, when in actual operation the punch raises only high enough to permit the corrugated metal to pass between the punch and the die, thus guiding it on the bottom and top, while side plates guide it on the sides.

The construction of the punch and die parts are as follows: The plate *A* is of cast iron, planed on top and bottom, and fastened with four screws to the top of the platen of the press. On the top of this plate *A* is located the die block *B* fastened with four screws and two dowel pins. The die and punch blocks are made of tool steel, but not hardened. Four dove-tail slots are milled on the top of the die block for the hardened corrugating pieces *C*, which latter are ground all over and drawn to a dark straw color. In the center of the die block a ⅞-inch hole is bored to fit the shaft *D*, which operates the side pieces *L*, which, in turn, bend over the sides of the corrugations to the shape indicated in Fig. 1. This hole in the die block through which the shaft *D* passes is counterbored to a 1⅛-inch diameter at each end. In this counterbored recess helical springs *E* are placed. These springs force the side-plates *L* outward and hold them in this open position until the punch has entered the die, and the side-plates are operated by the mechanism shown to the left in Fig. 2. The action of this mechanism is as follows: A long bushing *P* is screwed into the left side-plate *L*. This bushing is supported at its outer end by a bracket *Q*. Inside of the bushing is located the driving shaft *D* already referred to, which is prevented from rotating in the sleeve by the set-screw *R*, but is permitted to slide back and forth for a limited distance, as indicated. On the extreme end of the bushing *P* a dove-tail groove is provided, into which is driven a hardened tool steel wedge *S*. On the end of the driving shaft *D* is mounted a circular disk *T*, to which is fastened a sprocket wheel *V*, held by four screws. The disk *T* turns freely on the shaft *D*, and is provided with a wedge *X* which is hardened and ground on the face. Two check nuts *W* hold the disk and sprocket in position. The sprocket wheel is driven by a chain from a sprocket placed on the press shaft, on which also is placed the cam operating the feed motion, as shown at *W* in Fig. 4. The running of the sprocket wheel is so timed that the wedges *X* and *S* will commence to operate against one another, and thereby pull in the side-plates, when the punch is about to bottom in the die. This pulling in of the side plates bends the edges of the copper sheet. The copper metal extends 1/16 inch on each side of the die. The side-plates are recessed on the side opposite the first and second corrugation in the punch, so as not to operate on the copper plate while these corrugations are formed. Opposite the second corrugation in the die four three-cornered knives *M* are placed, which split the sides of the copper sheet in the four corners of the corrugation at the second stroke as already mentioned, in order to permit the sides to be bent over. Opposite the third, fourth and fifth corrugations, the side plates *L* are shaped in a manner so as to bend the copper sheet first to a 45-degree angle, and then to a sharp corner, as has, also, been previously explained.

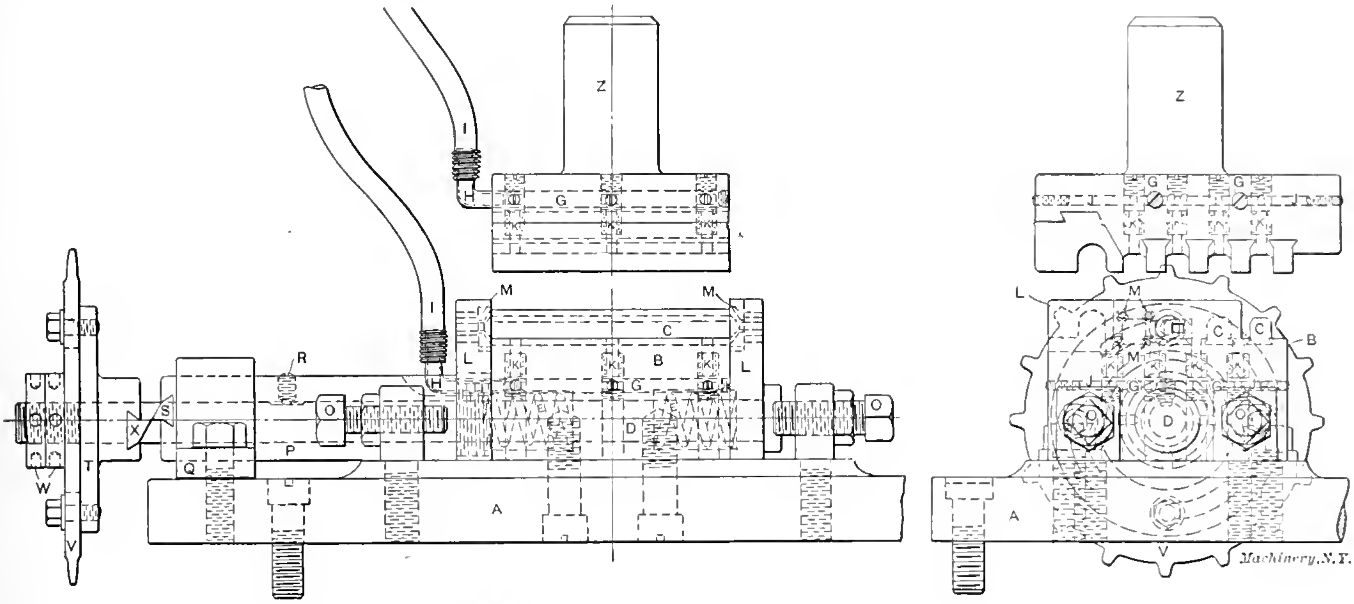

Fig. 2. Front and End View of Punch and Die.

Two stop screws *O* are placed on the outside of each side-plate in order to prevent the plates from opening any more than necessary to pass the metal through; thereby the side-plates are also enabled to guide the metal while feeding. On each side of the holes for shaft *D* in the die block *B*, ¼-inch air holes *G* are drilled the entire length of the block. One end of these air holes is plugged up with a screw, and a brass tube *H* is soldered to the other end. This tube is bent to a right angle, and a rubber hose *I* for the air supply is fastened to the outside with a brass wire. Air holes *J* are then drilled into the main channels *G*. These holes are also plugged on each end with a short screw. In the center of these holes, again, other holes are drilled, counterbored, and tapped, from the bottom of the die block for the plungers *K*, which are held down below the surface of the die by means of small helical springs. The stop screws at the bottom of the plungers are adjusted so that the latter will be flush with the top of the die. The air supply is connected with the machine, so that when the punch is ascending, air of 50 pounds pressure will be supplied below the plungers, thereby stripping the metal. The same arrangement is provided in the punch part of the tool. The copper sheet used is so thin that no mechanical device can be used for strippers excepting pneumatic plungers. Any spring-actuated device would remain open after having stripped the metal, and would have to be pressed down with the copper sheet. In so doing, the metal would be marked to such an extent that it might leak under the water pressure when the cooler is assembled.

Construction of Automatic Feed Mechanism.

The same press must be used at all times for this work on account of the fact that the details of the automatic feed mechanism must be fitted directly to the press, and while in operation become an integral part of it. In Fig. 3 is shown a front view, and in Fig. 4 an end view, of the automatic feed. In long dotted lines are shown the die plate, die block, sprocket and chain, in their position. The principle of the feed mechanism is that the guide hand *F* enters into the corrugation and holds it in place while the ram is descending, while, when the ram is ascending, by means of a combination of levers, the fingers *J* feed the copper strip along one corrugation. This mechanism is actuated through the cam *W* and the long lever *Q* shown in both Figs. 3 and 4.

On each side of the die are placed brackets *A*, held to the cast-iron plate *B* with two screws. On top of these brackets, on each side, are fastened guide plates *C*, which guide the copper strip. A U-shaped steel bracket *D* is fastened to the back of the ram. It is provided with a quarter-inch hole in each end, through which is passed the guide hand screw *E*, provided with two check nuts, acting as a stop when the screw comes to its downward position. The end of this screw is slotted to receive the guide hand *F* and a pin is passed through both so that the guide hand will move with the screw. The left-hand end of the guide hand *F* is connected to the end of a rod *G*. When the punch descends, the guide hand *F* follows and drops in a corrugation and locates the copper strip exactly in the correct position for the next stroke of the press. Back of the rod *G* is another stud *H*, having a link or plate attached to it with a free end. At the lower end of this link hangs a brass casting *I*. The opposite end of this brass casting is slotted, permitting the guide hand *F* to drop in. On the side of the casting *I* hang pawls or fingers *J*, being free to move around their fastening screws. When the casting *I* moves forward, being actuated through the lever *Q* one end of which rests against cam *W*, these pawls slip over the corrugation and drop into the next groove. When the casting *I* moves back again to the original position, the pawls hang down and catch against the side of the corrugation and feed the copper metal along.

To each side of the cast-iron plate *B* is fastened a steel block *K*, Fig. 3. To these blocks is fitted the cam lever shaft *L*, to which, in turn, are fitted the two feed arms *N*. These are located in position after the whole die and feed mechanism are assembled, a groove being turned in the shaft for the set-screws holding the feed arms *N* in position. On the other end of these feed arms two side plates *O* are attached. Between these plates a bushing is placed, a taper pin being driven through the bushing and the two plates. On the extreme left-hand end of shaft *L* the connecting link *P* is fastened, the other end of this link being connected to the cam lever *Q*, which is attached to the left side of the press by a screw *R*, holding it to the bracket *S* which in turn is attached to the press. The other end of the cam lever is bent to an angle of 45 degrees with the horizontal, and works against the cam *W* which is fastened on the press shaft together with the sprocket wheel which drives the sprocket wheel for the shaft *D* in Fig. 2. A long spiral spring *T* is attached to the end of the lever *Q*, and is connected on the other end to a rod *V*, which is fastened to the extreme end of the side of the press. A stop is provided for the cam lever by placing a bent steel plate *Y* on the left side of the press in the front as shown. The stop screw is provided with a head, against which the lever *Q* will stop. The other end of the screw is provided with a check nut to hold it in place. This arrangement has proved very satisfactory for carrying out the work for which it was intended. It looks rather complicated on the drawings, but in reality it is simple, and contains no superfluous parts.

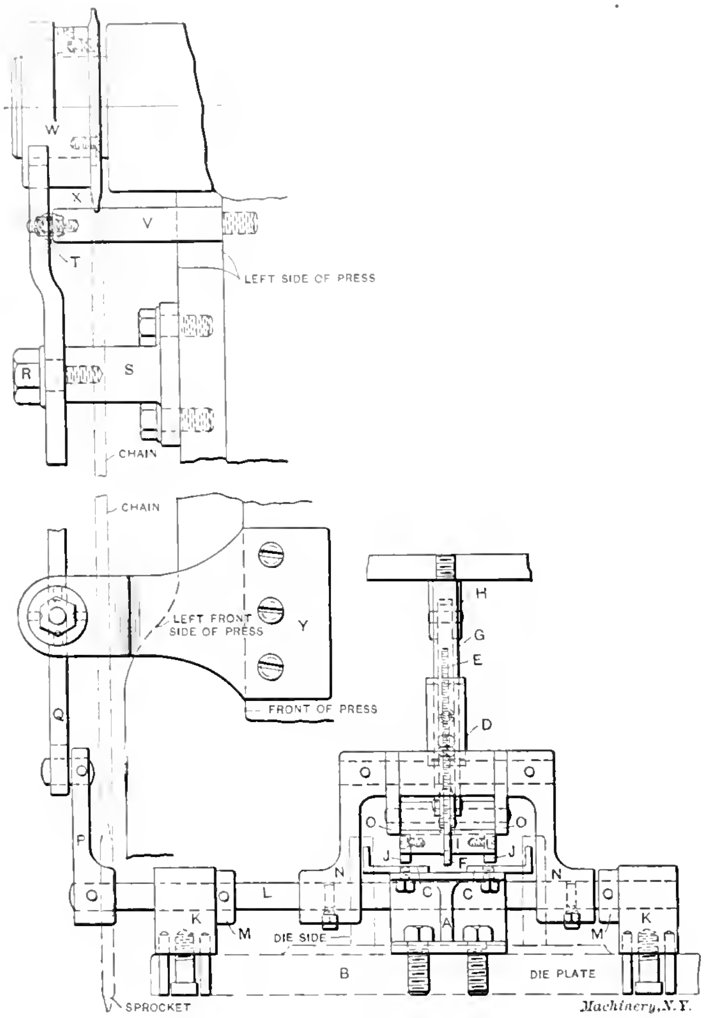

Fig. 3. Front View of Automatic Feed Mechanism.

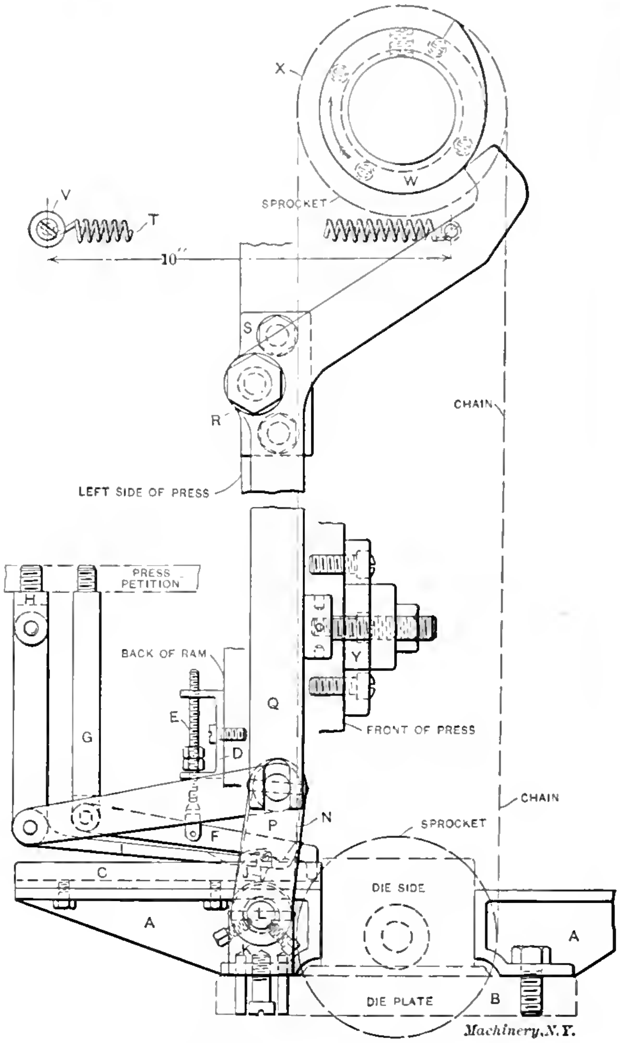

Fig. 4. End View of Automatic Feed Mechanism.

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The police department of New York City is said to be considerably excited by the moving pictures shows which illustrate how safes are dynamited and robbed by safe-crackers. The pictures illustrate vividly and true to life how a safe is covered with blankets to deaden the sound of the explosion, and the robbers looting it when the door has been blown off. The vividness of the illustration and accuracy to detail make the process so plain that the tyros in crime need no further instruction to become safe robbers. No doubt the suggestiveness of these illustrations is powerful and dangerous. In the March issue we spoke of the effectiveness of the moving-picture machine in education, and in the January issue suggested that it could be used very profitably in teaching a trade. If the machine can be made a powerful incentive to crime, it surely can be made equally powerful as an incentive to industry by illustrating processes and manipulations that honest young men are eager to learn and understand.

THE FORGING OF HOOKS AND CHAINS.*

JAMES CRAN †

Most of the available information relative to hooks and chains is of a technical nature, and is better suited to meet the needs of the designer and draftsman than the blacksmith. There are given numerous tables of dimensions, and sizes, angles, etc., for finished hooks, but no information or rule seems to have been published whereby the blacksmith may arrive at a definite conclusion as to the diameter and length of material to use for hooks of different capacities. This condition has been responsible not only for a great deal of guess work, but also for the existence of poorly-constructed and very unsatisfactory hooks, which generally have required more time and material to make than necessary. When hooks of either of the types shown at *B* and *C*, Fig. 1, are to be forged, stock of the diameter *A* of the hook should be used. If a hook is made in proportion to a chain to which it is to be attached, the easiest and simplest method of determining the right diameter of material to use is to multiply the diameter of the material of which the chain is made by 2½. For obtaining the length of the material for the hook, multiply the diameter by 7. Take for example a chain of standard pattern made from material ½ inch in diameter, which is generally recognized as the correct size for a working load of 1½ ton; then ½ inch × 2½ = 1¼ inch; 1¼ inch × 7 = 8¾ inches; therefore 8¾ inches of material 1¼ inch in diameter is the right amount of stock to use for a hook that will take a working load of 1½ ton. If properly forged, a hook made from this material will be in accordance with the tables of dimensions generally given for crane hooks.

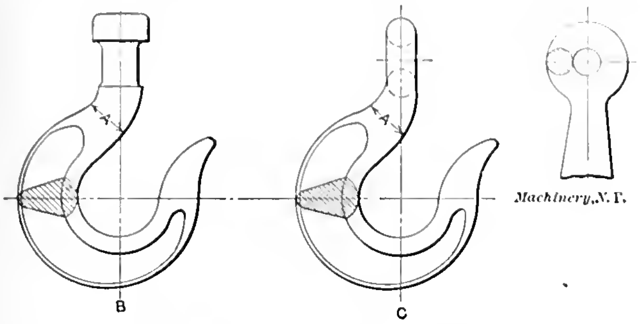


Fig. 1. Two Common Types of Crane Hooks.

Swivel hooks up to 3,000 pounds capacity are made from the end of a bar which ought to be cut the right length to permit the making of a certain number without waste. The first operation is to taper the end of the bar for the point of the hook as shown in Fig. 2. Where there is a power or steam hammer this is done by means of spring swages made with a taper impression as shown in Fig. 4. A sufficient length of the stock for one hook is then heated and bent to about two-thirds of a circle by using a bending device similar to, but heavier than, that shown in Figs. 7 and 8 in an article entitled "Tools for Increasing Production in Blacksmith Shops," in MACHINERY, November, 1908. After the hook is bent, it is removed from the bending device and is tapered or "fished" on the back at the same heat, by using tapering tools made on the same principle as spring swages, and shown in Fig. 5. The faces are slightly convex lengthwise, and the edges well rounded off to prevent leaving marks on the work. As the back of the hook is tapered, it is drawn a little on the outside; this closes it sufficiently, so that but very little finishing or truing up by hand is necessary. It is now ready to be separated from the bar. Material for heavier swivel hooks, and all sizes of hooks to be made with eyes, should be cut in lengths that will each make one hook. The reason for this is that swivel hooks over 3,000 pounds capacity would be too stiff and heavy to be bent by a hand bending device, and hooks with eyes must be tapered at both the neck and the point.


Fig. 2. Tapering the End of the Bar for the Point of the Hook.

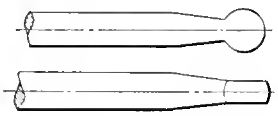
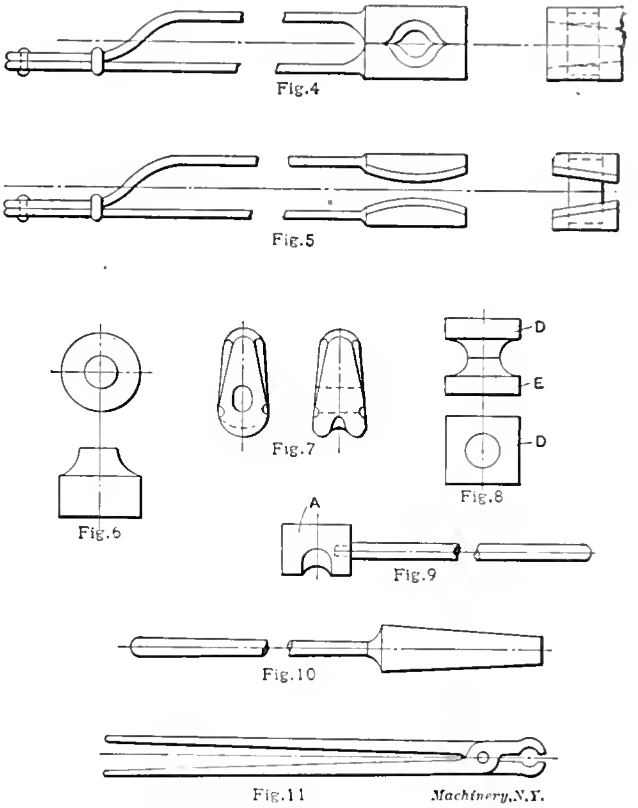


Fig. 3. Tapering and Shaping the Upper End of an Eye-hook.

Eye hooks can be tapered at both neck and point with the same swages as are used for tapering the points of swivel hooks. The first operation in making eye hooks is to taper the neck, after which the portion for the eye should be flattened down to about half the thickness of the material used, and roughly rounded as shown in Fig. 3. The hole for the eye is then punched, the blacksmith removing as little stock as possible and drifting until the hole is large enough to admit of tools of the style shown in Fig. 6 being used to finish the inside to a half circular section. These tools are used in pairs; one tool is placed upon the lower die of the steam hammer, the eye of the hook fitted over it, and the other tool is inverted and placed on the upper side of the eye. Two or three blows of the hammer practically finishes the inside of the eye.

The outside is finished at the anvil by using another tool of exactly the same shape as that shown in Fig. 6, but provided with a shank to fit the square hole in the anvil. A short swage, the face of which is radial and having a circular impression well backed off at the edges, as shown in Fig. 7, is used to smooth the outside as the eye rests on the tool in the anvil. When this is done, the point is tapered and the hook is ready for bending, which on the smaller sizes may be done at the anvil without special tools; but large sizes of both types can be more easily and quickly bent at the steam hammer by using the former shown in Fig. 12 to start the bend. The body of the former is of cast iron, with a steel wedge or binder. Hooks to be bent are heated all over; the portion for the shank of swivel hooks is placed between two V-blocks *C* which are made to fit between the lugs of the former, and are held firmly in place by wedge *B*. A steel block *A*, Figs. 9 and 12, the face of which is made on an arc to conform with the radius of the former, and having a circular impression the entire length of the face, is placed on the upper side of the hook, and the bend is started either by gradually admitting steam to the cylinder of the hammer and pressing the hook down as far as the former will admit, or by a series of light blows. The hook is removed



Figs. 4 to 11. Tools used in Forging Hooks and Chains.

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* For dimensions of hooks and chains, see MACHINERY'S Data Sheet No. 33, June, 1904, and also the Supplement with the current issue of the engineering edition.

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from the former, and the bending is continued until the hook is bent to about two-thirds of a circle, by placing it between the dies of the steam hammer as shown in Fig. 13. The back is tapered in the same manner as are smaller sizes, and the inside is trued up on the taper mandrel, Fig. 10. The advantage of having the mandrel tapered is that it can be used to true up different sizes. Large eye hooks are bent and finished in exactly the same manner except that instead of using V blocks to hold them on the former, two pieces of steel made to fit the eye of the hook and the lugs of the former as shown at *D* and *E*, Fig. 8, are used.

The Forging of Chains.

It is very seldom that chains are forged by the ordinary blacksmith, apart from making a link to repair an old chain, joining two pieces together, or attaching them to hooks or rings. Most of the chains used are made by chain makers who seldom do anything else. They are generally such experts in this kind of work that they can turn out chains in less than half the time it would take the men who only make a link occasionally. Nearly all blacksmiths, however, have to do more or less chain repairing, and it is well for them to be posted on this particular class of work. In making chains, the following dimensions will prove satisfactory for general purposes. For notation, refer to Fig. 14.

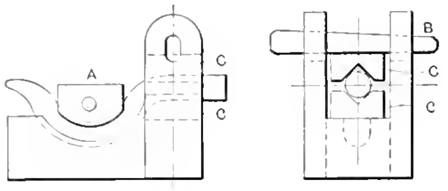


Fig. 12. Device for Starting the Bend in a Crane Hook

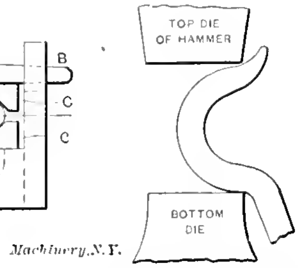


Fig. 13. Completing the Bend of the Hook.

B = width of link inside = $1\frac{1}{4}A$,

C = length of link outside = $5A$,

D = length of link inside = $3A$,

E = width of link outside = $3\frac{1}{4}A$.

Large sizes of standard pattern chains are a trifle shorter than the dimensions given above, but for all practical purposes, the formulas given can be followed. The length of chain links inside being only three times the diameter of the material of which they are made makes it rather difficult to join two pieces of chain together with a link the same length as the rest of the chain. One link of each of the pieces to be joined being placed inside the connecting link before it can be welded, leaves but very little space for holding the connecting link with tongs, and but small room for its being placed on the horn of the anvil for finishing up the end after welding. The easiest way to do work of this kind is to bend the link and scarf it as shown at *F*, Fig. 14; then bend the scarfed ends around and close them together as at *G*. After this the link should be heated all over and twisted at the lower end, as shown at *H*, until the scarfed ends come far enough apart to allow the end links of the pieces to be joined to pass over the ends. The ends are now twisted back to their first position and the link is ready for welding as shown at *K*. The link being already hot, and the end links of the chain cold, it comes to a welding temperature when placed in the fire, before the rest of the chain is affected by the heat. The tongs shown in Fig. 11 are the best kind to use either for chain making or repairing, as they take a good hold upon the work and do not cover enough of it to be in the way.

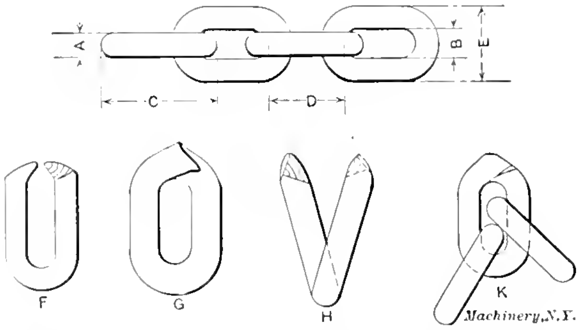


Fig. 14. Notation for Chain Dimensions, and Successive Stages in the Welding of a Chain Link connecting Two Pieces of Chain.

Chains used in connection with cranes or hoists for lifting heavy pieces are generally made with a hook at one end and a ring at the other; sometimes the chains are single, but quite often two, three or four chains and hooks may be attached to the same ring, according to the shape of the pieces they are intended to support. In places where a number of this kind of chains are used it will be found a good plan to give each chain or set of chains a number which should be marked upon them, together with their lifting capacity, in some place where it will be easily seen. A good way to do this is to use a large flat link made from the solid between the ring and the chain as shown in Fig. 15. The holes in the ends are punched and nicely rounded, the same as eyes for hooks. The flat space between the holes is used for the number, working capacity, or any other marks that may be necessary. Lifting chains should be annealed occasionally; by having them numbered or other ways marked it is easy to keep a record of each chain, when and how it has been repaired, when annealed, etc.

Crane hooks are often used for purposes which make it impossible to get the load in the center of the hook. The point then takes the greater part of the strain, and hooks for such service ought to be made from very heavy bar at least three times the diameter of the chain.

No definite information can be given for the rings, as the size of material to use depends entirely upon the diameter of the ring; the larger the ring the heavier the material should be. It is safest and best to make rings just as small in diameter as can be conveniently used; the material should in no case be less than one and one-half times the diameter of the chain to which the rings are to be attached. Links used for the purpose of connecting chain and hook should be made as short as possible, from material slightly heavier than that of which the chain is made; 9/16 inch is about right for ½-inch chains, larger and smaller chains to have the links for attaching the hooks or rings in corresponding proportion.

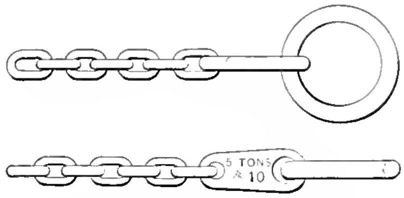


Fig. 15. Marking Chains on Special Marking Link.

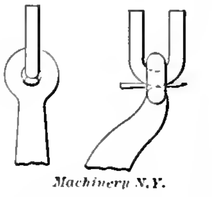


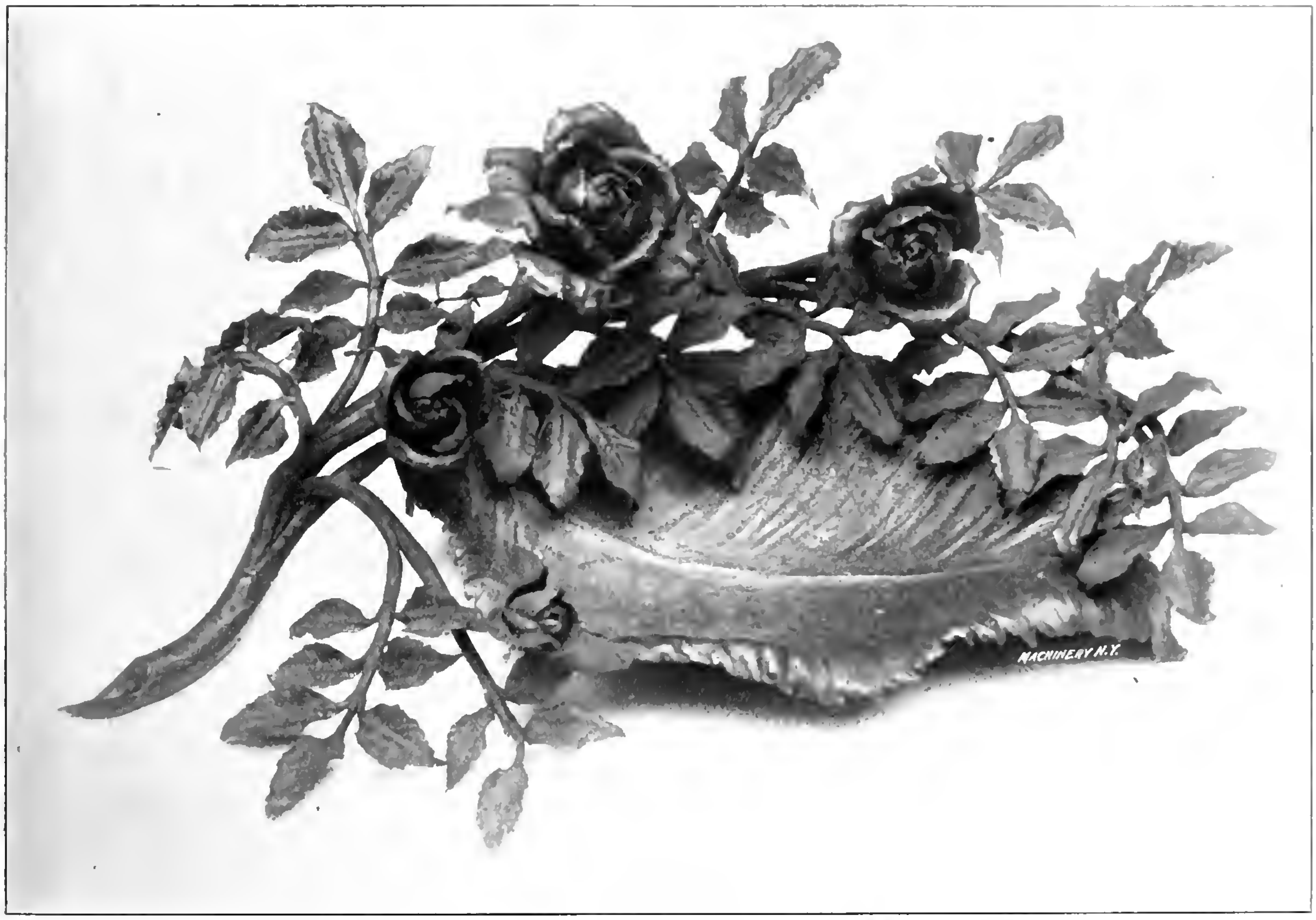
Fig. 16. A Kink when Welding Link connecting Hook and Chain.

Anyone who has ever attached hooks or rings to chains knows what awkward work it is, especially if the chains are of heavy dimensions; either the hook will come in the way when welding the link next to it, or the chain will keep moving around the sides of the ring. This difficulty can be overcome to a certain extent when attaching hooks by placing the link used for the purpose in the eye of the hook and driving a wedge behind it as shown in Fig. 16. This holds the link firmly in position while the hook is held in tongs. In attaching chains to a ring, when plain links are used for the purpose, these should be left open enough at one end for the ring. Rings should be prepared for welding in the same manner as shown at *F*, *G*, *H*, and *K*, Fig. 14. In cases where more than one chain is to be connected with one ring, the different pieces of chain should be bound together with wire to prevent their moving around the sides of the ring while it is being heated and welded.

In repairing old and worn chains, material heavier than the original size of the chain should never be used, as the new link then will act as a wedge, and will put a breaking strain on the link. It is always preferable to repair with material the same size as the chain, or, where the links are

very much worn, material slightly smaller than the chain will give better satisfaction, as it will readily find a bearing in the worn ends of the links without bringing any additional strain upon them. The new links will be just as strong as the rest of the chain. It is by no means uncommon to see chains that have been repaired with links here and there throughout their length of material considerably heavier than the original size of the chain, which is a mistaken idea of making a strong job, for "chains are never stronger than their weakest link."

The best material to use for chains, hooks and rings is a good grade of wrought iron, such as Swedish or Lowmoor iron, either of which is freer from silicon, phosphorus sulphur, or other impurities than the more common brands.



Tray for Letters, Cards, etc., representing a Rose Branch Hammered out of Swedish Iron, by Mr. James Cran.

The tensile strength of the best grades of wrought iron does not exceed 23 tons to the square inch, while mild steel of about 0.15 per cent carbon will have a tensile strength nearly double this; but the ductility and toughness of wrought iron, which is greater than for any grade of steel, is in its favor for making appliances that are to be subjected to heavy strains and loads, as it will always give warning by bending or stretching before it fractures or snaps off.

* * *

TESTS OF STANDARD CAST IRON FITTINGS.

The Crane Co., Chicago, Ill., recently made a test of standard cast iron fittings, including its own make and fittings made by seven other leading manufacturers. The fittings tested were one-inch cast iron ells, and three separate tests were made. The accompanying table shows the lowest and highest pressures at which the fittings burst, together with the average of the three tests. The tests show that the weakest fittings are amply strong enough to stand any pressure to which a cast iron fitting would ordinarily be subjected. It is unthinkable that an ordinary cast iron one-inch ell would be used in service that would require a pressure of even one thousand pounds per square inch, and the weakest fitting in the lot broke at an average of 2,500 pounds to the square inch. Cast iron fittings must be made with a great excess of strength, however, not to withstand internal stress merely, but also the blows and twisting to which they are subjected in erection and use. A valuable characteristic of

Lowest Pressure at which Castings Burst	Highest Pressure at which Castings Burst	Average of Three Tests
7,300 lbs	8,000 lbs.	7,666 lbs
7,000 "	7,500 "	7,333 "
6,400 "	7,500 "	7,066 "
5,000 "	8,400 "	7,133 "
6,000 "	8,200 "	7,166 "
5,800 "	7,900 "	6,733 "
4,400 "	8,200 "	6,533
2,500 "	5,800 "	3,866

cast iron fittings is that when they are a long time erected and it becomes necessary to remove a section of a pipe line, it is not necessary to begin at the starting point and unscrew length by length; a cast iron fitting can be easily broken with a hammer and the desired section removed and replaced by the use of a simple right and left coupling or a union.

* * *

MORE ARTISTIC BLACKSMITHING.

The illustration shows a piece of remarkable blacksmithing done by our contributor, Mr. James Cran, foreman blacksmith of the Pond Machine Tool Co., Plainfield, N. J. The piece illustrated is of the same general character as that appearing as Fig. 1 in the January, 1909, number of MACHINERY, but is much larger. Its length is 15½ inches, breadth 12 inches and weight 61 ounces. It represents a rose branch with three full blooming roses and two buds; and a large leaf forms a receptacle for letters, cards, etc. The forging is characterized by extreme delicacy of work and wonderful fidelity to form.

Mr. Cran's ability as an artist in this line seems the more remarkable because he had done comparatively little work of an artistic nature until within the last few months. The greater part of his experience was acquired on heavy machine blacksmithing where clean welds and plenty of stock to clean up to the required shape have been the principal considerations. We understand that Mr. Cran will establish a small shop where he will do artistic blacksmithing to order in his spare time.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1909.

PAID CIRCULATION FOR MARCH, 1909, 20,989 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

SIZES OF ILLUSTRATIONS.

The illustration of a machine or tool should show as clearly as possible the details of construction that are of general interest to the reader. If a machine is large, but simple in construction, it obviously does not require a large illustration to make its purpose and form apparent. On the other hand, a small machine that is not larger than a typewriter, may be so complicated and contain so much mechanism that it requires a larger illustration to show its design clearly than a massive planer weighing a thousand times as much. There really should be no comparison made of the actual sizes of illustrations, as it is the detail of each machine itself that determines in the editor's mind what size the illustration shall be.

We speak of this because of the supposed incongruity of illustration sizes that is found in these pages, particularly in the department "New Machinery and Tools" where a massive planer or milling machine is often shown on a comparatively small scale, while a screw tap or other small tool is shown much nearer its size. It is obvious to even the inexperienced that it would be impossible to show the two devices in their actual relative proportions: for if the tap illustration were made so small as to be barely distinguishable, the planer engraving would still be larger than could be spread on two pages. This fact is so simple and obvious that it is surprising that some of our friends have occasionally expressed dissatisfaction because the illustrations of their products were not as large as, in their opinion, the importance of the machine merited. We cannot be governed by considerations of mere size, but rather by the details of each case, and this is the rule by which all illustrations appearing in MACHINERY are made.

* * *

ETHICS OF ENGINEERING PAPERS.

Considerable trouble has been made in the American Society of Mechanical Engineers by the presentation of papers in which the author has quoted results of tests of his company's machines and competitive machines, to the discredit of the latter. Naturally the concerns whose machines have been put in an unfavorable light have taken exception to these papers. The situation is a very difficult one for the management of the society. It is absolutely necessary that papers on live commercial subjects be presented if the society is to live and prosper, and unless papers can be presented recording the results of tests made by mechanical engineers to determine relative economies, one of the best fields for papers will be shut off.

The society is not so situated that it can undertake on its own initiative extensive tests of various mechanical apparatus for the purpose of determining relative efficiencies and defects that should be corrected. It of necessity depends on the individual initiative of various manufacturers and the willingness of these manufacturers' mechanical engineers to report to the society the result of investigations.

A suggestion that has been made which seems worthy of consideration, is that whenever tests of competitive apparatus are to be undertaken by any concern, it should in courtesy invite representatives of the competing concerns to be present, and one or more disinterested engineers to act as referees. A report of the tests made under such conditions could consistently be presented before the society without unfairness to one concern. We hope that we shall not lose the benefit of such investigations made by engineers, and that reports can be made under substantially the conditions set forth. This would be to the material advantage of the society and the engineering profession as a whole.

* * *

NEW HIGH-SPEED STEEL.

The steel makers of Sheffield are reported to be greatly exercised over the published announcement of the "discovery" of a new high-speed water-hardening steel having from three to eight times the capacity of the high-speed steels now in common use. Knowledge of the wonderful new steel appears to have been common among the leading steel makers of Sheffield, and it seems that there was a tacit understanding to keep its existence secret until the existing stores of high-speed steel were used up. The steel makers of Sheffield in effect rebuked Prof. Arnold of the Sheffield University for his address delivered before the Royal Institution in which he announced the steel; and in a published protest they pointed out that the statement has caused the countermanding of orders for the old quality of high-speed steel, and serious losses of business have resulted.

The discovery of a water-hardening steel of even fifty per cent greater capacity than the old high-speed steels would represent a great advance, but what shall we accomplish with a steel from three hundred to eight hundred per cent higher capacity? We infer from the gossips of agents in this country that the increase of capacity is in the lasting qualities rather than in the feed and speed. A lathe tool that would stand up for, say, one hour and thirty minutes' heavy work when made of the older form of steel, will last a day or a day and a half in the same service when made of the new steel. The saving of time in grinding lathe tools is not of great importance, perhaps, but for classes of tools that require to hold a given size for long service, as in the case with reamers, boring tools, drills, automatic screw machine cutters, etc., the value of a high-speed steel of such lasting quality can scarcely be overestimated. It is probable that the new steel also has greater feed and speed capacity than the older steels.

The increased durability of the new steel is due, of course, to its ability to stand up under a higher temperature than the ordinary high-speed steel. The characteristic of "red hardness" is strongly pronounced at a temperature that would destroy other high-speed steels when cutting heavy chips. This characteristic enables a tool to be ground with a sharper angle, and the sharper angle reduces power consumption, generation of heat, and stress on machines. It is possible that the actual superiority of the new steel as regards the red hardness characteristic, is not much greater than of the other steels, but a slight increase which enables a sharper angle to be employed materially reduces heating and vibration, and these advantages being cumulative make a great increase of efficiency and durability.

The question that occurs to everyone concerned with the manufacture and design of machine tools is: "What next?" What will be the effect on machine design and shop organization? We have by no means yet realized the full capacity of the Taylor-White steels, and the discovery of a new steel of far greater capacity still further widens the gap between the steel maker and the machine shop organizer and tool designer. It is not too much to say that the discovery of high-speed steel was one of the greatest of modern times; and to have the value of the discovery more than quadrupled at one stroke, opens a vista of mechanical possibilities that causes past mechanical achievements to appear almost insignificant. It means so much for the advancement of manufactures, arts and science that the mind cannot grasp it.

* * *

THE APPRENTICESHIP PROBLEM.

The following letter, written by a well-known machine tool builder, describes the difficulties of training apprentices under present conditions and the typical methods followed in many American works (excepting the three-year contract feature) to train workmen. It is an old and well-known story, and our reason for publishing the letter is that it concretely illustrates a phase of our manufacturing development that has been wonderfully successful in production at low cost, but which, in the opinion of many, is a menace to our manufacturing supremacy, especially in the machine tool building business. If this industry cannot educate the force that will direct its future work, it will fall behind because of the lack of men trained to be resourceful and inventive, and comprehensive of the business in all its phases:

"In reply to your letter of a recent date with reference to instruction of apprentices, would say that we do not have any apprentices in our works, having discontinued this branch of our help some two or three years ago for the following reasons:

"First, our experience has been that there are only about 40 per cent of the boys that we had in hand that ever completed their course, the majority of them leaving about the beginning or during the second year. The principal reason for this was the inducements offered by other shops, many of them paying full wages to apprentices who had worked two years and over in our works.

"Second, our term of apprenticeship was four years, and in order to satisfy these boys we found that it was necessary to change them about at least once in six months; in actual practice their services were little more than a kindergarten, because no sooner had they become sufficiently accurate and practical to turn out work on the machine which they were operating, and oftentimes before they were competent, they were dissatisfied if not transferred to another machine of the same type or one of different type.

"Third, we find in our business that it is much more practical to procure the services of intelligent laboring men from twenty to thirty-five years of age. They enter our services on a three-year contract. The first year we pay them practically what they would be able to earn at common labor, advancing them each year until their term is completed. These contracts call for continual service on one line of machines or work; that is, if a man is started in at lathe work he is advanced from one class of lathe work to another as rapidly as his ability will permit; the same with planer work, etc.

"With this system we are able to keep our machines in constant operation and usually we get practical reliable help. You will understand that in machine-tool building much greater accuracy is required than is the general practice in the ordinary lines of engineering work, and the average apprentice does not attain sufficient accuracy and experience, nor has he ability to turn out work in paying quantities, when his experience is limited to six months, when changed from one machine or one class of work to another; consequently, he cannot turn out work in paying quantities to permit him to have the use of a high-priced machine to get his experience on."

* * *

An important case in commercial law was recently decided in New York State which concerns the builders of machine tools, and especially machines of a multiplex nature. It was decided that under New York statutes, a customer, who, for example, bought a twelve-spindle drill, could not claim the difference in cost between it and a nine-spindle drill when he had received the nine-spindle drill and accepted it. The use of the nine-spindle drill was held by the court to be a virtual acceptance of the drill ordered, notwithstanding the fact that it had three spindles less than the twelve-spindle drill desired.

ELEMENTS OF MACHINE MANUFACTURE.*†

FRED J. MILLER‡

Man has been described as a tool-using animal. He has used tools from the earliest times for obtaining food, making clothing and habitations, for defending himself, and for making war. It is only in comparatively recent times that he has made tools which are also machines, and which are therefore called machine tools, to distinguish them from the simpler tools which are used in the hands. In the present state of the arts and sciences these machine tools are the very corner stone and chief support of civilization. Without machinery our present mode of existence would be utterly impossible, and without machine tools we could have little, if any, machinery of any kind, agricultural, food preparing, textile, or transportation.

Machine tools are distinguished also from all other machinery because they possess, in a sense, the power of reproducing themselves. Machine tools are made by the use of machine tools. If we did not have any, the difficulty of producing the first machine tool would be enormous; but with a lathe, a milling machine and a planer to start with, the world's equipment of machine tools could be reproduced. In fact, it would be quite possible to do it with the king of machine tools, the lathe, alone. In view of these facts, machine tools, their design and construction, together with the manner of their use, constituting nearly all of what we call machine-shop practice, are well worthy of the most serious attention and study.

It might be inferred that from the first the most careful attention and study of the best equipped and best educated men would have been given to the subject of machine tool design—that the science of machine tool design would be among the things that had been most thoroughly worked out. This, however, is not the case. Generally speaking, the stresses imposed upon the various parts of a machine tool cannot be known to the designer of it. Different individual users, different shops in the same section, and different sections of the country have widely different views as to what constitutes a proper cut for a machine tool. Broadly speaking, there is to-day very considerable difference between New England and the Middle West as to what would be considered a proper cut for a lathe or planer.

Strength of Machine Tools.

Generally speaking, a designer can secure only unity of design in a machine tool, *i. e.*, he can make it approach the ideal of the wonderful one-horse chaise so that all the different parts will have substantially the same strength and power to resist wear in proportion to the load that will be placed upon them; but what that load will be, neither he nor anybody else can predict in most cases; that is determined by the user in his wisdom or his ignorance. For certain important work done in locomotive repairing, for instance, a certain railroad company uses something over three hours time of a man and an expensive machine tool. Another railroad company, using a similar lathe by the same maker, accomplishes the same work in 35 minutes. Shop practice is filled with these anomalies; and instead of there being fewer of them, as time passes on they have probably increased very much within the past ten or fifteen years, because shop practice has gone forward by leaps and bounds within that time, and, when rapid progress is being made, only a few keep pace with it; the rest drag out in a long

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* Lecture presented before a class in mechanical engineering at the Columbia University, New York City.

† In accordance with the policy of the Department of Mechanical Engineering of Columbia University of closely associating the instruction with actual practice, engineers engaged in practical work are now giving instruction to the students in their own specialties. The regular instructor also lectures in the same series. The courses in which this plan is followed extend through the third and fourth years. A course on Principles of Machine Manufacture comprising a detailed treatment of the economic performance of standard machine tools is conducted by Mr. Fred J. Miller, vice-president A. S. M. E.; Mr. Elmer Neff, of the Brown & Sharpe Mfg. Co.; Hugh Aikman, of the J. H. Williams Co.; Mr. D. B. Bullard, of the Bullard Machine Tool Co.; Mr. C. E. Coolidge, of the Niles-Bement Co., and Mr. George Jeppson and Mr. Charles H. Norton, both of the Norton Co. Courses will also be offered in elevating and conveying machinery, pumping machinery, air machinery, and refrigerating and icemaking machinery. In the fourth year, courses conducted with the assistance of outside experts will be offered in steam turbines, manufacturing plant design, works management, and water power machinery.

‡ Address: 280 Broadway, New York.

procession the trailing end of which is out of reach and hearing, and knows not even that progress is being made.

One of the peculiarities of the branch of mechanical engineering which we are considering lies in the fact that, in designing and using machine tools the ultimate strength of a member is relatively of minor importance; because in this work, long before sufficient straining has occurred to constitute an approach to the breaking point, the deflection that takes place renders the tool useless for its purpose. Parts of machine tools that are turned, ground, scraped, or lapped true, receive this final refining treatment while under little or no stress. It is certain that every stress subsequently put upon them causes a deformation, and we must decide in each case whether or not the stresses to be imposed will produce deformation to an amount not allowable; remembering always that the allowable deformation in machine tools and machine shop fixtures is usually very small.

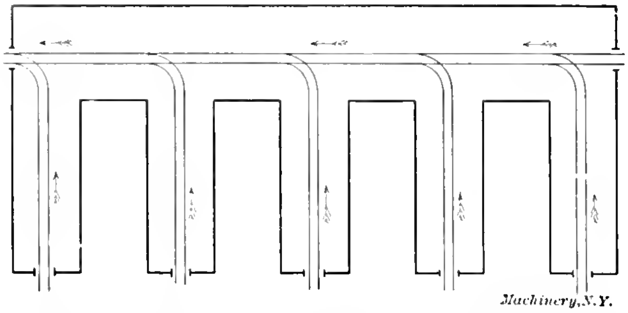

Machinery,N.Y.

Fig. 1. A Typical Layout of a Large Machine Manufacturing Plant.

Suppose, for example, that we bolt a casting to be planed upon the platen of a planer. Suppose that by unskilled shimming, or for some other reason, the casting does not lie solidly upon the platen at all the clamping points. Then, when the clamping bolts are tightened, the casting and the planer platen are both deflected. If the casting is much weaker than the platen it will be deflected much more than the platen; if they are of equal rigidity they will be deformed equally; if the casting is stiffer than the platen, then the platen will be most deformed. The same thing applies to the face-plates of lathes, boring mills, etc., when the work is fastened to them, and failure to realize this fact accounts for much bad work. Besides, both castings and forgings change their shape by the removal of the outer portions; usually some slight change of form continues to take place for quite a long time after such removal of the outer portions; therefore lathe beds, plug-gages and other things which must be quite accurately finished, are usually machined to very near their finished dimensions and then laid aside for a time in order that this slow change in shape resulting from the disturbance of the balance between the various contending internal stresses may be completed before the final finishing.

Baking in an oven up to about 400 degrees F., and slowly cooling, shortens the operation very much. The heat sets the molecules, or the atoms, or whatever we choose to call them, in rapid motion, and, during such motion, the forces tending to deformation produce their proportionate effect upon the final resting place of the molecules. The piece thereafter changes comparatively little.

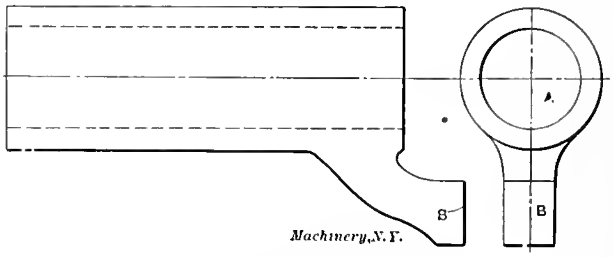
Thus we must not assume that machine tools and fixtures do not alter their shapes during constructive manipulation and use, for they certainly do to a greater or less extent. It is our business to see that they do not alter sufficiently to injuriously affect the work. The allowable deformation is, in the case of machine tools, probably less than in any other class of machinery, because accuracy of results is usually the first consideration in machine shop work.

Influence of Weight on Efficiency of Machine Tools.

Machine tools are somewhat peculiar in that mere weight seems sometimes to have an important influence upon their behavior, entirely independent of rigidity, or strength. When a machine tool has been designed to be plenty rigid enough—so that the deformation of its parts will be well within the allowable limits when subjected to legitimate stresses—one may still add more metal merely for weight, on what has been called the anvil principle. For example, a lathe taking a certain cut on work held between centers, chattered and acted badly. The small face-plate used merely to drive the work, through the medium of a dog, was removed and a large plate (as large as the lathe could swing) put upon the spindle nose in its place. Now the dog and the work were apparently driven precisely as before; neither the lathe spindle or any other portion of the lathe or work was more rigid than before; but the chattering ceased, and the cutting was steady. Whether the larger and heavier face-plate resisted torsional vibrations or lateral ones or both, I cannot say, but it seemed merely by its inertia or momentum to resist the rapid alternate accelerations and retardations which constitute vibrations. So far as I can see it added absolutely nothing except weight; but its effect was most strikingly beneficial.

This, however, does not mean that we should add chunks of pig-iron here and there for the purpose of getting sufficient weight; but it does mean that, sometimes, after patterns have been made heavy enough according to every rule and formula, they may be improved by being made still heavier, if they are for machine tools; as a prominent machine tool designer says: "In designing grinders, make them plenty heavy enough, and then as much heavier as the directors will allow."

Vibrations in machine tools seem to result in blows delivered upon the cutting edges of the tools, rapidly destroying them. In a large manufacturing establishment a great many twist drills were used which were 0.224 inch in diameter. This is an odd size and they could not be purchased at nearly as favorable prices as the standard sizes could be; and they were, therefore, made in the tool-room of the establishment in which they were used. At first a small, or No. 1 universal milling machine was employed in milling the helical grooves in these drills, but finally a larger machine by the same makers was installed for the general work of the tool-room. Occasionally both machines were employed in grooving the drills, and with the aid of special fixtures it was done rapidly.



Machinery,N.Y.

Fig. 2. The Work to be Machined.

The larger machine would have been pronounced entirely too heavy for the work, and it was used for these drills simply because it was more convenient to use both machines on the work at the same time. The cutters were made in large lots and were used indiscriminately on the two machines. The speeds were so arranged that the only practical speed on the larger machine was considerably higher than the one used on the smaller machine, but the cutters invariably held their edge and remained in service longer without grinding when used in the larger machine than when used in the smaller one. All conditions were favorable to an opposite result, except the greater weight of the larger machine. Its more massive knee and platen constituted a heavier anvil, which absorbed all vibrations. I became satisfied that if a machine were to be installed for use on that job continuously, the larger machine would have been the proper choice; although previous to that experience I would unhesitatingly have chosen the smaller as being ample for the work, as, I think, most others would have done, including the builders.

First Principles of Shop Construction.

One of the first things to be decided with regard to any shop designed for building a given machine is the general method to be pursued and the arrangement of the shop floor so as to have parts of machines progress between operations upon them in such a direction that, when finally ready for assembling, they will be near the place where they are wanted. There are two general ways of arranging for this.

In one, the castings coming from the foundry are delivered at one end of the shop, and at this end are the planers, chucking machines and boring and turning mills on which usually the first operations are performed upon castings. From here they progress from machine to machine for successive operations until, at the other end of the shop, they reach the stores or the assembling floor. About the same principle is applied in the case of forgings and it is quite common that castings and forgings enter the machine shop by the same door.

In the larger shops the alternative plan is often adopted of having a number of bays or shop floors arranged parallel to each other, either under the same roof, or separately, with open spaces between; these floor divisions all join, at one end, a floor running at right angles to them and usually devoted to assembling or erecting. Cars or trucks running on floor tracks, or overhead traveling cranes, convey materials through each of these bays, and the different classes of materials, entering at one end, progress toward the main bay; the progress of the work is analogous to the flow of water through various tributary streams until it finally reaches the larger river in which it again flows in one direction to its destination. Fig. 1 shows the direction of the movement of materials through the various sections of the shop.

In one bay there may be, for instance, the automatic and other screw machines; in another the smaller milling machines; in another the smaller lathes, planers, etc., while ordinarily there would be placed in the left-hand bay the heavier tools, floor plates, and portable tools required to deal with the heaviest castings. These when entering at the outer end of this bay, thus have the shortest possible distance to travel through the shop before reaching the general erecting floor at the left-hand end of the main bay, nearest the point of shipment.

Sometimes the main bay is higher than the others, to give head-room for the erection of large machinery, and there may be, along one side of the bay, a gallery devoted to such things as brass-working, automatic screw machines, gear cutting, etc.

The Cost Factor in Machine Manufacture.

One might suppose that, with the drawing or a sample of the machine before him, it would be possible for any one skilled in the art, by referring to data of the rates at which various operations can be performed to decide readily and almost infallibly, what methods to follow in carrying out any machine shop operation; but if one chooses a method based on the experience of a year ago, the chances are that he will deceive himself, and if he base his choice upon experience of five years ago, he will almost certainly be wrong. Besides, there are personal factors to be considered. It has been my experience that, in one first-class shop, there was a very firm belief that milling would not do at all for finishing lathe beds; that these must be planed, else time would be lost in scraping them true enough to pass inspection. In another shop all beds were milled and this was believed to be the best way of machining them. Both shops were in the front rank and both were doing the very best grade of work, of an approximately similar character, and in approximately equal quantities. It is evident that a very careful investigation would have to be made in order to decide which of these shops should be the model to follow in that matter; although it is certain that, if one could probe deep enough, one would surely find reasons for such variations in practice. One of these shops made neither planers nor millers and, presumably, had no interest in the one as against the other; while the other made both and, presumably, was as much in favor of the one as the other; so that this factor does not explain in this case such decided differences in practice.

Example of Decreased Cost Due to Interchangeable Manufacturing Methods.

In choosing a method of doing work, first, the quality of the work to be produced must be considered and then the quantity. I can perhaps best impress this by citing a case which has come within my own experience. A gray iron casting designed as the frame of a certain mechanism and shown partly in Fig. 2, was to be made. The first experimental machine had been made and tested, and four had been built precisely to the dimensions that were to be adhered to afterwards in manufacturing it, after the trial of these machines, it should be decided to take up their manufacture. The work to be done upon the castings was to bore accurately the hole *A* through the cylindrical body, face off the ends, true and square and to a definite length; and tool the surface *B* to a definite height above the squared end of the hub, true and square with it within a small limit of variation. The hole was cored in the casting, with about 3/16 inch to be removed in boring.

In the case of the first casting machined, it was held in the jaw chuck in an engine lathe, trued up by the usual process of chalk marking and adjusting, and then bored by a tool held in the tool-post in the usual way. At the same chucking the surface *B* was faced off and the adjacent end of the hub was then faced to give the right height for *B*; all this involved, of course, careful work by a skilled man. The piece was then reversed in the chuck, and by means of an indicator the bore was carefully trued up and the other end of the hub faced to give the piece proper length. For these operations it would have been put upon an arbor if the hole had been of any standard size for which an arbor had been on hand, but this was not the case. The cost of this machining was about $2.50.

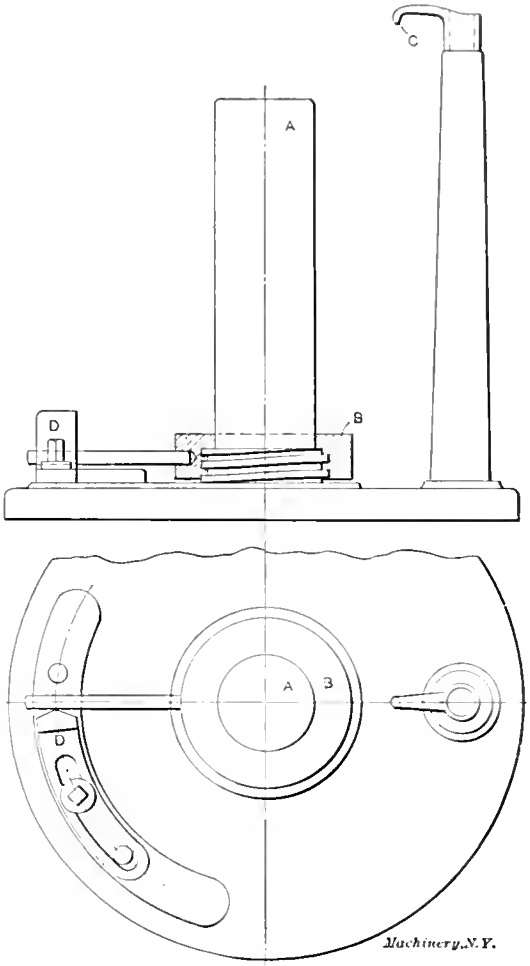


Fig. 3. The Fixture used for Facing Operations on Work in Fig 2.

Later, ten more castings were required, and for these it was thought worth while to make a flat chucking drill to precede the lathe boring tool and an arbor on which to drive them while facing the ends and the surface *B*. This facilitated matters somewhat, and reduced the cost of machining to about $1.50 each.

It was then decided to manufacture the machine of which this formed a part, and fifty per day were to be made. The lathe was now entirely abandoned for this work, and two ordinary drill presses of good quality and with automatic feed were placed side by side and close together. A fixture was made for one of them which simply held the casting vertical, the hub resting against set-screws fitted to the frame of the fixture, with check nuts to hold them when adjusted.

A clamp held the piece against these set-screws and it was not necessary to tighten this very hard, because the lug *B* was allowed to come against a projection in the fixture and prevent rotation of the work. A hardened and ground steel bushing in the top of the fixture guided the boring tool which was what is by some called a butt-mill and by others a three-, four-, or six-fluted twist drill. It was simply a solid cylinder with a taper shank to fit the drill spindle, and having cut upon its cylindrical surface four helical grooves of such a shape that the ends of these grooves formed radial cutting lips. They were made radial, *i. e.*, they were ground to lie in or nearly in a radial plane because cored holes in castings do not, by any means, come true, and, where the core is considerably out of center, any cutting lip which is ground at an angle similar to that of an ordinary twist drill, will be crowded over by the heavier cut on one side; whereas, if the cutting lips are square; there will be no tendency to crowd off and much better results will be obtained.

The workman (not a skilled mechanic but a specially trained man) started boring and threw in the automatic feed. While the boring was thus going on, he reamed, with a hand reamer, the piece which had been previously bored, removing about 0.003 inch. He then placed this reamed piece upon the stud in the fixture shown in Fig. 3. This fixture was mounted upon the table of the second drill press with the stud *A* directly under the spindle. In the spindle was the facing tool shown in Fig. 4.

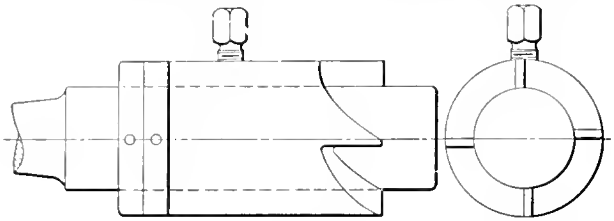

Machinery,N.Y.

Fig. 4. The Facing Tool Employed.

The work was first placed upon the stud so that the upper end, or that having the arm on it, was uppermost and the collar *B* was rotated until, by means of its internal square thread, it lowered the work upon the stud until the, as yet uncut face of *B*, Fig. 2, was at the height of the swinging gage *C*, Fig. 3. This was so made that, when the piece was adjusted to it, as described, enough metal would be left on the surface *B*, Fig. 2, to give a fair milling cut. The facing tool, Fig. 4, was then brought down and the facing continued until the end of the shank and the top of the stud *A*, Fig. 3, came together and thus stopped the cutting. The work was then reversed, *i. e.*, placed upon the stud with the opposite end uppermost, when the collar *B*, Fig. 3, was raised by rotating as before until the pin by which it was rotated came in contact with the stop *D*. The facing cutter could also be adjusted vertically upon the shank and was held in place by the threaded collars above it. All adjustments of the fixture and the grinding of the facing cutter were done by a skilled man, so that the operator had nothing to do but handle it as directed. By means of these tools, all this work was done while the boring was going on in the first drill press, and the labor cost was reduced to that necessary for the boring only. The face *B*, Fig. 2, was afterwards milled off while the piece was held in a fixture which permitted the use of a face mill.

By the plan described, the cost was reduced to about 6 cents per piece, as compared with the $2.50 and $1.50, which precisely the same work had cost by the methods previously described. Now, considered by itself, no one of these methods was necessarily any better than another. Each was adopted because believed to be the best for the conditions presented at the time. The first method, or one very similar to it, would still be the best one to follow if only one piece were to be made and if there were no assurance that there ever would be another like it.

As a first consideration the method followed in each case had to be such as to produce the results aimed at in accuracy, etc. After that it had to be adapted also to the number of pieces which were to be made, or the rate at which they were to be produced; this case has been described in detail to show that the best method of doing identically the same work usually depends very much on the quantity to be done, or the rate at which it is to be done. But it is not always possible to know how many pieces are to be made alike, and one of the most difficult problems connected with manufacturing is to decide wisely whether or not to make fixtures at a given time. A rule that is sometimes used is to make jigs and fixtures only when it is believed that their cost will be saved in one year. Some establishments charge off 20 per cent of the original cost of all fixtures at each yearly inventory, thus distributing their cost over a period of five years. One very prominent machinery building concern makes good jigs and fixtures for every machine it builds; this is done mainly because interchangeability and ability to supply parts at any time that will fit and work without question is a part of every sale or lease contract, and jigs and fixtures afford the only practical means known to them of certainly securing that object.

Rapid Development of New Tools and Methods.

Scarcely anything is as yet finally settled with regard to the details of shop practice. If to-day we are to consider the production of a new machine, the decision with respect to many things connected with its manufacture would vary between different experts; and, any decision which is reached at the present time would almost certainly differ from one that would have been reached a year ago, as well as be subject to revision a year hence.

High speed steel has exerted an important influence, enabling surplus metal to be removed from castings and forgings much more rapidly than was possible a few years ago; but this has not in the least shortened or reduced the cost of many of the most expensive operations which go into the production of machinery, *i. e.*, the careful laying out of the work, the careful measuring and gaging necessary to secure the required accuracy; the grinding, lapping, scraping, finishing and assembling. It has reduced the cost of turning, boring, drilling, milling, and planing, and, in some lines of work, these operations constitute the principal elements of cost; but in other lines they are relatively less important, and the faster rate at which these operations can now be done has affected the cost of production of such lines of machinery comparatively little.

Milling is a process which, within recent years, has undergone such changes that one who should have to decide as between milling and planing or upon the type of miller to install or the number of them needed for a certain production, would need to know the very latest attainments in that line. At first milling cutters were almost what might be called disk-shaped rotary files and were, in fact, used as substitutes for files, especially in producing forms which it was necessary to reproduce in considerable numbers with considerable accuracy—gear teeth for instance. The rate at which work was done was considered very fast, because it was so much faster than the methods which it displaced; but such a rate of doing milling would now be considered absurdly slow. Probably few milling machines used in those early days could remove more than a pound of metal per hour.

At the latest general meeting of the American Society of Mechanical Engineers a cutter was described that converts into chips and removes nearly 13.5 pounds of cast iron per minute. If capacity to remove metal were the only controlling factor, such figures would make it pretty easy to decide in most cases. But very often the amount of metal to be removed and the character of the pieces from which it is to be removed do not permit of milling at a rate anywhere near the figures given, and other factors have much to do with the choice of machines and methods.

The art of grinding has also progressed very rapidly within recent years. Grinding machines, at first used in machine shops almost exclusively for shaping or perfecting the forms of hardened steel pieces, are now quite generally used for finishing, to size and truth, spindles, piston-rods, automobile engine crank-shafts and numerous other things which are first turned roughly and considerably above the finished size; a very high finish is produced at less cost than that at which an inferior one could have been produced a few years ago.

Power for Machine Tools.

In nothing, perhaps, is the difficulty of establishing definite rules for machine shop practice more clearly shown than when we investigate the matter of the power required to drive machine tools. An old rule was to provide one horse-power for each ten men employed in a machine shop, including bench hands and all others, whether using power or not; and that rule fitted very well with former machine-shop practice. For any of the most modern machine shops, however, such an allowance would be absurdly inadequate.

As regards the practice of to-day, for example, the Westinghouse Electric and Mfg. Co., which has had a very extensive experience in equipping machine tools with electric motors, says that the conditions under which machine tools operate are so varied that it is impossible to represent even by empiric formulas the exact horse-power which should be used in all cases. They give some formulas, however, based on average practice, and assuming that ordinary carbon steel tools are used, the assumed cutting speed being 20 feet per minute. Under abnormal conditions of either machine or work the formulas will give very much smaller horse-powers than those which should be applied to the various machines.

For engine lathes: $H.P. = 0.15S - 1$ in which S is the swing of the lathe in inches. This would give, for a 10-inch swing lathe, a motor of 0.5 H.P. and for a 20-inch swing lathe 2 H.P. It may be remarked that, although the cutting speed is the same, the 20-inch lathe will have a motor four times as powerful as the 10-inch lathe, and that, if the cut taken were of the same character, the power required would be the same for both. The only way of accounting for the difference is in the fact that heavier chips are taken in the 20-inch lathes and also that more power is required to drive the lathe itself.

For lathes doing specially heavy work, such as forge lathes, the formula given is: $H.P. = 0.234S - 2$ which for a 20-inch lathe of this description would give 2.68 H.P. This is less increase of power as compared with the ordinary 20-inch lathe than might have been looked for. It will be found, however, that, as the sizes of the lathes increase, the power provided by this formula increases in a greater ratio than by the first. Thus, comparing 30-inch lathes, for example, we get 3.5 H.P. and 5 H.P., respectively, and for 40-inch lathes, 5 H.P. and 7.4 H.P., respectively.

For boring and turning mills the same authority gives: $H.P. = 0.25S - 4$ in which S = the swing in inches. This, for a 6-foot mill, gives 14 H.P. The formula for a lathe of the same swing would give us only 9 H.P.; but that formula is based upon the use of only one cutting tool; whereas boring and turning mills ordinarily use two and often more.

For drill presses the formula is: $H.P. = 0.06S$, where S = the swing of the drill press in inches; or for a heavy radial drill press: $H.P. = 0.1S$.

For planers of ordinary proportion between length and width the formula is: $H.P. = 3W$, where W = width between the housings in feet. For heavy planers for forge work: $H.P. = 4.92W$. These formulas provide for two tools cutting simultaneously; for a return speed of 3 to 1, and also for the overload at the moment of reversal. The increase in power required at the moment of reversal is considerable, and the motor must be of sufficient capacity to avoid that degree of momentary overload which, if the planer were to be used always at full stroke, might well be borne, but which becomes too much for the motor when the stroke is so shortened as to keep the planer for a very large proportion of the time in the act of reversing, and thus gives the motor practically a continuous overload.

The formula given for slab milling machines is: $H.P. = 0.3W$, in which W = distance between the housings in inches. This is for carbon steel cutters running at 20 feet per minute cutting speed; for a machine having 42 inches between housings the formula gives 12.6 H.P.

In a paper by Messrs. Wilfred Lewis and Wm. H. Taylor, presented at the annual meeting of the American Society of Mechanical Engineers December, 1908, some experiments with a milling cutter provided with helical, inserted blades of high-speed steel were described, with which cutting was done in a miller 42 inches between housings, and milling steel at a cutting rate of 88 feet per minute. As the power required to drive a milling cutter is proportional to the speed of the cutter, our formula would give 55.4 H.P.; but the power actually used in the experiment was 92.7 H.P., or, nearly 70 per cent more than the formula gives. This is a striking example of the fact, clearly recognized by the Westinghouse Company, that "the above formulas may be useful in approximating the horse-power required under given conditions, but it has been found that it is impossible to derive any formula which will take account of all the operative conditions and the results given by the formulas must be invariably tempered by judgment, based upon the character of the work, personnel and numerous other factors."

Much the same thing applies throughout the field of productive engineering. This, however, is no reason for becoming discouraged at the prospect of ever mastering it, for it is for this very reason that it is perhaps the field which, above all others, gives the widest scope for individuality and noteworthy achievement.

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THE FIRST LATHE MADE IN INDIA.

The accompanying illustration shows a machine of considerable general interest because of its makers, and the fact that it is the first lathe constructed in India. It is a copy of a Barnes No. 13 engine lathe manufactured by the W. F. & John Barnes Co., Rockford, Ill., and was constructed almost entirely by native Indian boys in the Methodist Episcopal Industrial School at Nadiad, India. Mr. H. F. Bishop, who is at the head of the school, says that very little machinery is built in India, and that what is made is mostly confined to railway work, cotton mill machinery and fittings, and structural steel fabrication. The Mission Industrial School is endeavoring to start manufacturing along the lines of small machinery, tools, etc., which will give employment to the natives and lift the industries of the country out of the primitive state in which they generally exist. Mr. Bishop writes that the lathe built by these Indian boys, who but a few years ago were ignorant famine waifs, works as satisfactorily as the original lathe. Of course the castings are somewhat rough and the illustration shows it because no filling or painting was done to improve the surfaces.


The First Lathe made in India, and its Makers

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Some of the native Australian woods have a very high tensile strength. The *Practical Engineer* states that the blue gum of Tasmania has an ultimate strength of 29,800 pounds per square inch, and weight for weight has 2.3 times the strength of nickel steel. The modulus of elasticity is 3,500,000. The swamp gum, red gum and salmon gum wood, also Australian native woods, have a tensile strength of about 20,000 pounds per square inch. Weight for weight, the swamp gum wood has double the strength of high-grade structural steel. While the tensile strength of these woods is high, the shearing strength is low as compared with steel as it does not exceed 2,000 pounds per square inch for any of the woods mentioned.

THE SQUARING OF THE CIRCLE.

ANTONIO LLANO *

The quadrature of the circle is a problem that everybody has heard of, but of which many persons have but a very vague idea. It has engaged the attention of mathematicians from the dawn of civilization to our own time, and been the source of many great discoveries; nor has its fascinating power failed to engage and wreck the scanty intellects of uncultured men that, having been destined by nature to dig the soil or guide the tilling plow, have lost what little reason they had in vain endeavors to solve a problem that some of them could not even state. The following brief exposition of the true nature of this problem, as well as of the simpler problems on which its solution depends, may be of interest to those that are not familiar with the subject; while the approximate graphic solutions given may prove useful to the draftsman.

"Nor has its fascinating power failed to engage and wreck the scanty intellects of uncultured men."

The simplest way of stating the problem is this: *Given a circle, to construct a square that shall have the same area as the circle.*

It should be noted that the required square is to be *constructed;* and this means that the side of the square is to be determined graphically with no other instruments than a straightedge or ruler and a pair of compasses. It is not necessarily required that the length of the side of the square should be computed; what is required is that a line should be drawn, whether its length can be calculated or not, that shall fulfil the conditions of the problem. An illustration will make clear the difference between solving a problem by computation and solving it by geometrical construction. The two methods are called, respectively, the *analytic* and the *graphic* method.

Suppose that a rectangle R, Fig. 1, is given, and that it is required to find another rectangle that shall have the same area but a different base c.

In the analytic method, the lengths of the base b and altitude h of the rectangle R, and of the base c of the required rectangle, are either given or determined by actual measurement. Suppose $b = 12$, $h = 3$, and $c = 9$, and denote by x the altitude of the required rectangle. Then, since the two rectangles are to have the same area, we must have

$$9 \times x = 12 \times 3 = 36,$$

whence $x = 36 \div 9 = 4$.

In the graphic method, it is immaterial what the lengths of b, h and c are provided these lines are given on paper; that is, provided they are already drawn. Draw AB, Fig. 2, equal to b. From A, lay off $AC = c$. From C, draw $CH = h$ in any direction other than the direction of AB. Draw AH, and produce it. From B, draw BX parallel to CH, intersecting AH produced in X. Then BX is the altitude of the required rectangle. For the similar triangles ACH and ABX give

$$AC : CH = AB : BX;$$

that is,

$$c : h = b : BX,$$

whence $c \times BX = b \times h$, as required.

When the object of a geometrical probem is to draw a line satisfying certain conditions, the line can always be drawn if its exact length can be computed; that is, a geometric construction can always be accomplished if an *exact* analytic solution can be found. Thus, in the preceding example, the rectangle can be constructed after its altitude x has been calculated. The converse proposition, however, is not true: a problem may have an exact graphic solution, and yet not have an exact analytic solution. Suppose, for example, that it is required to find the hypotenuse of a right-angled triangle whose sides are 5 and 3. We may draw a right angle, and lay off from its vertex, to any convenient scale, the lengths 3 and 5 of the sides; the line joining their extremities is the required hypotenuse. Yet, we cannot exactly determine this hypotenuse by computation, since its length is $\sqrt{9+25}$, or $\sqrt{34}$; and, although we can express $\sqrt{34}$ to any desired degree of approximation, we cannot determine its exact value.

The following additional illustration of the principle just explained has a direct bearing on the problem of squaring the circle. Let it be required to determine the side of a square having the same area as a triangle whose base and altitude are b and h, respectively. If the side of the square is denoted by x, the analytic statement of the problem is

$$x^2 = bh \div 2$$

and the analytic solution is

$$x = \sqrt{bh \div 2}$$

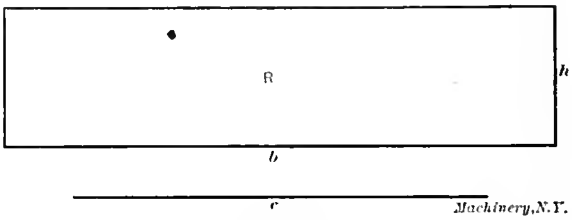

Fig. 1.

If $\frac{1}{2}bh$ is a perfect square, the value of x can be determined exactly, and the square readily constructed. Thus, if $b = 24$ and $h = 3$, $bh \div 2 = 36$, and $x = \sqrt{36} = 6$. If $bh \div 2$ is not a perfect square, there is no exact analytic solution. The exact geometric solution, however, is always possible, and is accomplished thus:

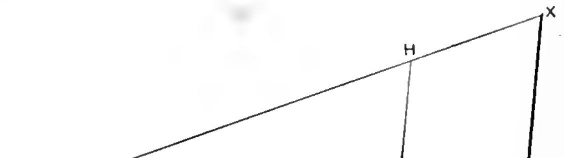

Fig. 2.

On an indefinite line AP, Fig. 3, lay off $AB = b \div 2$, and $BH = h$. Bisect AH at O, and, with center O and radius OA, describe a semicircle AQH. At B, erect a perpendicular to AH, intersecting the semicircle in X. Then BX is the side x of the required square. This follows from the fact that, the angles of the triangle ABX being equal to those of the triangle XBH, the two triangles are similar, and, therefore,

$$AB : BX = BX : BH, \text{ or } AB : BX = BX : BH,$$

whence

$$BX^2 = AB \times BH = (b \div 2) \times h = bh \div 2$$

Here, then, we have another case in which the graphic solution of the problem is always possible, whether the analytic solution is possible or not.

We may now return to the squaring of the circle; or, as mathematicians call it, the *quadrature* of the circle. If the area of a circle of given diameter could be exactly calculated,

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the construction of the equivalent square would offer no difficulty. Suppose, for example, that the exact area of a circle is 15.75 square inches. This area may be expressed as the area of a triangle having a base of (2 × 15.75) inches and an altitude of 1 inch, and the equivalent square can be constructed in the manner already explained.

It is, then, natural to try first to find an expression, or formula, for the area of the circle in terms of the diameter or of the radius. The investigation leads to the conclusion that the area of a circle is equal to the area of a triangle whose base is the length of the circumference and whose altitude is the radius of the circle; so that, if the length of the circumference can be either computed or constructed, the area of the circle and the side of the equivalent square can be readily determined.

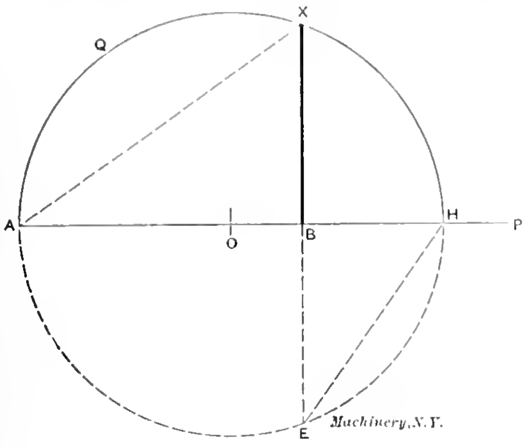

Fig. 3.

Algebraically, the relation between the area A, the radius R and the circumference C is thus expressed:

$$A = R\,C \div 2$$

Since all circles have the same form, any two circles of different diameters may be regarded as being the same circle drawn to two different scales; and so their circumferences must be proportional to their diameters or to their radii. If, for instance, the diameter of a circle is three times the diameter of another circle, the circumference of the former circle must be three times the circumference of the latter. Let R, D and C be, respectively, the radius, diameter and circumference of a circle, and R_1, D_1, C_1 the radius, diameter and circumference of another circle. Then, the principle stated above may be expressed algebraically as follows:

$$\frac{C}{C_1} = \frac{R}{R_1}, \text{ or } \frac{C}{C_1} = \frac{D}{D_1}$$

From the second of these two equations is derived the important relation

$$\frac{C}{D} = \frac{C_1}{D_1}$$

We thus see that the ratio of a circumference to its diameter is the same as the ratio of any other circumference to its diameter; that is to say, that the number obtained by dividing the length of any circumference by the length of its diameter is *constant*, or fixed, or always the same. This fixed number is usually denoted by the Greek letter π (called *pi*). From the equation $\frac{C}{D} = \pi$ follows

$$C = \pi D = 2\,\pi R.$$

If we knew the exact value of π, the circumference C, and therefore the area A, and the side of the equivalent square, could be determined, as already explained. The squaring of the circle, then, finally reduces to the determination of the number π. The French geometer Legendre proved, over 100 years ago, that π is an incommensurable quantity; that is, a quantity that, like $\sqrt{2}$, $\sqrt[3]{12}$, cannot be expressed exactly by any number, either integral or fractional. This disposed of the analytical solution of the problem, showing that it was impossible. The graphic solution, however, still remained a possibility, until the German mathematician Lindeman proved, in 1882, that this solution, also, is impossible.

But, although no exact solution of the problem is possible, approximate solutions, both analytical and graphical, have been found that meet all the requirements of practical computation and drafting. Various methods and formulas have been devised by which the value of π can be obtained to any required degree of approximation, and some astoundingly patient calculators have computed this mysterious number to more than seven hundred decimal places. For very accurate work, the approximate value 3.1415927 is used; but for nearly all practical purposes, 3.1416 is considered close enough. One-fourth of the latter value, or .7854, serves to calculate the area of a circle in terms of the diameter, according to the formula

$$A = \frac{R}{2} \times C = \frac{D}{4} \times \pi D = \frac{\pi D^2}{4}.$$

The value of π to twenty decimals is

3.14159265358979323846.

This value, as well as closer values, is obtained by means of series. Elementary geometry, however, affords some methods that, although exceedingly laborious, were for a long time the only ones used for the determination of π. The simplest method consists in computing the perimeters of the inscribed and circumscribed square in a circle of diameter 1; from these, the perimeters of the inscribed and circumscribed polygons of 8 sides; from these, the perimeters of the polygons of 16 sides, and so on. Since the length of the circumference lies between any two corresponding perimeters, the figures that these two perimeters have in common are figures of the number expressing the approximate length of the circumference, and, therefore, the approximate value of π, for in this case $C = \pi \times 1 = \pi$. It is found by this method that the perimeters of the inscribed and circumscribed polygons of 8,192 sides are, respectively, 3.1415926 and 3.1415928, nearly; whence it follows that the value of π, to six decimals, is 3.141593.

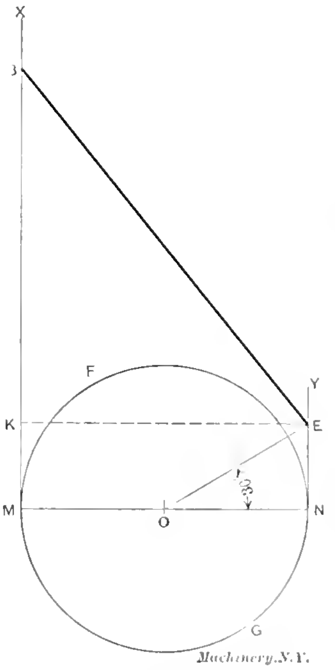

Fig. 4.

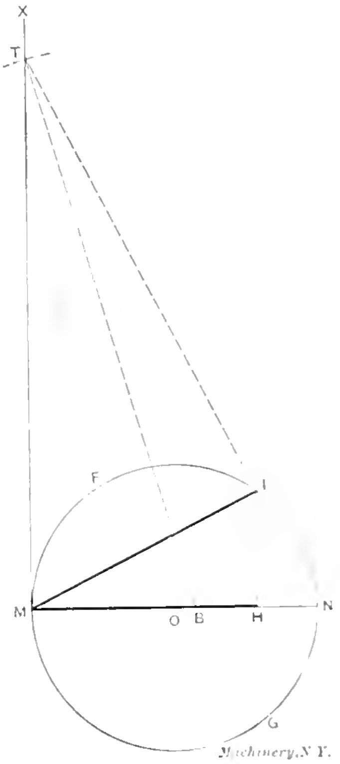

Fig. 5.

The value $\frac{22}{7}$, or 3.143, is convenient for rough calculations and estimates. A much closer value is that determined by Peter Metius in the sixteenth century; namely, $\frac{355}{113} =$ 3.1415929. The common fraction expressing this value is often used for slide-rule computations; it can be easily remem-

[illegible] applying the following rule: Write twice [illegible] first three odd numbers, thus: 113355; divide [illegible] group of figures into two groups of three figures [illegible] group, 113, is the denominator of the fraction; [illegible] group, 355, is the numerator. Since π is greater [illegible] easy to tell which of the two groups is the [illegible] and which is the denominator.

[illegible] the approximate graphic solutions, one of the simplest [illegible] in adding to 3 times the diameter one-fifth the side of the square inscribed in the circle; the result is the approximate length of the circumference. This method is equivalent to taking $\pi = 3.14142$.

A construction that gives a closer approximation than the preceding is as follows: Let *F G*, Fig. 4, be the given circle, *O* its center, and *M N* any diameter. Draw the tangents *M X* and *N Y*. On *M X*, lay off *M B* equal to 3 times the radius. Draw *O E* making an angle of 30 degrees with *O N* (which can be very readily done with a drawing triangle). The line *B E* will then be, approximately, equal to one-half the circumference. This method is equivalent to taking π equal to 3.14153, which differs but little from the usual value 3.1416.

The following construction is due to the French geometer H. Sonnet: Draw the diameter *M N* and the tangent *M X*, Fig. 5. From the center *O*, lay off *O B* equal to one-sixth the radius; from *B*, with a radius equal to twice the diameter, describe an arc cutting *M X* in *T*. Draw *T N*, intersecting the circumference in *I*. Then, the chord *M I* is, approximately, equal to the side of the equivalent square. Draw *I H* perpendicular to *M N*. Then, *M H* is, approximately, equal to the length of a quadrant, or one-quarter of the circumference. This method is equivalent to taking $\pi = 3.14158$—a very close approximation.

In practice, when the numerical value of the diameter, expressed in units of length, is known, the simplest way to lay off the length of the circumference on a straight line is to multiply the diameter by 3.1416, or, if a slide-rule is used, by $\frac{355}{113}$, and lay off the result to scale. When, however, a circle is simply given on paper (on a drawing), its exact diameter not being known, the graphic solutions are usually more convenient.

* * *

FORMULAS AND TABLES FOR HORSE-POWER OF GASOLINE ENGINES.*

MORRIS A. HALL.†

The horse-power of a gasoline engine can, of course, be figured easily enough from the well-known formula

$$\frac{P L A N}{2 \times 33{,}000}$$

in which

P = the mean effective pressure,

L = the stroke in feet,

A = the area of the piston or cylinder bore in square inches,

N = the number of revolutions per minute.

In order, however, to save calculations a table can be prepared, giving at a glance the horse-power of gasoline engines, when the bore and the stroke are known. Such a table is presented in the accompanying Supplement in Table I. This table shows the indicated horse-power or ideal power. To obtain the actual horse-power from the indicated horse-power given in the table, the figures stated must be multiplied by a factor based on the mechanical efficiency of the mechanism, which may vary from 94 to 70 per cent, and in some cases even less. As a fair average, however, 80 per cent may be used in the calculations. In the table presented in the Supplement the bore is given in the left-hand vertical column, while the stroke is given in a horizontal line at the top; beginning with a stroke which is equal to the bore, which is found in the column headed bore + zero, the stroke increases in each successive column by ¼ inch up to the final column, which is 2 inches longer than the diameter of the bore. Thus the powers given are for engines varying from 2-inch diameter by 2-inch stroke, up to 6½-inch diameter by 7-inch stroke. The figures given are, of course, for a single cylinder, and for multi-cylinder engines all that is required is to multiply by the number of cylinders. In figuring the table, the formula stated at the beginning of this article was used, the mean effective pressure being taken as 90 pounds per square inch, and the number of revolutions as 1,000 per minute. Ninety pounds mean effective pressure corresponds to a compression pressure of 68½ pounds. This may be verified by using Grover's well-known formula:

$$P = 2C - 0.01C^2,$$

where C is the compression.

This compression of 68½ pounds is taken as an average figure, but the compression may in reality vary all the way from 60 to 100 pounds, and racing automobiles have been built using a compression of 120 pounds.

As cars using 60 pounds compression, we may mention the Franklin and Covert cars; the Thomas and Meline cars use 65 pounds, while the Columbia cars use 100, and the Acme, 102. For these cases, the power corresponding may be found from the table by multiplying the figures there given by the following factors:

For 60 pounds compression, multiply by 0.933
" 70 " " " " 1.011
" 80 " " " " 1.066
" 90 " " " " 1.160
" 100 " " " " 1.111

As an example taken at random, illustrating the use of the table, let us find the power for a 5½-inch bore, 6-inch stroke, 4-cylinder engine. In the line of 5½-inch bore and in the column headed bore + ½ inch, we find the value 16.2, which, multiplied by 4, gives 64.8, as the indicated horse-power. Assuming a mechanical efficiency of 80 per cent, we get 51.8 H. P. as the actual horse-power. In Table II is given the direct or actual horse-power of gasoline engines, as figured from the empirical formula

$$\frac{D^2}{2.5} = \text{horse-power}$$

which was recently adopted by the Association of Licensed Automobile Manufacturers. This formula is based on a piston speed of 1,000 feet per minute, which gives 2,000 R. P. M. for a 3-inch stroke, 1,500 R. P. M. for a 4-inch stroke, 1,200 R. P. M. for a 5-inch stroke, and 1,000 R. P. M. for a 6-inch stroke. This table would then compare with Table I only on the basis of 1,000 R. P. M., which would give a uniform stroke of 6 inches for all engines regardless of diameter. As an example, take the same engine as above, 5½ inch diameter by 6-inch stroke, having 4 cylinders. In the table we find the horse-power given as 12.10. This, multiplied by 4 gives us 48.4, which is reasonably near the figure 51.8 for the horsepower, previously found, to indicate that the empirical formula given above is approximately correct.

* * *

Consul-General Frank H. Mason writes from Paris that some of the noticeable features at this year's exposition of automobiles in Paris was the evidence of the low-priced car, and the general attempt to reduce the price of standard automobiles, without reducing their comfort or usefulness. This reduction in price has been partly achieved by elminating unessential features, and also by improved construction tending towards simplification. Larger and more comfortable bodies have been placed on moderate sized frames; the cylinders are cast uniformly in one piece, and the motor is placed further forward on the chassis, with the radiator behind it. The gear boxes are shorter and smaller, and the cardan shaft and live axle drive are almost universally used on vehicles below 25 horse-power. Forced feed-lubrication is used on the high grade types. The high tension magneto is replacing the low tension type. Self-starting devices are common, even on medium priced cars, and the honey-combed radiators are losing ground.

* * *

The very best formal training for a young man is that of an engineer, no matter what pursuit he may follow. It establishes the true value of efficiency, the habit of orderly thinking.

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* See Data Sheet Supplement.

† [illegible] Walnut Street, Allentown, Pa.

CUTTING HELICAL GEARS ON THE BROWN & SHARPE AUTOMATIC SCREW MACHINE.

The ribbon spools of a certain typewriter are rotated by a system of shafts and gearing, which includes a pair of small spiral gears—or helical gears, rather, to be exact. These, until recently, were cut on small hand-operated gear-cutting machines of special design, which performed the operation in the same way that helical gears are cut in a milling machine; that is to say, the blank was fed forward and rotated at the same time under a revolving formed cutter. It was then returned to the starting position again, indexed and fed forward for a second cut—and so on until all the teeth were formed. Having had some previous experience in cutting triple worms for gas meters in the automatic screw machine, the Brown & Sharpe Mfg. Co. undertook to cut these helical gears in the same way. The tools and operations employed for this work are herewith illustrated and described. The effectiveness, rapidity, and comparative simplicity of the mechanism employed, will at once appeal to the mechanical mind; and the job, as a whole, is a first-rate piece of evidence of the versatility of the automatic screw machine.

Helical Gear Generating Tool for the Screw Machine.

The machine is shown rigged up for producing helical gears in Fig. 1. Figs. 2 and 3 show front and rear views of the tooth-generating tool, and Fig. 4 shows details of its construction. The principle of its operation will best be understood from the latter engraving.

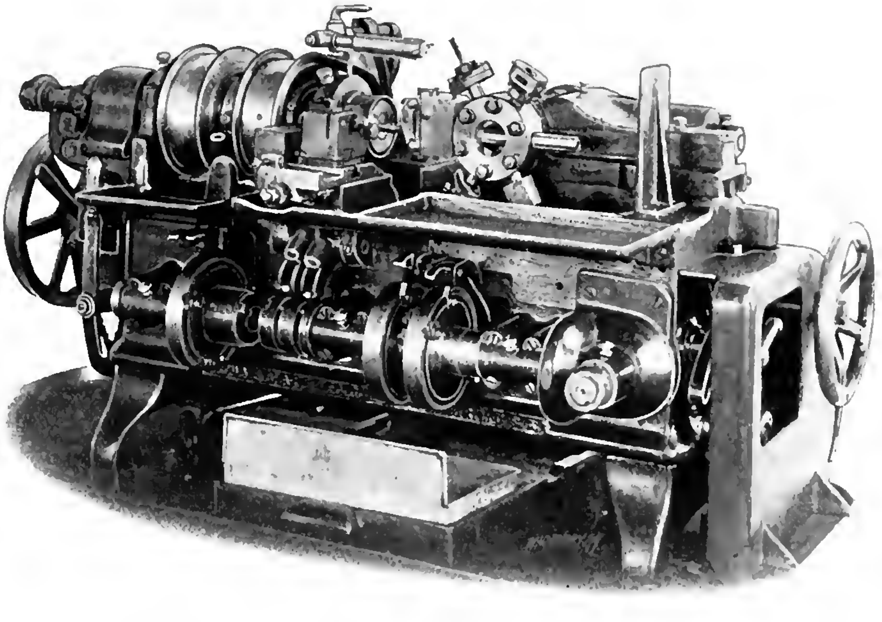


Fig. 1. An Automatic Screw Machine, arranged for Gear Cutting.

When this tool comes into action, the blank has been formed in the machine to the condition shown at *D* in Fig. 5. The hole has been drilled and reamed and the outside diameter formed to the required dimensions. When the tool is brought up to the work the three-cornered driving center *G* enters the drilled hole, and is thereby caused to revolve with the blank. As it is screwed firmly into the long driving gear *H*, this latter is also set in motion in unison with the spindle of the machine. Gear *H* has helical teeth cut on it engaging mating teeth in helical gear *J*, which is mounted on a short horizontal shaft having spur gear *K* keyed to it at the rear end. This gear, through a large idler *L*, drives gear *M*, which is keyed to the cutter spindle *S*. Cutter *N* mounted on the spindle has the form of a helical gear properly cut to mesh with the gear to be formed. It is made of hardened tool steel and is ground on one face, which face is set as shown in the end view, so that it is in the plane of the axis of the work. By means of the train of gearing just described, it will be seen that cutter *N* may be caused to revolve in unison with the work as though it were in mesh with the latter after the teeth have been cut.

Driving center G and the front bearing of gear H are supported in a sliding bushing O seated in the body P of the tool. A plunger Q in the shank of the tool is pressed by a long and stiff spring against the end of the bearing of H. This serves to keep G pressed into the hole in the work. As the tool advances over the work, G and H are forced back with relation to the holder, remaining stationary so far as endwise movement is concerned with relation to the work. The thrust between *Q* and the end of *H* is taken by a hardened ball pivot bearing as shown, so that the friction is inappreciable. The extended lip on the bushing *O* is simply for the purpose of providing the long keyway shown, which engages a pin in the body *P* to prevent *O* from turning. When the tool is not in contact with the work, screw *R* limits the outward movement of *G*, *H*, and *O* produced by spring plunger *Q*.

The Operation of Cutting the Teeth.

Consider now that we have a gear blank in the machine with the teeth all cut but not yet severed from the bar, and suppose the cutter *N* to be meshed with it as shown at *D* in Fig. 5. Suppose further that the spindle of the machine has been stopped. If now the turret slide be moved forward or back from the position shown, so that tool *P* is pushing forward or back over the work, center *G* and gear *H* remain stationary with reference to the work, but move back and forth with relation to the tool-holder. This axial movement of gear *H* will evidently rotate helical gear *J*, which, through the train of spur gears *K*, *L* and *M* will in turn rotate the cutter *N*. The ratio of this train of gearing is such that the rotary movement given to *N* by the longitudinal movement of the tool-holder in either direction keeps it exactly in step with the teeth of the work. Thus the movement of the turret slide rolls the cutter on the work just as if the latter were mounted perfectly free on its axis and were rolled by the teeth of the work itself, instead of through the train of gearing described.

Consider further, with the cutter and work set in the relation shown in Fig. 5, that the turret slide of the machine is fixed in position, but that the spindle and the work is rotated. The rotation of the gear revolves the three-cornered driving center *G*, which, in turn, transmits its motion to gear *H*, and thence to gears *J*, *K*, *L*, *M*, and cutter *N*. The ratio of this train of gearing is again such that the rotary movement thus given the cutter is in the proper ratio to keep the latter in step with the teeth cut in the work, so that the work and cutter revolve together as if they were a pair of helical gears driving each other, with no connection through the train of gearing.

It has thus been shown that the cutter will be kept in step with the work if the tool is moved axially back and forth over the work while the latter is stationary. It has also been shown that the cutter will keep in mesh with the work, while the latter is revolving and the turret slide and the tool are stationary. Since the cutter and work are kept in step under these two conditions separately, they are still in step when the two movements are combined. This tool and its arrangement of gearing can thus be moved back and forth over the revolving work without throwing the teeth in the cutter and the teeth in the work out of step with each other. This always supposes, of course, that the tool is not moved back so far that driving center G loses its contact with the work, as the proper meshing of the cutter depends on the driving connection between G and the blank. If G is ever moved back out of contact with the blank, this con-

nection is broken and when the cutter is again moved forward onto the work, it will probably be found out of step.

The action of cutter *N* will be readily understood now that the method of driving it has been explained. The face, which is in the plane *x—x* of the axis of the work, as shown in the end view of Fig. 4, is the cutting edge. As the tool is forced onto the work, this revolving cutting edge, having the exact shape of the helical gear which is to engage with the work, cuts teeth of that exact shape on the blank as it is gradually forced over it. In other words, the operation is an example of the molding-generating principle, the cutter *M* molding the proper surface to mesh with its own teeth.

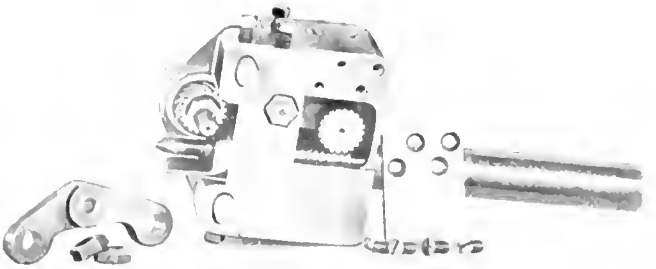


Fig. 2. Front View of the Helical Tooth Generating Tool.

Details of Construction of Generating Tool.

The various adjustments of the tool may be understood by reference to Figures 2, 3 and 4. The shank of the tool is made very long, as may be seen also in Fig. 1. This permits the use of a spring for plunger *Q* long enough so that its pressure will not be materially greater when the cutter is pushed clear over the work at the completion of the cut, than when center *G* first enters the hole in the work. If the pressure should materially increase, there would be danger that *G* might be pressed further into the edge of the hole, thus disturbing the axial relation of *G* and the blank, and consequently throwing the cutter and the work out of step with each other by that amount. The use of the long spring avoids the possibility of trouble on this score.

The cutter spindle *S* is mounted in bronze bushed bearings in front and back plates *T* and *U*, which are clamped together and to the body *P* of the tool by studs and nuts *V*. These studs, as is most plainly shown in the sectional view in Fig. 4, pass through elongated slots in the body so that the cutter spindle may be adjusted for a larger or smaller diameter of work by means of set-screws *W*, the adjustment being locked by nuts *V*. This adjustment would, of course, disturb somewhat the correct meshing of gears *L* and *M*.

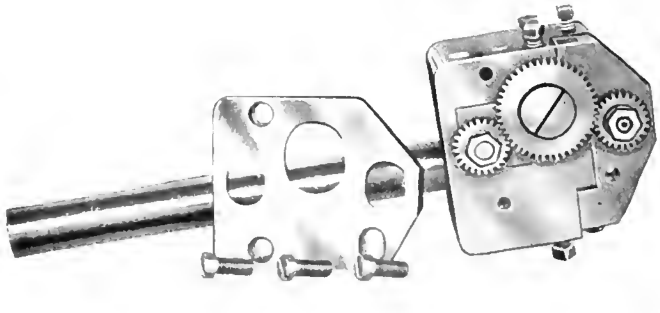


Fig. 3. Rear View of Generating Tool with Gear Guard Removed.

Gear *L* is therefore mounted on a stud *X* which floats in an enlarged hole in the body, and so may be adjusted by means of suitable set-screws which bring it into proper mesh with both *M* and *K*. The shaft on which the latter is mounted is also carried in a sliding block *Y*, by means of which gears *J* and *H* can be moved into closer or freer mesh. After the cutter has been set to the proper diameter for the work, the whole system of gearing may thus be adjusted to mesh without discoverable back lash and without binding. It is advisable to have as little back lash as possible between the cutter and the driving center to prevent the former from jumping or chattering when first commencing the cut. When there is much back lash the ends of the teeth where the cut commences are not formed to quite the proper shape. While there is no great harm in this in the case of a helical gear, in which the contact takes place in the center of the face, it gives a poor appearance to the work, and so should be avoided.

The thrust of the revolving work, pressing down on the cutter when the tool is in action, is taken by a ball bearing at *Z*. This is the only point where there would be any great danger of excessive friction so that the probability of *G* slipping in the work, due to too great a resistance in the mechanism it has to drive, is obviated. As was explained earlier, for the desired action, the cutting edge of the cutter must be in the plane of the center line of work. In the tool shown, no special provision is made for maintaining this condition. As the face of the cutter is sharpened it is necessary to pack it out with filling washers. In later designs, adjustments are provided for bringing the cutting point on a line with the center.

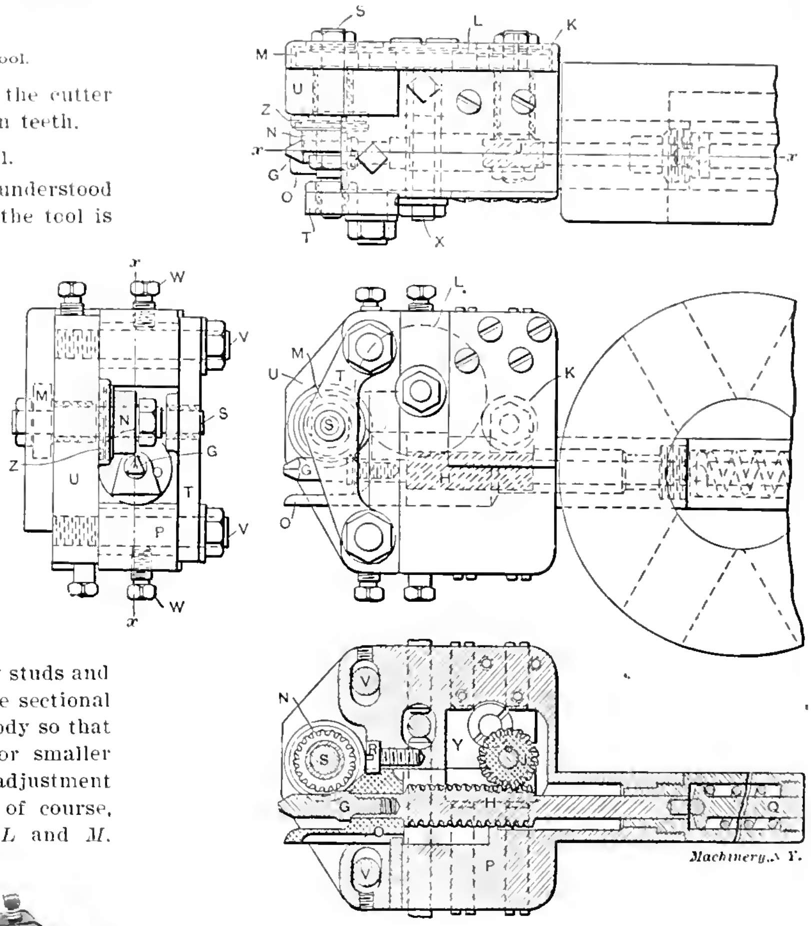
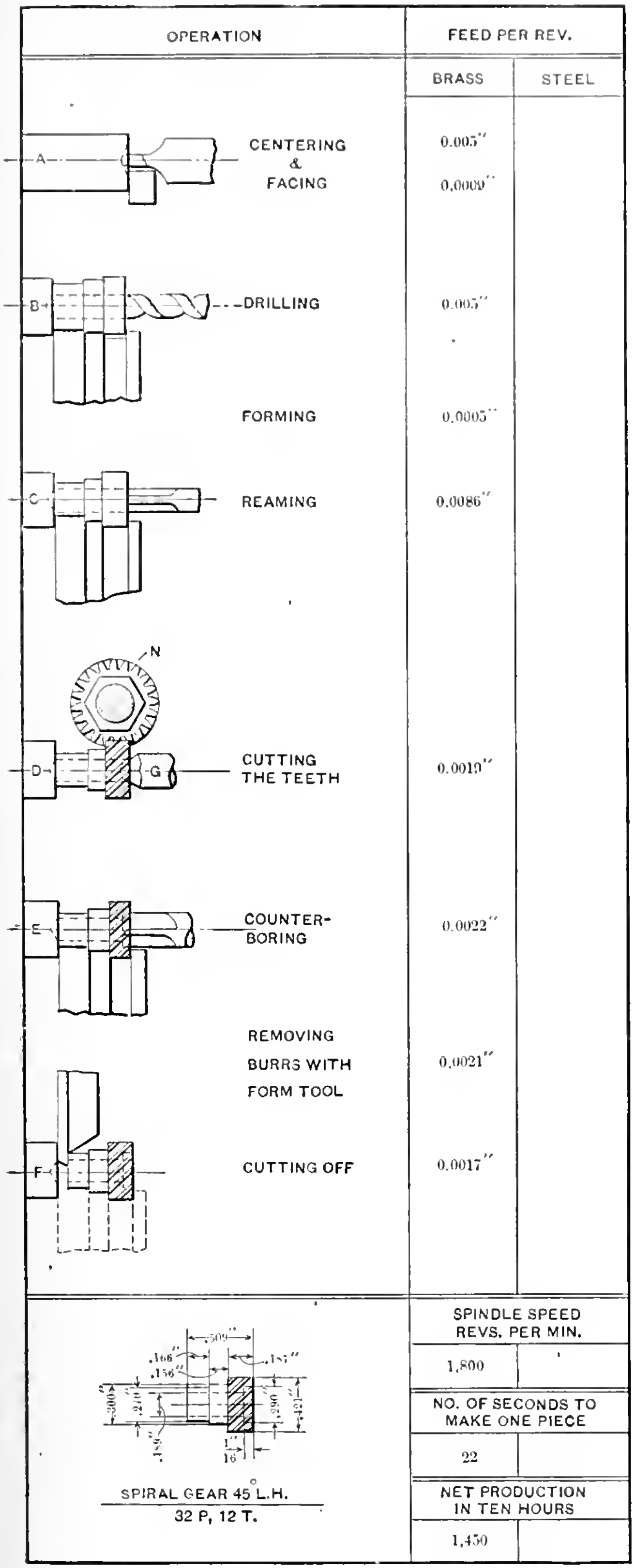


Fig. 4. Details of Construction of Generating Tool.

Order of Operations in making the Completed Gears.

The order of operations followed is shown in Fig. 5. The part to be made is shown with dimensions at the bottom of the engraving. The first operation after feeding the stock is centering and facing, as shown at *A*. This is done with a tool held in the turret, and shown pointing upward to the right in Fig. 1. The turret is next revolved two holes, and the drill is brought into action. Then the turret is revolved again and the hole is reamed. The reamer is mounted in a "floating holder" seen pointing downward to the left in Fig. 1 (the turret revolves in a counter clock-wise direction). This form of holder enables the reamer to be centered accurately, so that it will cut to size and take off an equal amount with all of its teeth. While the drilling and reaming are going on, the blank is being formed by a circular form tool mounted in the front cross slide, as shown at *B* and *C*. The operation of cutting the teeth at *D* has already been sufficiently described. At *E* the hole is being

counter-bored. This counter-boring incidentally removes the marks made by the sharp corners of driving center *G*. At *F* the completed piece is being severed from the bar. While the counter-boring is in progress, and during the first part of the cutting-off operation, the front form tool as shown at *E* and *F* is again brought down to clean off the burrs produced by the gear cutting tool.



OPERATION	FEED PER REV.	
	BRASS	STEEL
CENTERING & FACING	0.005" 0.0009"	
DRILLING	0.005"	
FORMING	0.0005"	
REAMING	0.0086"	
CUTTING THE TEETH	0.0019"	
COUNTER-BORING	0.0022"	
REMOVING BURRS WITH FORM TOOL	0.0021"	
CUTTING OFF	0.0017"	
SPIRAL GEAR 45° L.H. 32 P, 12 T.	SPINDLE SPEED REVS. PER MIN.	
	1,800	
	NO. OF SECONDS TO MAKE ONE PIECE	
	22	
	NET PRODUCTION IN TEN HOURS	
	1,450	

Fig. 5. The Order of Operations and Rates of Feed.

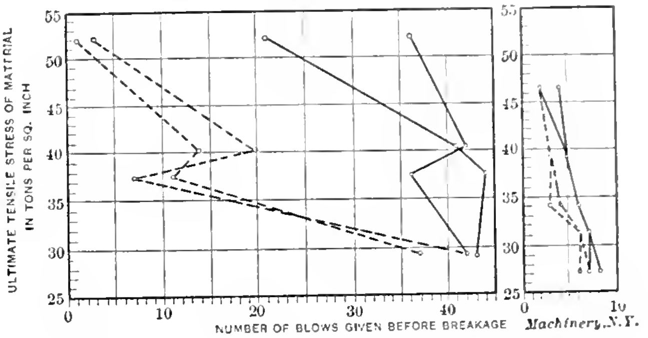
A pair of finished brass gears made by this process and mounted in a little angle plate is shown, as an initial piece at the beginning of this article. A few of these were made up to exhibit the work of this machine and the set of tools provided for it. The writer, who has one on his desk, can swear to its being a very attractive plaything. The little gears mesh smoothly with each other, and appear to be finished, on the whole, rather better than would be the case had they been shaped by a formed cutter as usual. There appears to be almost no limit to the possibilities of the automatic screw machine in the hands of a resourceful designer, and this little exhibition set of gears serves very well as a reminder of that fact. R. E. F.

* * *

COMPARISON OF STRENGTH OF THE U. S. AND THE WHITWORTH STANDARD THREADS.*

Strength is a very important feature of screw threads, and many experiments have been made with regard to it. There appears to be little doubt that bolts provided with the Whitworth thread are stronger than those provided with other standard screw threads. Experiments have been carried out in connection with the work of the Engineering Standards Committee of Great Britain, which indicate the difference in strength of the Whitworth and the U. S. or Sellers forms of screw threads. The tests were shock tests, and must be considered as conclusive, because in every case the Whitworth thread sustained a greater number of blows before fracture than the U. S. thread. The experiments were carried out by dropping a 400-pound weight through a distance of three inches, and also through a distance of twelve inches, and then recording the number of drops required before fracture occurred. In order to make the tests as authentic as possible, each set of screws compared were made from the same bar.

In the accompanying diagram, Fig. 1, are shown the results of the three-inch drop tests. The graduations on the base line show the number of blows given to the specimen before fracture occurred. On the scale to the left is given the ultimate tensile stress of the material from which the screws were made, in tons per square inch. It is interesting to note that the strength of the U. S. thread more nearly approaches the strength of the Whitworth thread when only mild steel is concerned; the higher the ultimate breaking stress, the greater advantage does the Whitworth form show over the U. S. form of thread. In Fig. 2 are shown the results obtained in the twelve-inch drop test. It will be noticed that in this case the difference, as a rule, is smaller, but the Whitworth thread maintains its advantages in strength, although not in so marked a degree as in the shorter drop tests.



Figs. 1 and 2. Shock Tests on Bolts with U. S. and Whitworth Standard Threads.

In the diagrams, the results obtained in the tests of specimens threaded with U. S. standard thread are shown by dotted lines, and the results of the tests of specimens threaded with Whitworth thread, in full lines. The two lines shown for each indicate results of two sets of tests on eight bolts each. The results of the individual tests are shown by the small circles, and these have been connected by the lines merely to show at a glance which circles refer to the same set of experiments.

* * *

The headings of one of the twin tubes under the Hudson River, connecting New York (Hudson Terminal) and Jersey City, were joined January 27, and the event was celebrated by an official inspection trip. The approximate distance between the terminal in Jersey City and the Hudson Terminal at the foot of Cortlandt St., New York City, is 6,000 feet. It is expected that both tubes will be completed and the system in operation about July 1, 1909. The headings of the second tube were joined March 11.

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* From an article by Mr. H. F. Donaldson in *Engineering*, February, 1909.

MACHINE SHOP PRACTICE.*

CYLINDRICAL GRINDING 1.

The grinding machine is one of the most useful tools found in a modern shop, for with this tool it is possible to finish a considerable variety of work in less time than is required when a lathe is used, and, in addition, the quality of finish and degree of precision attained are such as to make the production of interchangeable parts comparatively easy. The grinder is not only a tool for finishing hardened work and work requiring great accuracy, as it is widely used for finishing general machine details which have been previously roughed out in the lathe.

Cylindrical grinding machines, like milling machines, are divided into two general classes, known as plain and universal grinders. The first type is used for grinding work in large quantities, which varies comparatively little in form, which means that it is essentially a machine for manufacturing purposes. The general construction of the universal grinder is similar to that of the plain grinder, but it differs from the latter in having certain special features and auxiliary attachments which adapt it to a more general or universal class of work. Such a machine, as built by the Landis Tool Co., is illustrated in Fig. 1. With this particular type of machine, the platen *A* remains stationary, while the revolving wheel *B* is traversed past the work, which is mounted between the centers of the head- and tail-stock *C* and *D*. The length of the stroke of the wheel carriage is regulated for work of different lengths by varying the position of the dogs *E*, which are mounted on the dog-wheel *F*. On the periphery of this wheel worm-teeth are cut, and the dogs are held in any desired position by worms *G*, which may be lifted out of engagement with the wheel when the dogs are to be moved a considerable distance. The tappet *H* against which these dogs strike, thus reversing the movement of the carriage, can be swung out of the way when it is desired to let the dogs pass, so that the work being ground may be inspected or measured. The amount that the wheel carriage moves longitudinally per revolution of the work is regulated by changing the position of the lever *I*. The lever *J* is used for reversing the carriage at any point, by hand, while the traverse is started or stopped by lever *K*. When it is desired to move the carriage longitudinally by hand, the wheel *L* is used. The platen *A* may be swiveled about a central stud when grinding taper work between the centers, unless the taper be too great, when the lower wheel slide is set to the required angle. There are two sets of graduations on the end *M* of the platen, one giving degrees and the other the taper (by eighths) in inches per foot. It might be mentioned that the graduations on grinding machines are only intended to give an approximate setting, gages and micrometers being used to test the accuracy of both taper and straight work. When slight adjustments of the platen are found necessary, the fine adjusting screw *N* is used. It will be noticed that there are two pulleys *O* and *P* mounted on the head-stock. The first is for driving the head-stock spindle when grinding work held in a chuck (which replaces the pulley *P*) or when driving large work held between the centers; but as it is advantageous to grind most work on dead or stationary centers the loose pulley *P* is provided, which simply revolves upon the head-stock spindle, which is then locked. The object of grinding work while it revolves on stationary centers is to secure accuracy, as then any slight error which may be in the spindle bearings is not reproduced in the work. As it is often necessary to grind the sides of milling cutters, disks, etc., which must be held in the chuck, the head-stock is made to swivel and is provided at *Q* with graduations in degrees. The emery wheel is moved to or from the work by the hand-wheel *R*, which is graduated to indicate reductions of 0.001 inch in the diameter of the work. In conjunction with this hand-wheel there is a feed which is actuated at the end of each stroke and which may be set to advance the wheel at each reversal from 0.000125 to 0.0025 of an inch; the corresponding reductions in the diameter of the work are, of course, equal to twice this amount. This feed is effected by the pawl *A* (Fig. 2) which meshes with ratchet teeth in the periphery of the wheel *R*. Provision is made for automatically disengaging this feed when the wheel has ground any predetermined amount (within 0.00025) from the work. This is accomplished by a removable ring *B*, mounted on the hand-wheel, which has attached to it a knock-out cam *C*, which engages with the pin *D* on the pawl *A*. When setting this feed to grind a given amount, the wheel is first brought into contact with the work, by turning the hand-wheel *R*; the ring *B* is then moved around until the cam *C* is against the pin on the pawl *A*. As the machine makes its first stroke the pawl is disengaged from the ratchet. The wheel should then be allowed to pass over the work until it has practically ceased cutting, when the traverse should be stopped, say at the foot-stock end. The diameter of the work is next measured carefully with a micrometer. The thumb-latch *E* is then pressed against its stop four times for each 0.001 inch reduction in diameter required. As this thumb-latch has attached to it a spring pawl *F* which engages with the ratchet teeth on the wheel *R*, the ring *B*, with its knock-out cam, is moved away from the pawl, each time the latch is pressed an amount equivalent to one ratchet tooth, which means that the emery wheel will be fed in 0.000125 inch farther before the feed is automatically thrown out. Hence the latch is pressed once for each 0.00025 inch reduction in diameter required. After the feed is set to grind the required amount, the cut should be continued until the wheel has practically ceased cutting, when it should be stopped at the foot stock end as before, and the work again measured. If the wheel used is adapted to the work, and the relative speed of wheel and work are at least approximately correct, the reduction in diameter will be equivalent to that for which the feed was previously set, providing the amount of metal removed is not too great, for in that case the work will be large, owing to the wear of the wheel.

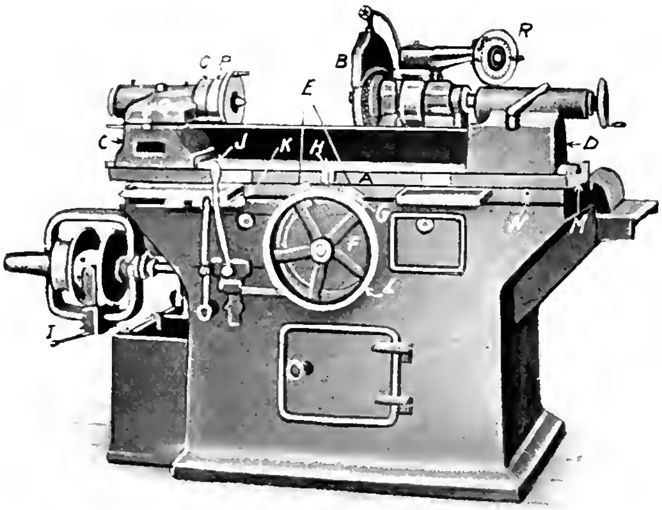

Fig. 1. A Universal Grinding Machine built by the Landis Tool Co.

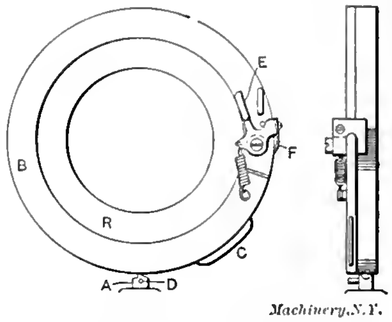

Fig. 2. Mechanism for Setting the Automatic Feed to grind any Predetermined Amount.

If satisfactory work is to be done in the grinder, it is absolutely essential that the grinding wheel be of a grade and grain which is best adapted to the material to be ground. Grinding wheels are composed of a large number of grains or kernels of some suitable abrasive material, such as alundum or corundum, which are held together by what is known as a bond. By varying the amount of this bond, wheels of different grades are obtained. The term grade does not refer to the degree of hardness of the abrasive, but to the

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* With Shop Operation Sheet Supplement.

tenacity with which the bond holds the grit in place, and it is designated by the letters of the alphabet; *A* being extremely soft, *M* medium, etc. The grain or coarseness of a wheel is designated by numbers which indicate the number of meshes to the square-inch through which the kernels of grit will pass. The degree of hardness and the kind of material to be ground are factors which determine the grade and grain of a wheel. For example, machinery steel requires a harder wheel than does hardened tool steel. The reason for this will perhaps be better understood if we think of an emery wheel as a cutter having attached to its periphery an innumerable number of small teeth, for this is literally what the thousands of small grains of abrasive are. When the wheel is of the proper grade, these small teeth or kernels of grit are held in place by the bond until they become slightly dulled, when they are torn out of place by the increased friction. Obviously, these grains or cutters will become dulled sooner when grinding hard than when grinding soft steel; hence the harder the material the softer the wheel, and *vice versa*. When a hard wheel is used for grinding hard material the grit becomes dulled, but it is not dislodged as rapidly as it should be, with the result that the periphery of the wheel is worn smooth or glazed, so that grinding is impossible without excessive wheel pressure. Soft materials, such as brass, however, are ground with a soft wheel, which crumbles easily, thus preventing the wheel from becoming loaded or clogged with metal, as would be the case were a hard-bonded wheel used. When a wheel is used which is too soft, the wear is, of course, greatly increased, as the particles of grit are dislodged too rapidly, and consequently the wheel is always "sharp." This means that the abrasive has not done sufficient work to become even slightly dulled, and the result is a rough surface on the work.

The area of the surface which is in contact with the wheel is also a factor which should be considered when selecting the proper grade. As the contact area increases as the diameter of the work increases, the wheel should be correspondingly softer because the grit is more quickly dulled by this greater contact. The grain or degree of coarseness of the wheel is another item which should be considered in making a selection. Generally speaking, coarse wheels are better adapted to most work, as deeper cuts may be taken, and, in addition, the work is kept cooler because of their porosity. When a very fine finish is required, however, particularly on a number of duplicate pieces, fine wheels are often used to advantage for finishing, after the work has been ground to within, say 0.003 inch of the required size, with a coarse wheel. If little stock is to be removed from a hard surface, however, the coarse wheel could be dispensed with and a fine wheel used to advantage, as the wear of such a wheel is less, though the tendency to burn the work is greater, as the water (a copious supply of which should always be used) does not reach the grinding parts so easily. There is, of course, an advantage in using one wheel for both roughing and finishing, and a coarse wheel, say of 36 grain, will produce a finish fine enough for most purposes, if the work speed is reduced somewhat, and the wheel is trued with the diamond just before taking the finishing cuts.

Proper preparation of the work is another important item in connection with grinding which should be considered. The machine centers should be accurately ground to an angle of 60 degrees, but it is also essential that the centers in the work be true, to the proper angle, and clean when the work is placed in position. Parts which have been hardened (such as the mandrel illustrated in the Shop Operation Sheet accompanying this issue) prior to grinding, are occasionally so distorted by this hardening process that they cannot be finished to the required size. Straightening can then be resorted to, but this should not be done while the work is cold, as there is always a tendency for it to resume the original shape, owing to internal strains, and even if properly heated there is more or less danger of such distortion. When necessary to straighten hardened work it should always be heated, though not enough to anneal it, and then straightened in a press. By proper annealing prior to the hardening process the tendency of the work to spring out of shape is often overcome. This annealing, which releases the internal strains incident to the rolling or forging operations, should take place after the outer surface has been removed in the lathe, then if the work when tested runs practically true it may be machined to the grinding size, which, for a mandrel such as illustrated on the Shop Operation Sheet referred to, would be about 0.010 or 0.012 inch above the finish size. If, however, the test should show that the piece was badly warped, it should be heated to a cherry red, straightened, and then annealed as before.

Whenever possible, grinding should be the last operation performed so that the work will not be marred or sprung out of true. Key-ways in shafts, etc., should invariably be finished prior to grinding, as the removal of metal for the key-way from one side of the shaft will often distort the latter. The machine itself should be carefully examined frequently, as its efficiency often depends upon a little intelligent care. The bearings of the head- and tail-stock spindles, and particularly those of the wheel spindle, should be carefully adjusted to eliminate all lost motion, and the cross-slide for the wheel should also be adjusted and oiled so that there will be that perfect freedom of movement which is necessary if this part, as is often required, is to move as little as one-eighth of one-thousandth of an inch with accuracy.

A continuation of this article will appear in the May issue, which will also be accompanied by a Shop Operation Sheet giving an example of cylindrical grinding.

* * *

THE PUNCH THAT WAS "PINCHED."

C. TUELLS.

Jim was master mechanic at the old novelty shop when it was located just back of Chinatown in the dirtiest section of one of Boston's poorest streets. The novelty shop made most anything that could be made cheaply with sheet brass and punch presses, and many were the ragged youngsters who played under its windows and went through the scrap barrels for souvenirs.

"Running up the street at full speed was a ragged urchin with Jim's punch in his hand."

Although Jim was master mechanic he didn't travel around the shop with a slide rule in his hand, figuring out speeds and timing the presses, and looking for trouble in general. Jim's trouble all came to him, for all the mechanical work of the shop between the toolmaker and the presshands fell at his door; in fact Jim was the general utility man of the press room. If a punch needed grinding, Jim ground it; if a die was to be set, Jim set it; if a countershaft needed adjusting, why send for Jim, of course.

The novelty shop was a small affair, and the tool room was in proportion; one toolmaker did all the work, but when

times were [illegible] he sometimes had to turn up his sub-press pins while the shaper was running a long cut over a die blank in order to keep ahead of the job.

Well, one day Jim was setting up a new die in the punch-press, and, like every other new job, a few little things had to be done before the punchings came out satisfactory, and among these things half an inch had to be sawed off the end of the punch shank, which was, as the Irishman said, "too long on one end." It was only nine-sixteenths inch diameter, so Jim, anxious to get the job going, hustled over to his bench vise, gripped the punch and started his hack-saw going to the tune of "Yankee Doodle," one eye on his work and the other through an open window on a group of ragamuffins playing tag in the street below.

Jim was in a hurry. He thought (as we all thought once) it would be quicker to break the last quarter-inch, so holding the surplus end that he *did not want* in the vise, he hit the punch a much misjudged and mighty blow with his two-pound hammer. It broke—and the punch went sailing through the window into the middle of the street.

Jim looked out the window just in time to be too late, for running up the street at full speed was a ragged urchin with Jim's punch in his hand, and a broad grin on his face. Pursuit was useless, for before Jim could get to the street the boy was out of sight, and most of his comrades as well. The punch never came back. After trying to explain the situation to the boss, the toolmaker, much to his disgust, had to drop everything and put in the rest of the day getting out a new punch.

Jim is wondering to this day whether that punch found its way to the cupola of some iron foundry by way of the "junky," or if it still reposes among that particular youngster's treasures. Jim now holds the end of the punch that he *wants* in the vise before breaking, because—well, "there's a reason."

* * *

POWER OF INSURANCE COMPANIES TO IMPROVE LIVING CONDITIONS.

The power of the casualty insurance companies of the United States is being employed to improve the working conditions in factories and reduce the great number of accidents to life and limb that makes America an industrial slaughter house. A further development of the great work of the insurance companies in this line, of much broader scope, is proposed, which is hoped will improve living conditions and materially increase human longevity. It has been shown by the work of Col. Gorgas in Havana, Cuba, that the improvement in sanitation tremendously decreased the death rate. The death rate in Havana was cut in two, being brought down to about twenty-four deaths per thousand per year. In New York City it was materially decreased by Col. Waring's street cleaning crusade. Of course, it is to the material advantage of the casualty and life insurance companies to reduce the number of accidents in manufacturing establishments and to improve general sanitary conditions throughout the country, and this work of enormous scope, if undertaken, would be undertaken on the basis of good business policy alone. The life companies may aim to stamp out the great scourges, typhoid fever and tuberculosis, both preventable, one being caused almost entirely by infected drinking water and the other by bad housing. The reduction of accidents and increase in length of life would reduce the amount of claims and increase profits, but all true philanthropy has practically the same result. The improvement of living of the poorer classes reacts favorably on general conditions and increases common prosperity.

* * *

A novelty which has come into use in a number of British drafting-rooms is the employment of "cross-section" tracing cloth for detail drawings. The tracing cloth is ruled with vertical and horizontal lines one-eighth of an inch apart, in the same manner as ordinary cross-section sketching paper. It is claimed that the use of this kind of tracing cloth is the source of considerable saving in time, as it is easier to terminate lines at correct points and it makes it possible to draw simple details directly on the tracing cloth.

IMPROVEMENTS IN HIGH-SPEED STEEL.

Recent advances in the manufacture of high-speed steel have enabled the Firth-Sterling Steel Co., of McKeesport, Pa., to obtain results with their "Blue Chip" steel in every-day machine shop work, which are believed by the makers to mark a definite advance in machine shop practice. These improvements have resulted in a steel that is less affected by the heat of the cutting action, and so is capable of increased cutting speed and longer life. For finishing cuts on fine-grained metals, it is hardened in air or in oil, though for roughing work, or cuts in coarse-grained metals in general such as cast iron, it can be quenched in water the same as old-fashioned tool steel. For hardening, it is heated to the extremely high temperature required by all high speed steels.

To bring the advantages of this new product to the attention of manufacturers, Wheelock, Lovejoy & Co., of Boston, Mass., and New York City, agents for the Firth-Sterling Steel Co., have been giving exhibitions of its work in Worcester and Springfield, Mass., and Providence, R. I. The three half-tone engravings shown herewith were made from photographs taken in the plant of the Baush Machine Tool Co., where the Springfield exhibition was held. In Figs. 1 and 2 is shown the "Lo-swing" lathe (built by the Fitchburg Machine Works, Fitchburg, Mass.) engaged in rough turning spindles for a large size of the Baush multiple spindle drill. These spindles are of 45-point carbon steel and have the dimensions shown in the sketch in Fig. 3. The "Lo-swing" lathe, as is well known, is particularly adapted to the rapid turning of bar stock, being arranged to use as many tools for this work as may be required by the number of diameters and shoulders to be turned. In the case shown two chips are taken, the first reducing from 2¾ inches to 1¾ inch, and the second making a further reduction to 1½ inch for a short distance, as shown in Fig. 3. The rear of the lathe, in Fig. 1, shows the work just before the second tool comes into action, while Fig. 2, taken from the front of the machine, shows the conditions at the completion of the cut. The figures given for this cut in 45-point carbon steel are: 165 revolutions per minute, giving a surface speed of about 120 feet per minute; feed, 75 revolutions per inch; length of time required for taking cut, about 4 minutes and 50 seconds. These feeds and speeds on this metal are claimed by the makers of the steel and the builders of the lathe to be obtainable in common, every-day practice. Results much more spectacular than these could be and have been obtained for exhibition work, but they are not considered practicable for recommendation as standard shop practice.

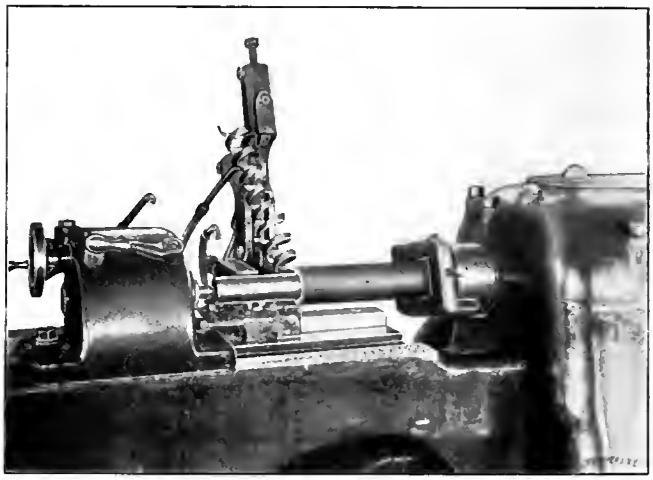


Fig. 1. Taking a Stiff Chip on the "Lo-Swing" Lathe with "Blue Chip" Steel.

The steel makers state that the "Lo-swing" lathe was selected for this test because it is capable of putting a lathe tool to more severe service than any other machine that had been met in their experience in selling tool steels. They, in common with other steel makers, had been previously unable to furnish cutting tools which came up to the possibilities of this machine. The way in which the work and the tool are tied together, and the rigid support for both, make the action one of pure cutting only, so the size of chip taken is

limited purely by the heat resisting qualities of the metal and the strength of the work, instead of by the breaking of the cutting edge from chattering and vibration, as is common in the standard lathe. Of course, cuts comparable with that here described have been taken from heavy forgings on lathes of great size and weight, but the size of the machine employed should be taken into account in making comparisons.

An improvement in a tool steel which increases its capacity of resistance to heat gives it a greater advantage than is indicated by this fact alone. A tool deteriorates, so far as heating is concerned, from the fact that it is unable to carry the heat away fast enough through the blade and shank to prevent the cutting edge from reaching a dangerous temperature. This heat-carrying capacity may be increased by using a blunt cutting edge, which furnishes a larger body of conducting material for the blade. Owing to the heat-resisting qualities of the improved steel, this cutting angle can be greatly reduced, making the action more knife-like. This, in turn, reduces the heat generated per cubic inch of metal removed, since less work is done in shearing the metal, the action being more nearly the ideal one of slicing it off. This advantage of the sharper cutting angle gives the further advantage of less power consumption per cubic inch of metal removed per hour, so that there is a gain in every direction. In the particular lathe shown, also, it should be considered that the design is such as to permit the use of more acute cutting angles with any steel than is ordinarily possible with the standard lathe.

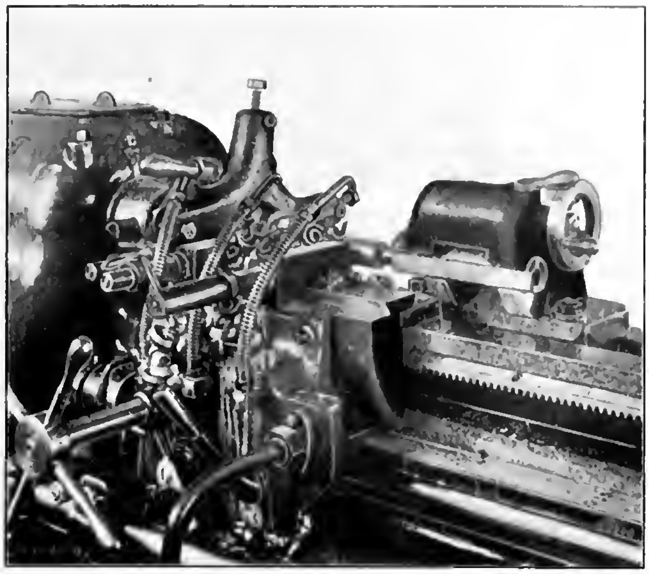


Fig. 2. Front View of Lathe at Conclusion of Cut.

An interesting point as to the use of water or other cooling compounds for turning, was mentioned by Mr. Juthe, who had charge of the exhibition. This relates to the most effective point to apply the cooling liquid. Mr. Fred W. Taylor advises that it be directed on top of the chip, over the top face of the tool. In work of the kind here illustrated, however, it has been found that the important point is to keep the work itself cool. If the tool is cutting in cold metal, its action is satisfactory and the edge is durable. If, however, it is cutting in metal already highly heated, it has been found impossible to cool it properly by directing the stream against the already severed chip. That the plentiful supply of cooling liquid furnished in the machine shown is effectual in cooling the work is evidenced by the fact that it is not found necessary to readjust the tail-center during the course of a high-speed cut in which much heat is generated

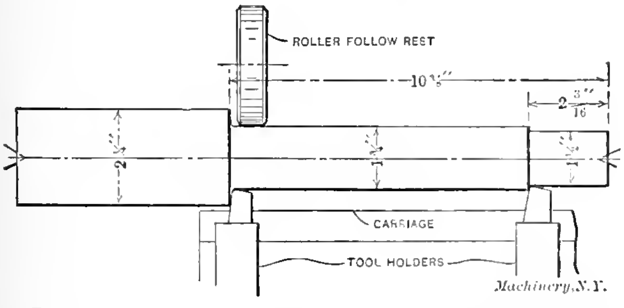


Fig. 3. Dimension of Work and Arrangement of Tools in Fig. 2.

Fig. 4 shows an unusually interesting planer, which was also used at this same exhibition. This planer is built by the Powell Tool Co., of Worcester, Mass., and employs the ingenious principle of an accelerated speed *on the cutting stroke*. So far as we know, this is the first planer built employing this principle. In action, the cutting tool first enters the work at the ordinary cutting speed or slightly less, and, when well started, is accelerated to a much faster rate of travel. At the end, before running out of the metal, it is again slowed down to the medium speed just before reverse. This has the advantage of starting in a heavy cut slowly, without danger of breaking the tool, and still permitting the highest practicable speeds to be taken during the main part of the cutting action. The slowing down before the cut runs out has the advantage of preventing the breaking out at the ends which is otherwise inevitable on heavy cuts. For the occasional work in which the cut is not continuous, but passes over a succession of cuts with intervening clear spaces, the accelerated mechanism may be thrown out by the simple shifting of a lever, permitting the planer to operate in the ordinary way. The increasing of the speed during the cutting action increases the output of the planer very greatly, as compared with the increase obtained by accelerating the return stroke, to which the most attention has been given by designers of planers. The accelerating mechanism is of very simple construction and does not require an extra belt. The design appears to have been worked out in a very simple and effective manner.

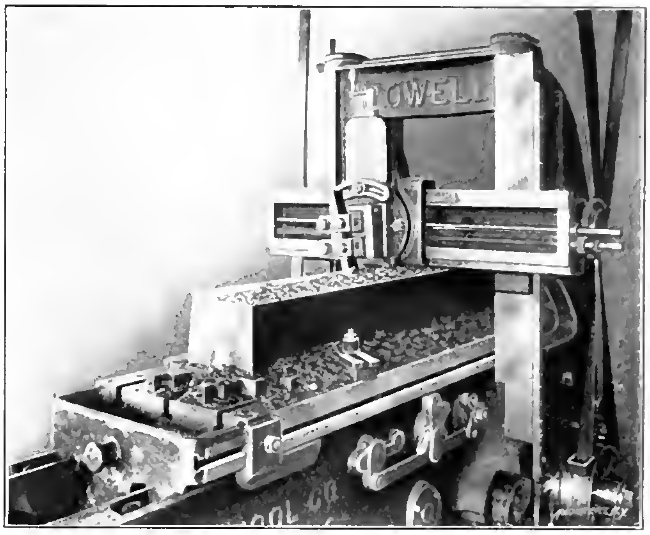


Fig. 4. The Powell Accelerating Cut Planer.

It will be interesting to compare the steel exhibited at this demonstration with the new English water-hardened tool steels, about which so much has been written lately, as soon as the latter reach the American market, and are used sufficiently to get a thorough understanding of their capabilities.

* * *

A large hydro-electric power plant will be erected by the Grand Falls Power Co. on the St. Johns River at Grand Falls, New Brunswick. The contract for the construction work has recently been placed with the Frank B. Gilbreth organization of New York. The plant will generate 100,000 H. P. electric current, which, it is stated, will be furnished to cities in New Brunswick and Maine. The work involves the construction of a number of shafts in rock excavation 130 feet deep, a power chamber 30 x 260 feet and 130 feet deep, and a tail race tunnel 28 feet in diameter and 2,400 feet long, and also a power house 350 x 260 feet. The intake shafts will be nine in number, the diameter of each being 12 feet. The total head developed at this place is 135 feet. Numerous auxiliary structures, sub-stations, and long distance transmission lines will also be erected and the total expenditure is estimated at over $5,000,000.

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

CHART FOR THE COST OR PURCHASING DEPARTMENT.

The accompanying chart is very useful in the drafting-room, cost, or purchasing departments. When ordering stock or checking up to see if enough material is on hand, a glance from the drawing to the chart is all that is needed. The inner circle of figures is for the length in inches of the piece required; while the figures on the outside give the number of linear feet of stock necessary to make 100 pieces.

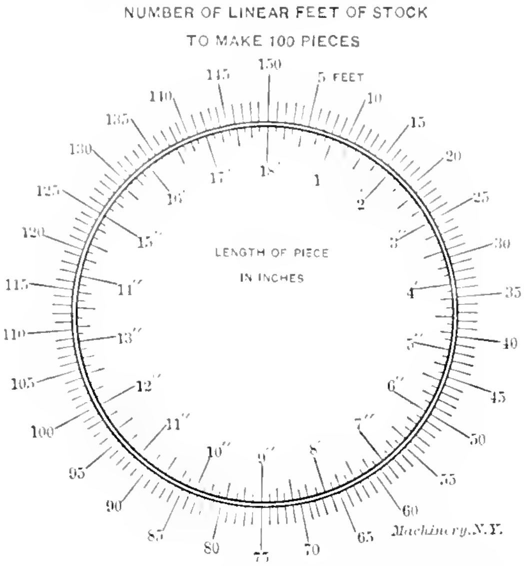


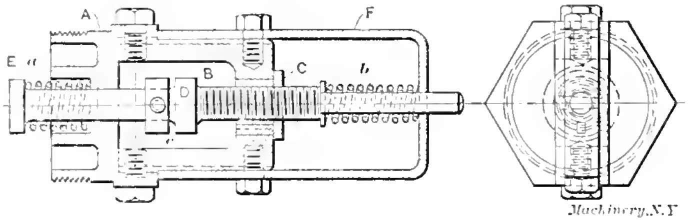
Chart by which the Number of Linear Feet of Stock required for a Number of Pieces of given Length, may be determined.

For example, if the length of a piece as per order, is 2⅞ inches, and there is an allowance for cutting off of ⅛ inch, the total length of the piece would be 3 inches. By locating the figure in the outer circle which is opposite the figure 3 in the inner circle, we find that the required number of feet for making 100 pieces is 25; having this, the amount of stock for any number of pieces may easily be determined.

Rochester, N. Y. RALPH W. DAVIS.

VALVE TIMING GAGE FOR AUTOMOBILE MOTORS.

The valve-timing gage, shown in the engraving, has been in use for some time and has been found very satisfactory. It is far superior to the old method of timing valves, with a screw driver. With this gage the exact opening and closing of the valve, relative to the fly-wheel, can readily be determined. The body *A* is made to fit the valve plug hole in the cylinder head of the motor. *B* is a guide for bushing *C* which is keyed to keep it from turning when spindle *D* is adjusted. Bushing *C* must be a slide fit in guide *B*. Spindle *E* is held in contact with the valve head by spring *a*. *F* acts as a guide for the upper part of spindle *D* and also holds spring *b* in position. The construction of the gage can readily be understood by referring to the engraving.



Gage for Obtaining the Opening and Closing Point, Relative to the Fly-wheel, of the Valves on Automobile Motors.

When the gage is to be applied to an engine it is threaded into the cylinder valve-plug hole, and the spindle *D* is adjusted until a thin piece of paper can freely move between the collar *c* and the spindle *D*. This should be done when valve to be timed is closed. The fly-wheel of the motor is then turned very slowly until the paper is held tight between *c* and *D*; but the bushing *C* should still be seated on the guide *B*. A point is then marked on the fly-wheel for the valve opening. The fly-wheel is again turned slowly in the same direction, while pulling on the paper, until the paper is released; this will indicate the closing of the valve. These points are numbered on the fly-wheel according to the number of the cylinder timed.

St. Louis, Missouri. C. T. SCHAEFER.

A THREE-SPINDLE MILLING ATTACHMENT.

A three-spindle attachment for the milling machine is shown in the accompanying drawing, where Figs. 1 and 2 represent the front and side elevations of the complete device, while Fig. 3 is a sectional view. The device is clamped to the milling machine by fastening the bracket *A* to the overhanging arm. The central or main spindle *B* is driven by the spindle of the machine to which the head is attached, by means of the taper arbor *C* which is fastened to the spindle of the attachment by a locking cap, as shown in Fig. 3. Each of the three spindles has an independent longitudinal adjustment. This adjustment is made by screwing the rear bearing in or out of the housing, as the work may require. The spindles are locked in place by the check-nuts *D*. The small spindles *H* are driven from the main spindle by the gears *E*. Figs. 1 and 2 show part of the supporting bracket cut away in order to expose the worm-wheel and worm which are used for rotating the spindles *H* about the main spindle *B*, by turning the handle *F*. The latter is provided with graduations which read to minutes, for measuring the angular adjustment of the spindles. Figs. 4 and 5 show the attachment set for cutting three T-slots, which, in one case, are close together, and in the other further apart. The rotation of the head is sufficient to obtain a considerable

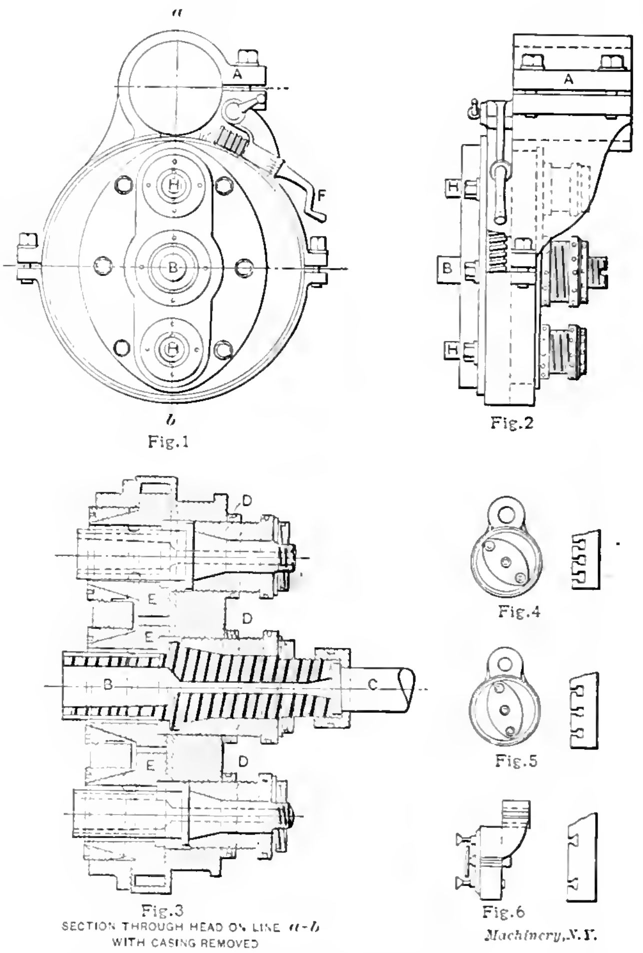


Fig.1

Fig.2

Fig.3
SECTION THROUGH HEAD ON LINE *a-b* WITH CASING REMOVED

Fig.4

Fig.5

Fig.6

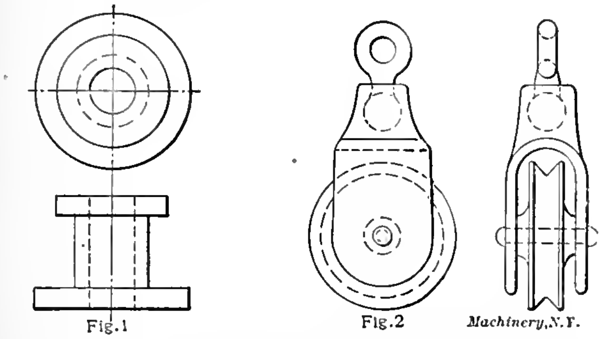
An Attachment with Spindles having an Angular Adjustment for Varying the Distance between T-slots, etc.

variation in the distance between slots. Fig. 6 shows the device as equipped for cutting dovetails, finishing the several surfaces at one cut. Various forms of dovetails, T-slots, grooves, etc., can be worked out in similar fashion. Obviously, the same cutters may be used in many cases for milling parts which are to fit together, a slight rotation of the head giving the necessary play in the finished piece. The same method can be employed for compensating for wear, or allowing for a reduction in size by grinding. The cutters for these different purposes may, of course, be of various sizes, and the one on the main spindle will differ from those on the outer spindles in that it will be cut to the opposite hand. This attachment will be found to be more useful for factory than jobbing purposes, and where any amount of such work, as illustrated in Figs. 4 to 6, is being done it will be found to greatly reduce the labor cost of production as compared with the old single spindle method.

Washington, D. C. G. ROBERT O'NEAL.

SOLUTION OF THE CASTING PUZZLE.

In MACHINERY for January, there appeared a short article descriptive of a casting puzzle. The engravings accompanying it showed a brake ratchet with a loose bushing, flanged on each side, cast in the center of the pawl. The usual method of making castings of the kind in question, is to first cast the bushing, as shown in Fig. 1, clean it, coat it with graphite, and place it in the mold in which the piece to surround it is to be cast, in the same manner as an ordinary baked sand core would be placed. The coating of graphite prevents the molten metal from adhering to its surface. A little observation shows that castings of this kind are more common than is generally supposed. Pulley blocks of the type shown in Fig. 2 are a fair example of the class of casting referred to. They are commonly used for stretching clothes lines or for similar purposes, and retail at 10 cents each.



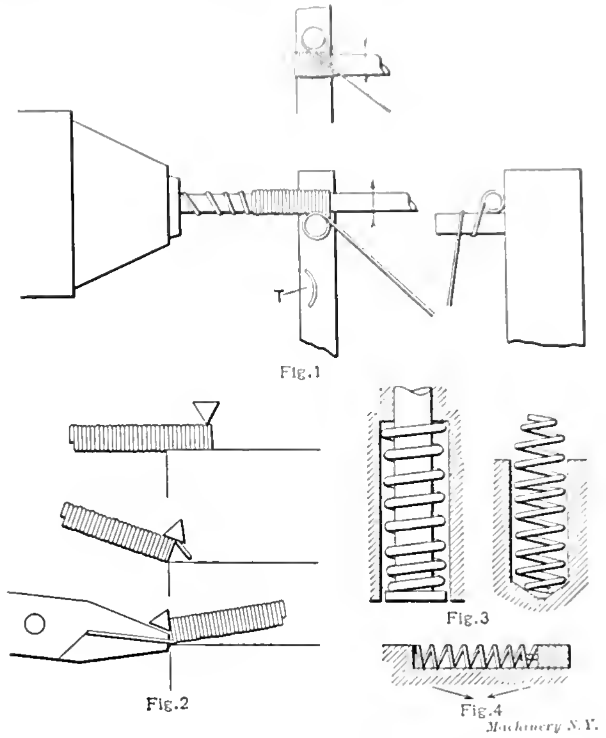
Figs. 1 and 2. Bushing around which Pawl is cast, and Sheave and Block which are cast together.

JAMES CRAN.

Plainfield, N. J.

WINDING SPRINGS.

I have used, for some time past, a tool for winding springs with initial tension which is not only effective, but is much simpler and more convenient than the one described by Mr. Viall in the February issue. With this tool, springs can be wound without any gearing up or bother other than to put a drill chuck in the spindle and clamp a tool in the tool-post. I keep a piece of steel with my lathe tools of the same size as the tools, and use it principally as a rest for the hand tools and polishing sticks, when working out punch and die contours, and for several other purposes. This tool has several holes in it in various positions, some of them tapped and others blank. One of these holes serves to hold a quarter-inch pin that is used when winding springs. Fig. 1 shows this tool in use, and it should be noticed, in particular, that it is set at such a height and in such a position that the spring mandrel is well supported. With this tool, right- or left-hand springs can be coiled and the lathe may be run forward or backward. As before stated, it is not necessary to gear the lathe, but if this were done, the lead should not be a few thousandths more or less than the size of the wire, but theoretically just that size; as it would not come out just right anyway on a long spring. My method is to throw in the nearest carriage feed, set the compound rest parallel to the ways, and with it take up the difference between the wire lead and the feed of the carriage. It makes little difference whether the wire leads off the pin exactly in line with the last coil, a little ahead of it, or three or four coils behind; and if the spindle speed is not too high it is easy to make the necessary adjustment with the compound rest. At *T* is illustrated the set given to the wire in rounding the post, which gives it the initial tension—it is really a spring coiled against itself.



Figs. 1 to 4. Methods of Winding and Fitting Springs.

There are several other things about coiled springs that come to my mind which may be of interest. Eyes for the springs may be formed over the sharp edge of a vise or plate with a three-cornered scraper or file ground smooth. This work, which is done in three stages, as illustrated in Fig. 2, is accomplished quickly, and a very neat and square eye is the result. When a number of springs are to be made alike, I count the coils by drawing the edge of the scraper along the length of the spring, allowing one coil for the eye, and then press the scraper down, as illustrated. By keeping the eye already formed on the end in the proper position, all the springs will come out with a full eye and all eyes will bear the proper relation to one another, all being alike or half-quartered one way and half the other, as desired. When springs are always wrong there is usually a good reason. The spring *A* in Fig. 5 will lie flat and stay on its pins. Spring *B* is adapted to pins in different planes, but if used instead of *A* it will probably be necessary to make another soon for want of the original. Sometimes a spring should act both torsionally and in tension; then one like *C* will answer if given sufficient twist before it is pinned in place. Compression springs are more often used in this way. When fitting a compression spring over a stem and in a hole, close the end that thrusts against the stem until it is a tight fit and is fairly central, and open the end that bears in the hole until it also is a good and a central fit, as indicated in Fig. 3. If the spring is heavy grind the ends about square. When

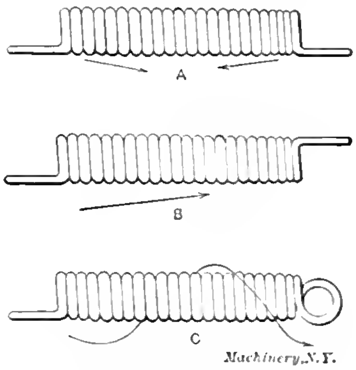


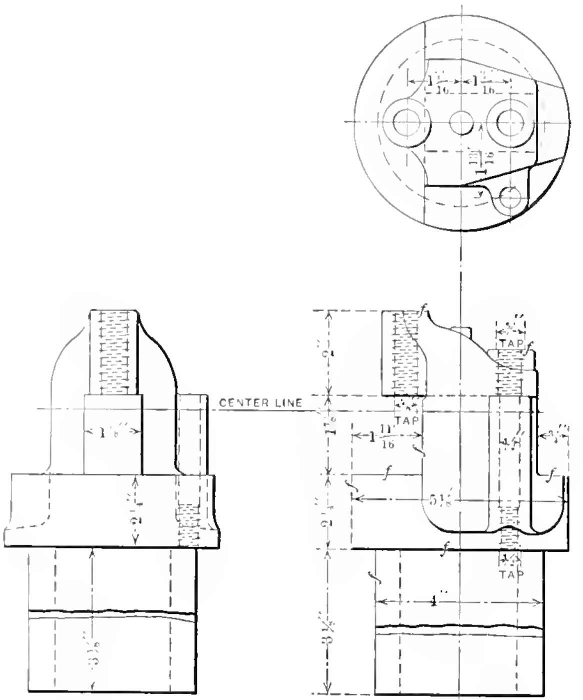
Fig. 5. Springs having Eyes located with Reference to the Retaining Pins.

springs are fitted in this way the stem is not chewed in half, and dust from the holes does not clog other working parts. In fact, the spring is just as good and works as freely at the end of a year as when new. Fig. 4 shows a spring that was used continuously and had to be replaced often and quickly. Many schemes were tried in order to keep it in place and at the same time have it accessible. By cutting the ends so that they both bore on top and placing the spring as shown, the thrust kept it in place and the spring was easily removed and replaced when necessary. When grinding heavy springs to square them, do not quench them when they are red hot, or you may have trouble in getting out those same ends after they have broken and done some damage.

SIRIUS.

ELEVATING TOOL-POST DESIGN.

In the February number of MACHINERY under the title "Changing Old Lathe to Increase Cutting Value" an article appears which lays particular stress on the so-called "new" design of tool-post. The tool-post, as outlined, almost to the identical dimensions, was first used by us in 1883, under patent rights purchased from Mr. Lipe. We continued its use under the patent, exclusively, until about 1897-8, when the patent expired. Blue-print of our shop drawing No. 23, March 15, 1883, (reproduced herewith) will show that the designs of the two tool-posts are practically identical.



Elevating Tool-post used by the Bullard Machine Tool Co.

S. H. BULLARD, Vice-President

Bridgeport, Conn. Bullard Machine Tool Co.

[The contributor of the article in question did not claim that the design was new, and the title to the illustration, Fig. 2, was unfortunately worded. Its meaning is that the illustration shows the *new* tool-post that was substituted for the old one, and not that it is of new *design*.—EDITOR.]

USE OF BOW-DRILL IN THE MANUFACTURE OF KNIVES.

That a curiosity like the hour glass finds a place in modern manufacturing, as cited in the January issue of MACHINERY, is an instance of how the mechanical world in its ceaseless striving for the improved, will turn to the records of the past and take from them and adapt to present-day use some primitive mechanism long since discarded and forgotten. A parallel case is found in the employment of the prehistoric bow-drill, of the North American Indians, in certain knife factories. Probably few of us ever give a second thought to the initial plate inserted in the handles of our pocket knives. In cutting the recess for these the bow-drill works with a neatness and dispatch that surprises one. More intricate shapes demand a more laborious process, but the simpler ones, such as ovals, round-ended oblongs, and other forms not requiring sharp corners, are mortised out with the bow-drill. The spindle carries in its lower end a chuck in which is held a tool made of two prongs of steel much like a tuning fork but sharpened and pointed so as to fly outward with the centrifugal force generated by the revolution. A metal templet having a hole the size and shape of the recess to be cut, is placed over the wooden handle which is gripped in a special vise *A*. Then the operator, usually a boy, grasps the bow-drill in both hands, gives the bow a couple of vigorous pulls, meanwhile imparting a slight longitudinal swinging motion in the direction of greatest length, and produces almost instantaneously a hole which is the counterpart of that in the templet. The cutters *B* are made from a piece of rectangular stock turned the full length, except that part which fits in the slot of the chuck or socket. After the pivot pin holes *C* have been drilled, the piece is split in two and it is then ready for tempering. Cutting edges are formed on the lower ends by grinding the inside, as shown at *D*. But a small part of this sharp end touches the templet, so that the wear of the templet and cutters is hardly more than would occur between two unbroken hardened surfaces running at the same rate. To cause the points to spread more readily, a spring acting in the same manner as a caliper spring is slipped over the upper ends, as shown at *E*. Except for the purpose mentioned above, the bow-drill is, for the most part, merely a museum curiosity, yet for this mortising of knife handles it holds its own and gives complete satisfaction.

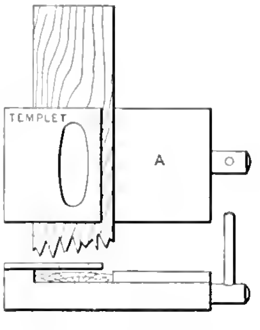


Fig. 1. Vise and Templet with Handle in Position.

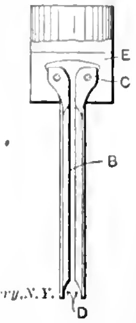
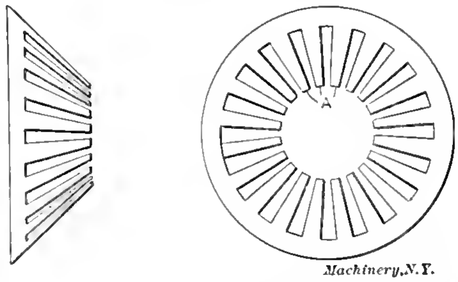


Fig. 2. Centrifugal Cutter which is controlled by the Templet.

Middletown, N. Y. DONALD A. HAMPSON.

TO KEEP AN ANGULAR REAMER FROM CHATTERING.

We have a 45-degree reamer which is used for reaming valve seats in our cut-out valves. This work was formerly done in the lathe, and when the reamer was so used, it did very satisfactory work; but in order to lessen the cost of production the drill press was tried. At first, the reamer chattered so that the drill press had to be abandoned; but this chattering was finally overcome by the use of a leather washer, such as here illustrated, under the reamer. The leather strips *A*, which are a little thicker than the depth of the teeth, are placed between the latter. When making the washer a block of hard wood was fastened to the drill press table with the grain vertical, and an impression made in the wood by running the reamer into the end. A piece of leather of suitable size was then soaked in warm water until it was perfectly pliable. At night, when the shop shut



Leather Washer which fits between the Reamer Teeth and prevents Chattering.

down, the leather was laid over the impression in the wooden block and the reamer forced into it by the hand feed. The leather was left in this position over night, and in the morning it was dry, and formed perfectly to the tool. All that remained to be done was to cut spaces for the reamer teeth.

Geneva, N. Y. Roy B. Deming.

UNIVERSAL CAMERA BRACKET.

In the February, 1908, issue of Machinery, the writer described a simple camera holder to be used when photographing tools or other objects laid on the floor. However, the writer has since then seen another camera bracket which is even better and which combines the features of being universal, rigid, and cheap. It is far superior to the ordinary ball and socket joint universal camera holder, where the camera is liable to fall over in any direction when the thumb nut is loosened.

Fig. 1. Universal Camera Bracket of Simple Design.

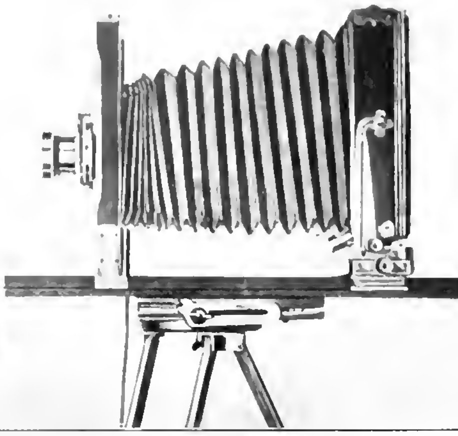


Fig. 2. Camera mounted in Horizontal Position in Bracket.

Fig. 3. Camera mounted in an Inclined Position.

The accompanying illustration, Fig. 1, shows very plainly the general construction of the bracket, and the illustrations, Figs. 2, 3, and 4, show the camera in different positions, mounted on the tripod. The detail dimensions given below are for brackets used with a 5 by 7 inch camera. The top and bottom boards, which are each made of three layers of wood glued together, are 5¼ inches wide, 7½ inches long, and ⅜ inch thick. The top of the tripod, on which the bracket is mounted, is 5 inches in diameter, and the boards were made 5¼ inches wide, in order to make the side clamping pieces clear the top of the tripod. The two boards were made by a trunk maker for 35 cents. The two hinges are common 1¼-inch brass hinges which will cost 5 cents. The two thumb nuts and the thumb screw required may be bought for another nickel. The adjusting slides are cut and filed out of 1/16-inch spring brass, the slot in them being 2¾ inches long, and just wide enough to admit a 3/16-inch bolt. This bolt is made like an ordinary stud bolt, except that it is provided with wood-screw threads on one end. The end provided with standard threads has a screw driver slot cut into it. A brass nut is set into the lower board, 2½ inches from the edge on which the hinges are fastened. The regular tripod thumb screw is screwed into this nut. The thumb screw which fastens down the camera is set into the upper board 3½ inches back from where the tripod thumb screw comes through the lower board. A hole, 1⅝ inch in diameter, is cut into the lower board, for the head of the thumb screw in the upper board, so that two boards may be folded together. The object of placing the thumb screw holding the camera so far back, is to provide means for getting at both thumb screws at the same time, no matter what the position of the camera. A piece of cotton flannel cloth is glued to the top of the upper board to avoid scratching the camera base, and to prevent slipping. The bracket is easily carried fastened to the tripod, and provides the cheapest and most useful camera bracket the writer has ever seen. Ethan Viall.

Fig. 4. Camera held in Vertical Position on Bracket.

Decatur, Ill.

SQUARES ON THE ENDS OF TAPS AND REAMERS.

It is to be regretted, in these days of standardization, that our tap manufacturers cannot all get into line regarding the sizes of the squares on the ends of taps. Owing to the bruised and twisted squares on the ends of taps in a shop I recently worked in I had to help in systematizing the whole matter of squares on the ends of taps and reamers. It was found that the taps as made by the makers did not have the same size squares; they were thus often very loose fits for our tap wrenches, so it was decided to ask six of the best-known tap manufacturers to submit the sizes of squares adopted by them for their taps, and from these details to determine a standard.

Table I shows the different makers' practice, which, as can be seen, varies very much, and as experience has shown that even these sizes are only used approximately, it was decided to adopt the standard as shown by the last column, to use solid tap wrenches with square holes of these standard sizes, and to grind down the squares of all taps in use to a few thousandths below these sizes. By comparing the last column with the other sizes, it will be found that it is now possible to buy taps from any of these six makers with the assurance that the square can be made to suit our standard tap wrenches. All new taps bought must, of course, be carefully examined regarding the squares, and, where necessary, be at once ground down to the standard.

While the above only discusses the question of squares, I should like also to say that there seems to be a difference of opinion among manufacturers as to the amount to leave on the diameter of new taps so as to ensure a reasonably long life and yet, at the same time, make them conform to standardized screw gages. For instance, one maker sends out his ¼-inch taps 0.0025 inch above nominal diameter, while another sends them 0.01 inch above. Why this difference? It cannot all be accounted for by distortion in hardening; it therefore raises the question of what are the practical limits. If 0.0025 inch is sufficient, then 0.01 is too much, and *vice versa*. This point, therefore, should receive some special consideration from tap manufacturers so that one set of limits might be adopted and adhered to by all manufacturers of taps.

TABLE I SIZES OF SQUARES ON TAPS

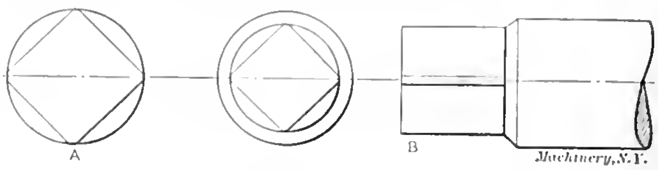
Diameter of Tap.	Maker No. 1.	Maker No. 2	Maker No. 3.	Maker No. 4	Maker No. 5.	Maker No. 6.	Adopted Squares.
1/8"	5/32"	7/64"	1/8"	0.145"	3/16"	5/32"	3/32"
5/32	5/32	9/64	1/8	0.145	3/16	5/32	1/8
3/16	5/32	5/32	1/8	1/8	3/16	5/32	1/8
7/32	5/32	11/64	3/16	11/64	3/16	5/32	5/32
1/4	3/16	3/16	3/16	13/64	3/16	3/16	3/16
5/16	3/16	1/4	7/32	1/4	1/4	13/64	3/16
3/8	7/32	1/4	7/32	7/32	1/4	15/64	7/32
7/16	1/4	9/32	1/4	7/32	1/4	7/32	7/32
1/2	5/16	5/16	1/4	17/64	9/32	5/16	1/4
9/16	11/32	11/32	5/16	5/16	5/16	11/32	5/16
5/8	3/8	13/32	11/32	11/32	3/8	25/64	11/32
3/4	7/16	15/32	7/16	27/64	7/16	15/32	13/32
7/8	9/16	9/16	1/2	1/2	9/16	35/64	1/2
1	5/8	21/32	19/32	9/16	5/8	5/8	9/16

The squares on the shanks of reamers are in the same unstandardized state. Table II gives sizes of squares adopted by two of the most prominent American makers of hand reamers. Each maker has a standard of his own, which is different from his neighbors', and is also different from that adopted by the tap manufacturers, so that it would be required to buy a great many wrenches to cover the requirements unless some such plan of standardization as outlined above is adopted. Of course, adjustable tap wrenches might be used, but solid tap wrenches are preferable if a number of taps and reamers are in daily use, because there are no parts to get out of order; they are, as a rule, lighter and are thus easier to handle, giving the operator more command over the tap or reamer; they are cheaper, and therefore a fuller equipment can be had with the same investment of capital; and a much closer working fit can be maintained between square and square hole, thus obviating the unsightly twisting off of the squares. "MECHANIKOS."

TABLE II. SQUARES OF HAND REAMERS.

Reamer Sizes.	Maker No. 1.	Maker No. 2.	Reamer Sizes.	Maker No. 1.	Maker No. 2.
1/2"	3/8"	3/8"	1 3/16"	11/16"	11/16"
9/16	3/8	3/8	1 1/4	7/8	7/8
5/8	7/16	3/8	1 5/16	15/16	7/8
11/16	15/32	3/8	1 3/8	15/16	7/8
3/4	15/32	9/16	1 7/16	15/16	7/8
13/16	17/32	9/16	1 1/2	15/16	1
7/8	9/16	9/16	1 5/8	1	1
15/16	5/8	9/16	1 3/4	1	1 1/4
1	5/8	11/16	1 7/8	1	1 1/4
1 1/16	11/16	11/16	2	1	1 3/8
1 1/8	[illegible]	11/16	2 1/4	1	1 3/8

[The question of uniformity in the size of squares on taps and reamers is certainly one that ought to receive proper attention. In the case of the squares on taps as indicated by the last column in Table I. it will be seen that when the square is made small enough to be below the size of that used by all the makers of taps, sharp corners are produced when the squares are ground down to this size. Square corners on a tap or reamer square are rather objectionable; not only does it make the tool unpleasant to handle, but the appearance and finish of the tool is greatly impaired. The proper square for any size of shank is to make the size of the square equal to ¾ of the diameter of the shank. This will leave small rounded portions at the corners of the square, as shown at *A*, in the accompanying engraving. In the case of hand reamers, however, the squares should not be milled directly on the shank as is the case with taps, because the shank on hand reamers is of nearly the same diameter as the reamer itself, and is supposed to be able to pass clear through a reamed hole. If the square is milled directly on the full diameter of the shank, burrs will be thrown up by the wrench, and these are liable to mar the reamed hole. The end of the shank of a reamer should therefore always be made as indicated in the engraving at *B*. The shank should be turned down a sufficient amount below its full diameter for the length of the square, and then a square equal to ¾ of the diameter of this turned-down portion should be used. Some makers do not turn down the end of the shank, but simply mill the square small enough so that the edges of the square come below the outside diameter of the shank, but this, of course, produces sharp corners, gives an unsightly appearance to the reamer, and makes it unpleasant to handle.—EDITOR.]



Squares on Taps and Reamers.

HOW MANY GASHES SHOULD A HOB HAVE?

In the article with the above title published in the engineering edition of the January, 1909, issue of MACHINERY, the author, after mentioning the well-known relation between the number of flutes in the hob and the number of threads in the worm, says, "this is one requirement, but there seem to be other factors that enter into the decision as well." He then proceeds to explain the relations existing between the number of teeth in the worm-wheel and the number of threads in the worm.

In a letter in the *American Machinist* for October 11, 1906, the writer uses the following language: "Another point learned in the work of Messrs. Brown & Sharpe, is that a hob will sometimes cut rough teeth if the number of teeth in the wheel is a multiple of the number of threads in the hob, even though the hob is fluted in accordance with what I have pointed out in this letter." I have written in regard to this matter, thinking you might like to call attention to the fact that the principle discovered was known in the Brown & Sharpe Works some little time ago.

The outlines of the wheel teeth can sometimes be cut somewhat more accurately and smoothly by shifting the thread of the hob into different tooth spaces, but I should not care to recommend this scheme as coming from the Brown & Sharpe Mfg. Co. OSCAR J. BEALE.

Providence, R. I.

A BEVEL GEAR PROBLEM.

In cases where a bevel gear drive with a shaft at an angle to the face of the frame, and also at an angle to the vertical center line of the machine, producing what might be called a double diagonal shaft, cannot be avoided, the following formulas and illustrations will be of great value in figuring the actual angle between the shafts, as well as the two angles to which the bearings for the double diagonal shaft must be bored.

Fig. 1 shows three views of the drive, and indicates clearly how it is arranged. Fig. 4 is a front view showing the angle x between the shafts in a vertical plane. Fig. 3 is the development of the plane AB, showing the actual length AB_1 between the apices of the bevel gears, and also the actual distance BB_1, to which the upper apex is offset from the lower, and the actual angle between the center lines of the upper gears.

Fig. 2 is a development of the oblique plan AB_1C on which the gear apices A and B_1 are located, showing the actual

length AB_1 between the apices, and the actual angle z between the center lines of the lower gears, for which these gears must be figured. Fig. 5 is a side view showing the shortest distance CB_1 between the center line of the lower shaft and the upper gear apex.

The angle x, the vertical height BC (Fig. 4), and the horizontal distance BB_1, are considered as given. From these we can easily get angle y.

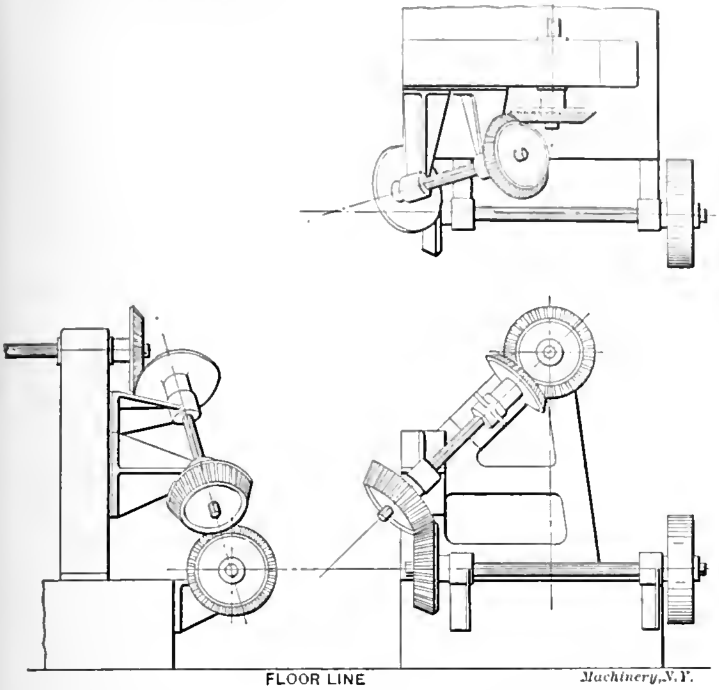


Fig. 1. Arrangement of Bevel Gearing with a "Double" Diagonal Shaft.

The formula for figuring the angle y is deduced as follows: In Fig. 4, let $BC = a$; and angle $= x$; then

$$AC = \frac{a}{\tan x}; \text{ and } AB = \frac{a}{\sin x}.$$

In Fig. 3, $AB = \dfrac{a}{\sin x}$; angle $= y$; then

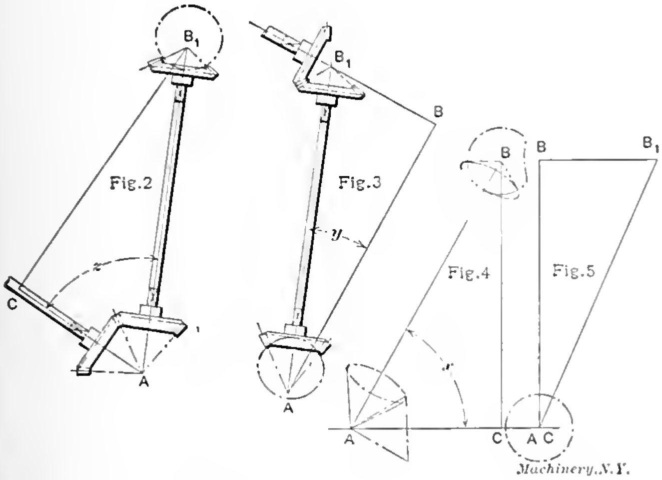


Fig. 2. Diagrams for Solution of Problem shown in Fig. 1.

$$AB_1 = \frac{\dfrac{a}{\sin x}}{\cos y} = \frac{a}{\sin x \cos y}.$$

In Fig. 2, $AC = \dfrac{a}{\tan x}$; $AB_1 = \dfrac{a}{\sin x \cos y}$; angle $= z$; then

$$\cos z = \frac{\dfrac{a}{\tan x}}{\dfrac{a}{\sin x \cos y}} = \frac{a}{\tan x} \times \frac{\sin x \cos y}{a} = \frac{\sin x \cos y}{\tan x};$$

But since $\tan x = \dfrac{\sin x}{\cos x}$

$$\cos z = \frac{\sin x \cos y}{\dfrac{\sin x}{\cos x}} = \cos y \cos x.$$

$$\cos z = \cos y \cos x \qquad (1)$$

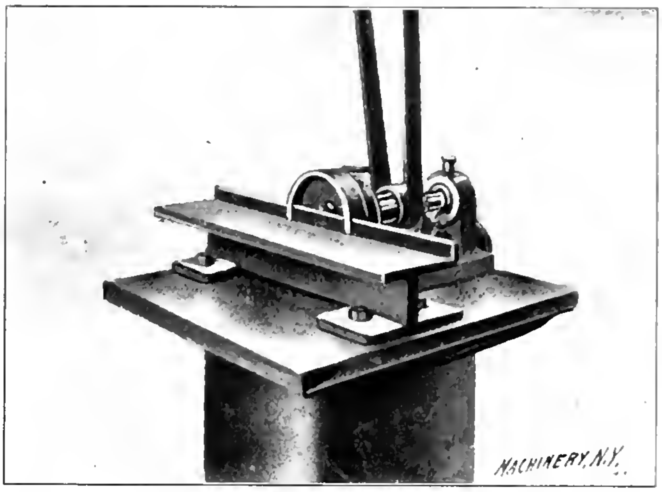
$$\cos x = \frac{\cos z}{\cos y} \qquad (2)$$

$$\cos y = \frac{\cos z}{\cos x}. \qquad (3)$$

Brooklyn, N. Y. EDW. PERSON

SPECIAL GRINDER.

The half-tone engraving below shows a grinder on which work is done much in the same manner as on a buzz planer. A large number of drawn steel strips of various lengths are found to be slightly convex on the sides, the difference being about 0.001 inch in thickness for a width of 5/8 inch. It was required that these strips be of exactly the same thickness for the full length, and for the purpose of making them uniform the grinder illustrated was built. The table is provided with a rib, which is slotted in two places, and the cylindrical part of the cup wheel passes through these slots as shown The table itself is set at a very slight angle to the plane of the face of the wheel, so that only one side of the wheel (that which is running in the downward direction) extends beyond the rib. This side of the wheel projects through the rib about 0.001 inch. By means of this device the operator is enabled to quickly remove the superfluous stock from the steel strips, and to do it accurately.



Special Grinder for Accurate Grinding.

Middletown, N. Y. DONALD A. HAMPSON.

THE EXPERIENCE OF A CUSTOMER.

After reading your editorial entitled "The Experience of Purchasing Agents" I was led to compare the experience of the founding firm mentioned with the treatment handed me by a like firm which, by a queer circumstance, happens to make just such a device as mentioned in the editorial. In my case I was not the seller but an inquiring buyer, with ready cash to pay for what I wanted, out looking for someone to make an article at the best price. The matter I made inquiry about was not of much account, I acknowledge, but it was not the only work I was likely to have to offer such a concern. I went to this company and asked them to cast two sets of parts and to give me an estimate of their charge for finishing a lot of the pieces. The castings were to be ready in two days and at that time I was also to have the figures of their estimate. When the time came I got the castings, for which they charged just seventy-five per cent more than I could get them made for at another place, as I found out later. As for the estimate—well, the official that took my order was out of town and no one else seemed to know about it. "He will be back tomorrow," I was told, so to be decent I went again the next day, but he had not re-

turned I was taken up to see the superintendent whom I found busy with another official painting a box. After waiting about three minutes I was finally approached by the superintendent, but he knew nothing of the estimate. In reply to a query about the cost of castings and how they came to charge so much for the ones they had made, he gave the arguments that one usually hears when a price is questioned. I wanted to laugh when he suggested that when I bought a watch I had to pay for something more than metal at so much per pound. The comparison between making a watch and a simple block of cast iron seemed just a bit bright.

Now what I am writing all this for is to draw attention to the point of view of the purchaser who goes out seeking the best place to spend his money, and what effect the manner in which he is received will have on his decision to leave an order. Surely he will not be likely to waste much time on a firm that does not endeavor to give him good service, and if he goes away with a feeling of disgust he isn't coming back very soon.

If firms have difficulty in selling their wares, and what firm does not, I would like to ask why it is that some neglect to make friends of purchasers who come inquiring about goods.

Somebody will say, perhaps, that the small jobs are not worth bothering with; but everything has been begun in a small way and who can tell what is not going to develop? As in the case previously referred to, the little job might be closely connected with something more important that would be worth getting—at least in these slack times. I have considerable work that I must send out, such as castings and machine work that I can not handle. Will this firm get the work? Hardly, but they would have had it, for they are the handiest for me to go to at present. They also make drill presses and bench lathes that I might need if my present tools gave out or I needed more. How much cheaper it is to make sure of the trade that comes inquiring than that which has to be sought; this seems to me to be a matter for consideration that seldom enters into the business plan of machinery concerns.

How often have I noticed, when going to a factory to inquire about tools or some other product, how patient one has to be to get waited on. Generally one goes into a door and lands up against a rail or a partition with a hole in it, and, after waiting awhile, a small boy asks you how you dare come in, and after you have told him that you only want to spend some money, he goes off and leaves you to sit down to wait. If you do not sit down you are quite likely to get tired of waiting and walk out to some other house. After the salesman finally gets to you he has to make you forget the time and trouble it has been to be able to tell him what your business is.

If the sales agents find that inducing a purchaser to buy something they want to sell is discouraging work, let them get busy and devise some new ways of handling the customer that is trying to spend his money. "A Buyer."

HARDENING TAPS.

Some time ago a certain jobbing shop contracted to produce 100 taps which, as expected, furnished no little trouble in the hardening, before a successful *modus operandi* was worked out. The contract specified a No. 10 tap, 7 inches long, with 4 inches of thread. Threading and fluting was a simple and inexpensive matter, the only extra outlay being for master dies for the screw machine and a special support to keep the taps from springing under the milling cut. Hardening, however presented life-size difficulties. Several of the usual ways were experimented with and discarded. The taps were heated in an open fire, a pot of lead, or a gas furnace, and quenched in oil or water, but the result was always the same—the taps were warped 1/16 inch and worse. A sample submitted to the customer was promptly and emphatically rejected. Then case-hardening was tried, and with an unlooked-for degree of success. The taps were heated in the gas furnace, rolled in a mixture of powdered prussiate of potash and flour, and quenched in water. They came out perfectly true and straight, and the temper was afterward drawn with a blow torch. A subsequent duplicate order (at an advanced price) was an assurance of the satisfaction they gave in service. Just why the taps warped in one case and not in the other, is not apparent, for, with the exception of the case-hardening application, the methods were identical.

Middletown, N. Y. Donald A. Hampson.

DRILL PRESS VISE WITH ADJUSTING JAW PLATES.

I noticed in the February number of Machinery an article on a drill press vise. Mr. A. J. DeLille, in describing the vise, which has several excellent features, devoted the major part of his description to one feature only, viz.: the jaws being under-cut and the jaw plates sliding down when the article to be held is gripped. The work is thus pressed firmly and uniformly down upon the surface of the vise.

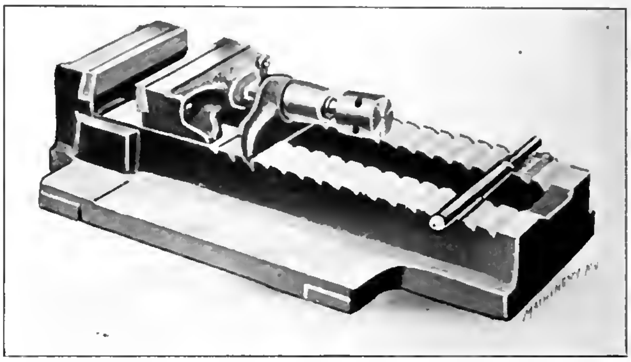
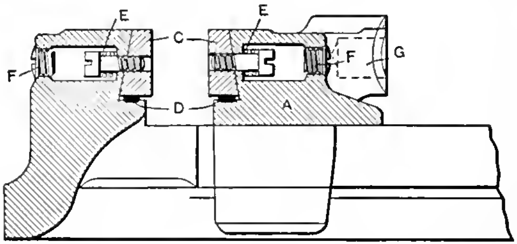


Fig. 1. Taylor's Standard Pattern Machine Vise, with Adjusting Jaw Plates.

It may interest Mr. DeLille to know that I am the inventor and patentee of this vise, and I take this opportunity of expressing my surprise that it has not come into wider use in the United States. I do not see why practically every machine vise should not be made with these sliding jaw plates. My patents expired some years ago, and there are six or seven British firms, in addition to myself, making this type of vise, and on the continent, especially in Germany, it is made by thousands. Yet none of the leading United States makers show it in their list of vises. I have failed to find any adequate reason for this vise not meeting equal popularity in America. Charles Taylor.



Machinery,N.Y.

Fig. 2. Section through Vise, showing Construction of Jaws and Sliding Plates.

Birmingham, England.

[The following description is supplied by Mr. Taylor: Fig. 1 shows the Taylor standard pattern vise, and Fig. 2 is a section of part of the vise showing that the rear faces of the steel jaw plates *C* are inclined, thus causing them, when an article is gripped in the vise, to slide downward for a very short distance, carrying with them the article held, the pin holes in the jaws being slotted to allow of this motion. The jaw plates are held back against the jaw by screws and springs *E*. The jaw plates are raised again, when the article held is released, by simple springs, working in the recesses *D*, shown at the bottom of each plate. The small cap-screws *F* keep water and dirt from entering the pin holes. *G* is a piece of hardened steel fixed in the jaws to receive the pressure of the screw.—Editor.]

* * *

A rival of the Maxim muffler for firearms has been invented by Joseph C. Coulombe, a graduate of Norwich University, Northfield, Vt. The Coulombe invention differs from the Maxim silencer in that it is not an attachment to the end of the barrel, but forms part of the barrel itself.

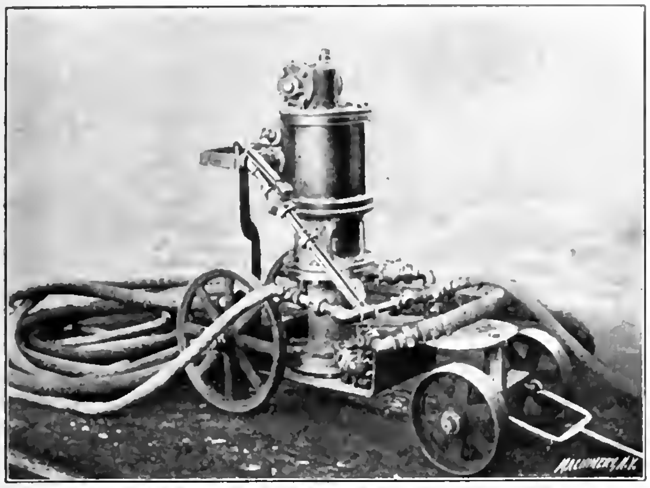
SHOP KINKS.

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

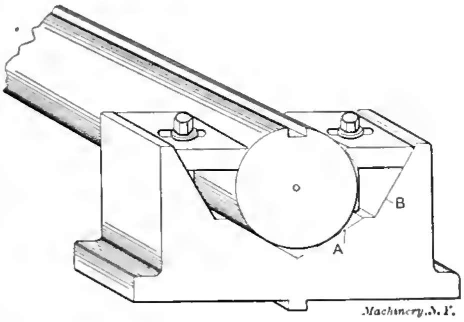
A PORTABLE LOCOMOTIVE BOILER TESTER.

A very convenient apparatus for testing locomotive boilers is in use in the Fort Wayne shops of the Pennsylvania Railroad. The device consists of a powerful water pump operated by air, which is mounted on a truck as shown in the illustration. This machine, together with the necessary hose, is easily moved to wherever it is needed; the air hose is then connected with the regular shop air supply and the water suction hose with the water supply. The discharge end of the water hose is coupled to the inlet valve on the boiler. The pump is then started and the cold water pressure run up to the desired point. After the test is over, the air and water hose are coiled around the pump cylinders and the machine is moved out of the way until it is again wanted. E. V.



ADJUSTABLE V-BLOCK.

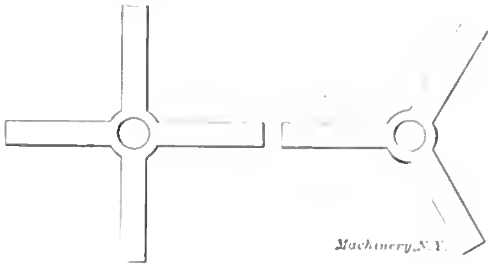
Of the thousand and one appliances such as jigs, etc., that are in use in machine shops, there are but few that are applicable to more than the one purpose for which they were designed. In the shop in which I am employed, there is a pair of V-blocks used for the purpose of holding spindles that are to be splined their entire length and which vary in diameter from 3¾ to 7 inches. It was found quite difficult to hold these spindles in ordinary V-blocks or in a slot of the planer platen with ordinary clamps and bolts. The V-blocks shown herewith not only hold the work securely, but adapt themselves to spindles of different diameters. They are cast hollow to make them light. The angles of the sides *A* and *B* are 30 and 60 degrees, respectively. The clamps are slotted, as shown, to permit adjustment and are tightened against the work by two ¾-inch collar bolts. These blocks, which have a very powerful grip, are also useful for holding large impression rolls when slots to receive a steel blade are being cut in the rolls. They can also be used to advantage on the milling machine when doing work such as here illustrated. C. E. Hale.



Lockport, N. Y.

PARALLELS FOR VERTICAL BORING MILLS.

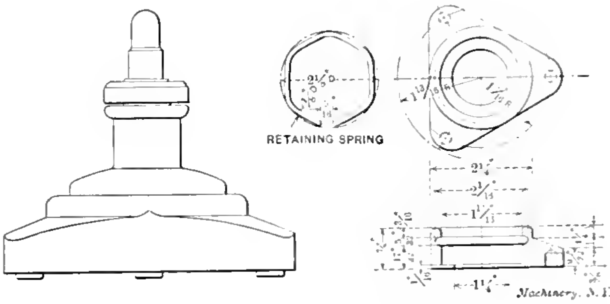
The parallels illustrated herewith, which are for use on the vertical boring mill, are almost invaluable for the chucking of pulleys, gear blanks, or anything that requires to be parallel with the face of the chuck. The parallel with four arms is intended to be used in conjunction with a four-jawed chuck, while the one with the three arms is for a three-jawed chuck. A cored hole should be provided in the center, as shown, which is somewhat larger than the holes being bored, to provide clearance for the boring tool. One of the most valuable features of a parallel of this type, is that it is impossible, when starting up the machine at high speed, for it to fly out and strike the operator. We have all our mills fitted with these parallels to accommodate the different sizes of work, and would dislike very much to have to do without them.



Franklin, Pa. B. M. Weller.

HOLDER FOR THE INK BOTTLE.

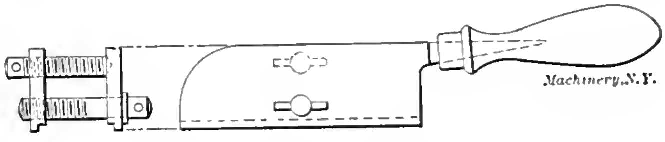
One of the draftsman's troubles is that of keeping the ink bottle right side up, and although there have been many holders for this purpose, the one shown herewith will, I think, be of interest to fellow draftsmen. The bottle is held in place in the holder by a retaining spring which fits in the recess shown in the sectional view. This spring can be made in different shapes, if necessary, so as to receive almost any size or shape of bottle which will pass through the opening. When the spring is made to the dimensions given, it will be the right size when in place for holding a Higgins ink bottle. Common lead pencil rubbers are inserted into the three holes shown in the bottom of the holder for the purpose of preventing it from sliding when it is placed on a very slanting surface. C. S. Blank.



Indianapolis, Ind.

OFFSET FILE HOLDER.

A simple form of offset file holder is shown in the engraving. The two sides are made of ¼-inch soft boiler steel, and between these the file is gripped. The lower screw shown, draws the jaws together, and the upper screw spreads them apart, thus forming a powerful clamp. The file is gripped anywhere along its body, and as the teeth sink into the soft jaws, the handle is prevented from coming loose. This device may be used with more comfort when the handle is set at an angle as shown. L. J. Sparks.



Chester, Pa.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give details and name and address. The latter are for our own convenience and will not be published.

TO OBTAIN THE SIDES OF A RECTANGULAR AREA IN THE SAME RATIO AS THE SIDES OF A GIVEN RECTANGLE.

B. W. C.—1. What is the rule for finding the dimensions of a rectangular area that shall have the same ratio between the sides as a given smaller rectangle? 2. What is the rule for finding the dimensions of a square prism whose sides shall be in the same proportion as a given smaller square prism?

A.—The rule is to divide the area of the required rectangle by the area of the given rectangle, and extract the square root of the quotient. The square root is the factor by which the dimensions of the given rectangle are to be multiplied to yield the dimensions of the required rectangle. For example, having given a rectangle 3 × 4 square feet, what are the dimensions of a rectangle having 192 square feet, with the sides of the same ratio? The area of the given rectangle is 3 × 4 = 12 square feet. 192 feet divided by 12 equals 16. The square root of 16 is 4. Multiplying both dimensions of the given rectangle by 4 yields 12 and 16. 12 × 16 = 192 square feet, the required rectangle. 2. Follow the same procedure for a solid as in the case of a rectangle, except that the cube root of the ratio of the given and required solids is found, and dimensions of the given solid are multiplied by the cube root, the result being the dimensions of the required solid. Example: A tank is 3 × 4 × 5 feet and it is desired to construct another tank containing 480 cubic feet with sides in the same ratio. What are the dimensions? Divide 480 by 60 the cubic contents of the given tank, extract the cube root of the quotient and the root is 2. Then the required tank dimensions will be 6 × 8 × 10 feet.

PROBLEM IN GRADUATING.

J. H.—The illustration shows a measuring tool which has a table in which two plugs *A* and *B* are located. The pin *a* is concentric with the plug *A* which is stationary. The plug *B* is free to turn, and pin *b* is 0.016 inch eccentric with it. The illustration is not drawn to scale in order that the problem may be made as clear as possible. The distance between the centers of the pins *a* and *b* is 11.984 inches, when *b* is in the position shown. I want to graduate the table, as shown at *C*, so as to increase the distance between the pins by thousandths of an inch. That is, so that when point *o* reaches the first graduation, the center of pin *b* will have advanced 0.001 of an inch, and so on up to 0.016 inch, when the center distance will be 12 inches.

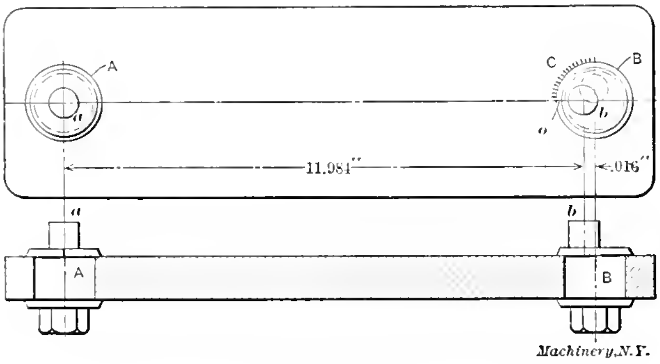


Fig. 1. Tool which is to be Graduated as shown at C, so that the Distance between the Pins a and b may be varied by Thousandths.

A.—A graphic solution to the problem, which answers all practical requirements, is comparatively simple. It is unnecessary to take into account the slight increase due to the angularity, as the eccentric pin *b* is rotated toward the right-angle position, as the difference, because of the angularity, between the distance from the stationary to the eccentric pin when the latter is in the right-angle position, and the distance between these pins when they are in the same horizontal line, is only 0.00001 inch. That is to say, if the distance between the pins in the same horizontal line is 12 inches, the distance between them when the eccentric pin is removed 0.016 inch at right angles, as shown by the dotted lines, will only be 12.00001. Hence, this effect may be ignored entirely, and we may proceed as though the eccentric pin remained in the same horizontal line as the stationary pin and simply receded from it in a straight line as the movable bushing *B* is turned. To locate the graduating marks graphically, draw a quadrant as shown in Fig. 2, with a radius of, say 4 inches, the center being on the horizontal line *A*—*B*. Divide the radius into 16 equal divisions. Each one of these divisions will correspond to a movement of 0.001 of an inch in the ratio of 250 to 1. Then, from each of these division points erect perpendiculars cutting the circumference of the quadrant at 1, 2, 3, 4, 5, etc., and from the points of intersection draw radial lines to the center *C*. These lines subtend the angles to which the graduating marks on the table should be laid out. These angles can also be obtained directly without the trouble of laying out, by referring to a table of sines and cosines, or better to a table of versed-sines. A versed-sine of an angle is the difference between the cosine and 1. Inasmuch as all tables of natural trigonometrical functions are for a radius of 1 and the eccentric bushing is to move on a radius of 0.016, it will be necessary to multiply the respective departures of 0.001, 0.002, 0.003 inch, etc., by 62.5 (which is obtained by dividing 1 by the radius 0.016) to make them agree with the versed-sines given in the table. Thus we find that the first departure from the circumference, indicated as 1 in the accompanying diagram, Fig. 2, multiplied by 62.5 equals 0.0625 which is the versed-sine of 20 degrees and 22 minutes, and 0.002 multiplied by 62.5 equals 0.1250, the versed-sine of 28 degrees, 58 minutes. In the same way we find the versed-sines for the sixteen angles as follows:

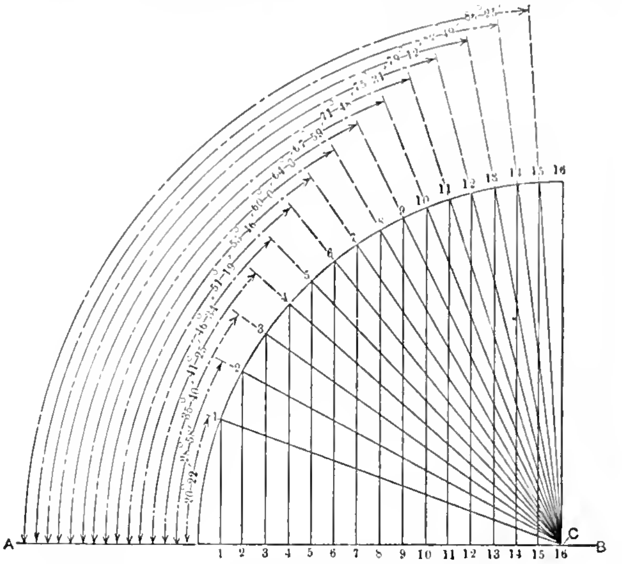


Fig. 2. Graphical Method of obtaining the Angular Positions of the Graduation Marks.

.0625 = 20 degrees, 22′
.1250 = 28 degrees, 58′
.1875 = 35 degrees, 40′
.2500 = 41 degrees, 25′
.3125 = 46 degrees, 34′
.3750 = 51 degrees, 19′
.4375 = 55 degrees, 46′
.5000 = 60 degrees, 0′
.5625 = 64 degrees, 3′
.6250 = 67 degrees, 59′
.6875 = 71 degrees, 48′
.7500 = 75 degrees, 31′
.8125 = 79 degrees, 12′
.8750 = 82 degrees, 49′
.9375 = 86 degrees, 25′
1.0000 = 90 degrees, 0′

Most handbooks do not include tables of versed-sines, and if a table is not available, first subtract the result obtained by multiplying 0.001 by 62.5 from 1, the result being 0.9375, which is the cosine of 20 degrees and 22 minutes. Proceed in the same way for all the others, first multiplying the departure by 62.5 and substracting the result from 1 to get the natural cosine of the angle.

* * *

The operating cost of the Brooklyn Bridge is found to be as high as $360,000 a year, according to an investigation made by the Comptroller of New York City. This figure is the average of ten years' maintenance and operating costs, beginning with 1898. In 1907 the cost slightly exceeded $400,000. The city's revenue from the bridge has exceeded $400,000 per year during the same period, and has always been larger than the cost until 1907, when there was a deficit of $3,250.

New York, April 1, 1909.

Dear Sir:-

Not long ago a well known firm of machine tool builders, of whom we made some enquiries regarding their apprenticeship system, wrote us that they had discontinued employing apprentices, and now employ, instead, laboring men twenty to thirty-five years of age, under a three year contract which calls for continuous service on one line of work.* These manufacturers do not lack public spirit by any means; they were forced into this common practice† by competition, as many other concerns are; but it is time for us all to consider the effect on our mechanical future of the almost total lack of opportunity to learn machine shop practice in our works. Unless such conditions materially change, we are not likely to be the leading mechanical nation in the world twenty-five years from now.

As you know, thousands of our mechanics, young and old, lack sufficient elementary education to read a mechanical journal intelligently or profitably; and for them such papers do not exist. They should be educated to a point where the mechanical journal begins; yet the general tendency of shop work is to deprive them of whatever ambition to acquire an education they may possess.

We acknowledge that the tastes and inclinations of perhaps three-quarters of the young men in our shops are away from, rather than towards, educational work; but let us consider the remaining fourth, among whom must be found the designers, superintendents and mechanics of the next generation. This aspect of the proposition should appeal to everyone connected with the manufacture of machinery; and we need not point out the results of even a modicum of education--the awakening of a man's ambition, the quickening of interest in his work, the increased chance of an appeal to his reason on questions between employer and employee.

MACHINERY began fifteen years ago as a shop paper--an educator-- but the character of its reading matter gradually and necessarily improved as its readers advanced in age and knowledge. For eight years we have kept a careful record of their occupations, and a majority now occupy positions of responsibility. There is now no publication which contains matter of sufficiently elementary

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*The text of the letter referred to will be found in an editorial, "The Apprenticeship Problem" on page 609 Engineering Edition.
†Common with the exception of the three-year contract provision.

character to supply the educational requirements of the shop man. The naked truth is that such a publication would not pay, because shop men are not buyers to any extent; advertisers therefore do not care to reach them, and it is the advertiser and not the reader from whom three-fourths of the income is derived.

Considerations for the future have appealed to a number of public spirited manufacturers, and have added impetus to the movement for training apprentices; but in thousands of shops it is impracticable to institute such a system, and out of the 600,000 workmen of all kinds in the machinery industry a small fraction only is systematically reached through that or any other educational method.

To supply this need--this great need--and not primarily as a money-making proposition, MACHINERY began in January, 1908, a system of self-education in mathematics and mechanics, planned to cover the entire field of mechanical practice, which should be available by every mechanic without regard to his means, and which he could pursue in connection with his work. The development of this system has been gradual and the cost considerable; but the results have been satisfactory and the future of the work looks bright, although we are only at THE BEGINNING. During 1908 we invested in this undertaking about $16,000, a portion of which has come back; and in 1909 we plan to expend about $24,000. We regard this work as of such far-reaching importance that we are quite willing to invest therein the major part of MACHINERY'S earnings for some years to come--say a hundred thousand dollars--and we believe this investment will prove a profitable one, both for the machinery industry and for ourselves.

But of equal importance with the educational work, and fully as necessary to results, is the cultivation of sentiment in its favor among manufacturers; and for that reason we are sending you this letter. If your position is one of authority, you can help us materially by encouraging the men in your employ to study systematically, and by rewarding them for improvement; if it is a subordinate one, you can help the movement by your influence and by a good word whenever you have an opportunity to speak it.

Will you do this?

Very truly yours,

THE INDUSTRIAL PRESS.

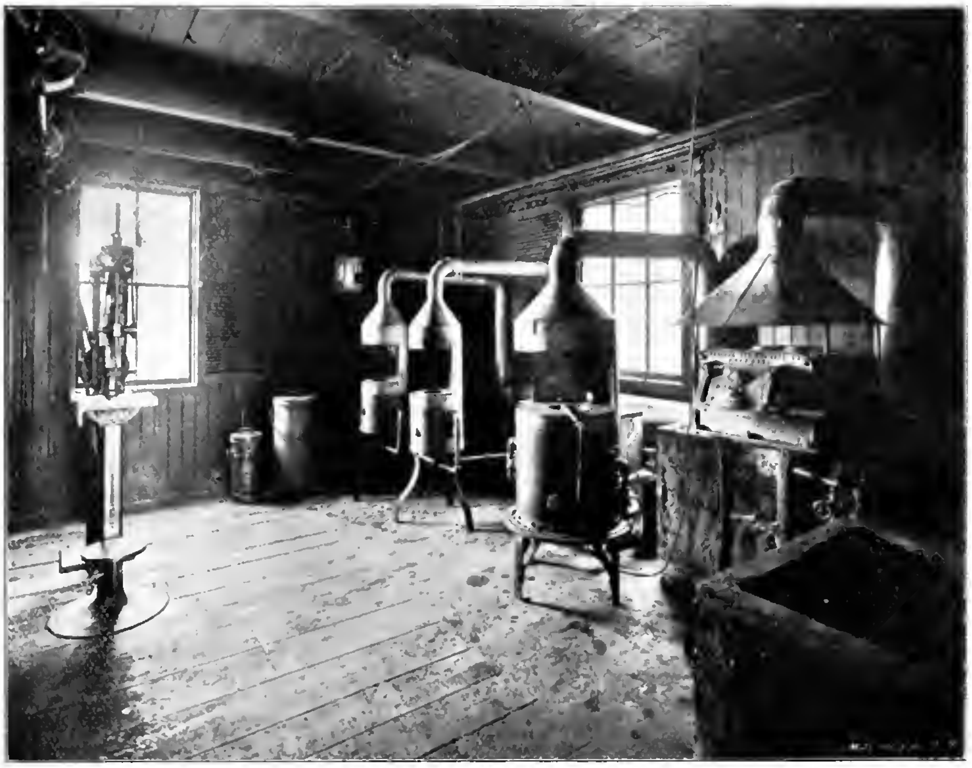
Alex Luchars

L/H

President.

THE HEAT TREATMENT OF STEEL.

From time immemorial when iron in its most crude form was introduced into the manufacturing and commercial field, it has been a well-known and accepted fact that heat with its varying degrees of intensity has a direct action on both the physical and chemical properties of the metal when the iron is submitted to its action; and, as a direct result, the entire structure of the iron is altered, and by altering or changing the method of application of the heat treatment, any desired structure of the metal, either steel or cast iron, may be obtained. In spite of the fact that the truth of the above exposition was generally acknowledged, very little, if any, use was made of it; but as science developed, competition grew keener and keener, and the general cry in the manufacturing world became "reduced cost and greater output." To balance the effect of increased power and consequently larger machines, the working strength of the cutting tool, together with the working stress of the machine members, had to be greatly increased, and, during the past decade, the heat treatment has done more than its share in the work of accomplishing the desired results. Therefore, the Worcester Polytechnic Institute, following its old and well-established custom of being the pioneer in all branches of scientific investigation, has, during the past year, through its department of Mechanical Engineering, designed, constructed and equipped a modern plant devoted exclusively to the heat treatment of steel; the more important operations to be performed are hardening, annealing, tempering and case-hardening. From the very general description given in the following paragraphs of the equipment and facilities of this plant, it will be easily seen that all grades of steel from the 15 point carbon steel to the high-speed, alloy, air- and water-hardening steel may be conveniently and efficiently handled and treated.



Plant for the Heat Treatment of Steel, in the Worcester Polytechnic Institute.

The plant consists of a room of spacious size, in the design of which the comfort of the operator was well provided for. The temperature and ventilation of the room is controlled both by a fan and large windows which admit subdued natural light but exclude the direct sunlight, which is so undesirable in this kind of work. These windows are provided with shutters so that the natural light may be excluded; artificial illumination is obtained by means of incandescent electric bulbs. The room appears to a visitor, at first, somewhat like a dungeon, as the walls and ceiling are painted a "dead black," which color prevents any reflection of the various colored rays when the operator is experimenting on "color work." After this first impression has left the visitor and he has become accustomed to the light, the next thing that catches his eye is the row of various shaped furnaces placed symmetrically on the right side of the room. For convenience and simplicity, we will designate these furnaces (from right to left in the engraving) by the letters *A*, *B*, *C* and *D*. Furnace *A* (constructed by the American Gas Furnace Co.) is built on the principle of the muffle furnace, is of the box type, and will readily heat a block of steel 8 x 4 x 14 inches. A temperature of from 2,000 to 2,100 degrees F may readily be obtained by means of this heater, which is used to heat such work as requires an even heat and which would be destroyed by oxidation and the decarbonizing action of the air; reamers, mandrels, taps and drills in their finished state are good examples of this type of work. Furnace *B*, known as the "barium chloride heater," is circular in form and lined with fire-brick, and the chloride solution is heated in a crucible built of fire-resisting material. This furnace is of sufficient size to accommodate all ordinary tools and is employed to heat such grades of steel as require a rather high temperature, as high speed steels, and which, at the same time, must be well protected in heating. This form of heat treatment is well adapted to those types and forms of tools which tend to heat unevenly, thus producing an unbalanced distribution of the shrinkage strains with the accompanying cracks. Furnace *C* is of the same general design as furnace *B*, with the exception that this heater is made use of in connection with the lead bath. As the lead melts at a comparatively low temperature, this furnace is used when a lower temperature than that obtained with the chloride solution is desired; for example, when heating carbon alloy steel. Furnace *D* is devoted to an entirely different operation, namely, oil tempering. Either linseed or machine oil is used in this heater, which is brought into action when the desired range of temperature is between the limits of 300 and 630 degrees F. The fuel used in all of these furnaces is the ordinary city gas, due to its convenience and ready accessibility, but oil fuel could be employed if so desired by the operator. As will be seen from the engraving, all the furnaces are provided with hoods of convenient form connected with an exhaust line, so that all poisonous fumes and gases such as lead, cyanide, barium chloride, etc., may be eliminated from the atmosphere of the room. At various and convenient positions about the plant are to be found rectangular tanks of convenient size, containing water and brine of varying densities. All the other baths, as for example, the various grades of oil and other cooling baths, are kept in covered cylindrical galvanized iron tanks. In order to properly care for and treat the air-hardening steels, an air jet is provided with a pressure of about 2 pounds.

The one feature which removes this plant from the class of the ordinary manufacturing establishment and places it in the ranks of those of scientific research and investigation, is its complete set of measuring instruments, including the Bristol and Le Chatelier pyrometers and thermometers covering a range of temperature between the limits of 0 and 2,960 degrees F. On one of the walls of the room is to be found the Bristol pyrometer, which is of the thermo-electric type, and consists of a permanent magnet moving coil type of galvanometer. The scale is graduated to read direct in degrees. Leads from the instrument extend over the entire room, so that it is a matter of a few seconds only to connect with the thermo-couple and obtain any desired temperature. If any question as to the accuracy of the instrument, or the action

of gravity on its oscillating parts is advanced, a Le Chatelier pyrometer, operating on the same principle but having a vertical support, may be brought into action and the first readings verified

In order to facilitate the preparation of test specimens and other work, a Washburn drill and also a grinder are provided and placed on the opposite side of the room. The work in this new plant is not confined to experimental work alone, because the range of equipment provides all the requisites necessary for performing outside commercial work for those who have not the facilities to properly treat their own tools. This heat treatment room offers excellent opportunities for those taking the mechanical engineering course to become thoroughly conversant with the most approved and up-to-date methods of heat treating steel, and with this in mind, the attention of the student is frequently called to both the scientific and also the economic features of this work, which, during the senior year, has its position in the curriculum of the school.

* * *

IMPROVED METHOD OF CUTTING SCREWS.

An interesting method for the manufacture of power, lead- and feed-screws of all dimensions has been developed by the Screw Cutting Co. of America, 150 Berkley St., Wayne Junction, Philadelphia, Pa. The principle of the method employed by this company for cutting screws is conducive to a high degree of accuracy, and makes it possible to absolutely duplicate the lead-screw used in cutting the thread. The method is, briefly, as follows: A hollow lead-screw is employed, on one end of which a chuck is mounted; this chuck clamps the blank stock on which the thread is to be cut, the stock passing through the hole in the lead-screw; thus the lead-screw, the chuck, and the work on which the thread is to be cut, revolve together. The lead-screw passes through a stationary nut and thus feeds forward when revolving. The thread is cut by a milling cutter mounted in a stationary head provided with an arrangement permitting the cutter to be swiveled to the angle of the thread. The fact that the cutter head is stationary and that the work is attached directly to the lead-screw, makes it possible to exactly duplicate the thread on the lead-screw, there being practically no chance for lost motion of any kind. The lead-screw being comparatively short can be made with great accuracy, but its length in no way limits the length of the thread to be cut, as an arrangement is provided by means of which the lead-screw with its carriage can be returned to its original starting position at regular intervals. The blank stock is guided in bushings so as to run concentric, and the overhanging portions outside of the machine are supported by roller bushings, thus preventing any bending or springing action due to the weight of the over-hanging part. By the employment of the means referred to, it is possible to cut screws of any length for which blanks can be provided. The accompanying illustrations show some interesting examples of work carried out on the machines of the company. One interesting job lately completed was a 5/16-inch diameter screw threaded for a length of 18 feet, and on the same machine threads down to 1/16 inch in diameter have been cut. The highest capacity of the present machines is 12 inches diameter.

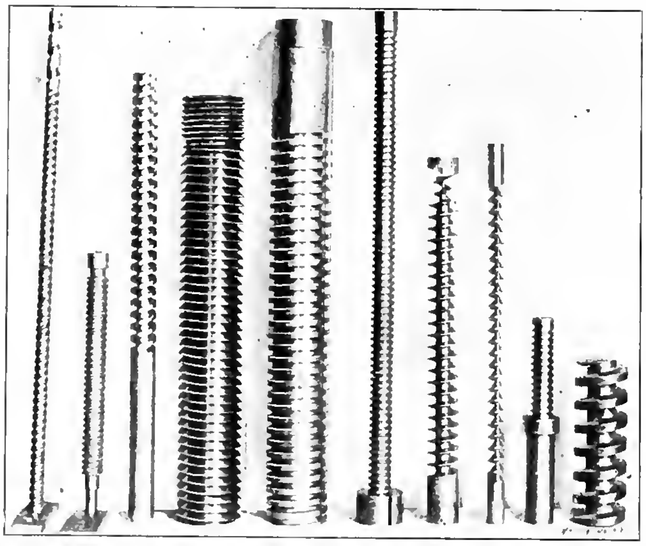


Fig 1. Examples of Screws cut by the Method Developed by the Screw Cutting Co. of America.

The upper view in Fig. 2 shows an interesting test applied to some of the screws cut by this method, indicating the truth of the lead of the screw. One-half of the screw is milled away in each of the two parts shown, and the two halves are put together as indicated, the thread of the one half matching exactly the thread of the other half. The supreme test of the truth of the lead is that the halves may be reversed, end for end, and put together, and still the same relation remains. If the lead were not correct, or if the shape of the thread were not uniform or the screw not exactly straight, it would not be possible to show so satisfactory a result when testing the screws in this manner. As the manufacture of accurate screws is one of the most difficult problems known, this method of producing screws is extremely interesting, and the production of screws with unlimited length of thread is a new departure in screw manufacture which undoubtedly will interest many mechanics.

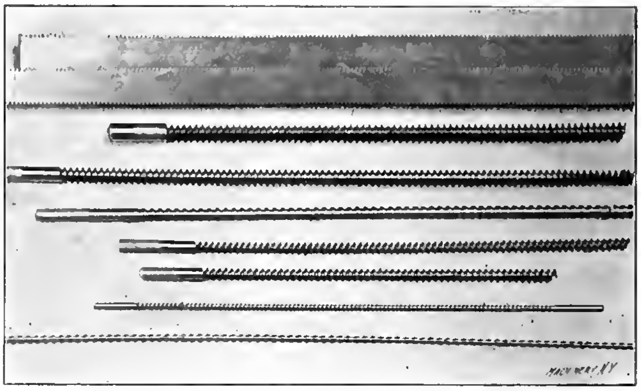


Fig. 2. Method of Testing Accuracy of Pitch of Thread, and Examples of Threaded Work of Small Diameter.

The Screw Cutting Company of America devotes itself exclusively to the making of screws, but the machines on which the screws are manufactured are not made for the market. The company is at the present time building a larger factory in order to meet the increased demands for its product. The heavier machines will be placed on the concrete ground floor so as to eliminate vibrations that tend to impair the character of the product.

* * *

PROFIT IN TECHNICAL BOOK-MAKING.

Fiction is far from being the only big money making department of book publishing. Indeed, it is perhaps the most risky, because its public is the most fickle. On the other hand, no public is so faithful as that of technical publications, like law books and mechanical handbooks. More than one firm that very few people outside of technical circles ever heard of clears more than $1,000,000 profit every year out of just such publications, and most of the profit in each case goes into the pocket of one man. Take a volume like Kent's "Mechanical Engineer's Pocket Book," largely composed of tables and data. It was first published in 1895 and has been revised from time to time so as to keep it up to date. It has now sold a total of 60,000 copies, though it is an expensive book. Its author has made $5,000 yearly from its sale ever since it was published. Still another similar publication constitutes a family estate. This is Trautwine's "Civil Engineers' Pocket Book." It was written in 1882 by John C. Trautwine; its first revision was made by John C. Trautwine, Jr., and its third revision by John C. Trautwine, 3rd. It is strictly a family affair. It is a $5 book and its total issue to date is 94,000 copies. From its sale the Trautwine family has been in continuous receipt of an income of something like $6,500 yearly. Yet it is probable that not one person in a thousand who reads these words ever heard of the Trautwines.—*New York Sun.*

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

HOEFER MFG. CO.'S VALVE INSERTING MACHINE.

Machines for making pipe connections with water mains under pressure have been in use for a great many years and it would be difficult to get along without them. They are a part of the equipment of every water works plant and of every large manufacturing establishment. Their use permits making extensions to the piping system without the annoyance and danger involved in shutting off the main on which the work is to be done. But while this operation is common enough, so far as we know no one has up to this time attempted to insert a stop valve in a main without reducing the pressure or interfering with the flow. This feat is now easily performed by the aid of the ingenious valve inserting machine, shown herewith, made by the Hoefer Mfg. Co., of Freeport, Ill. This device was suggested by a water works superintendent, who felt the need of replacing old and worn out valves in his water system and of inserting new ones as well. The device is simple and ingenious, and its action will be readily understood from the following description and illustrations.

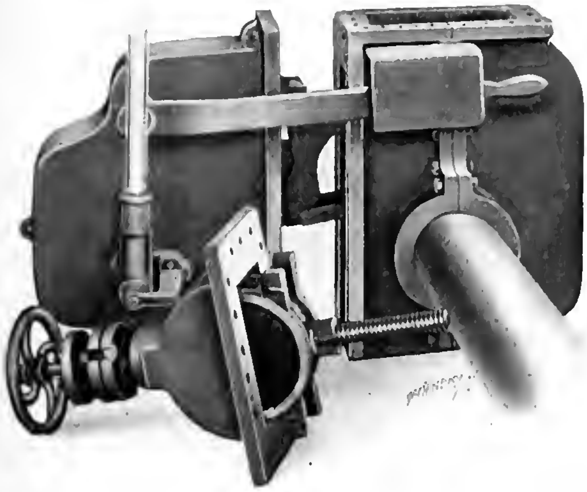


Fig. 1. A Device for Inserting a Stop Valve in a Pipe under Pressure.

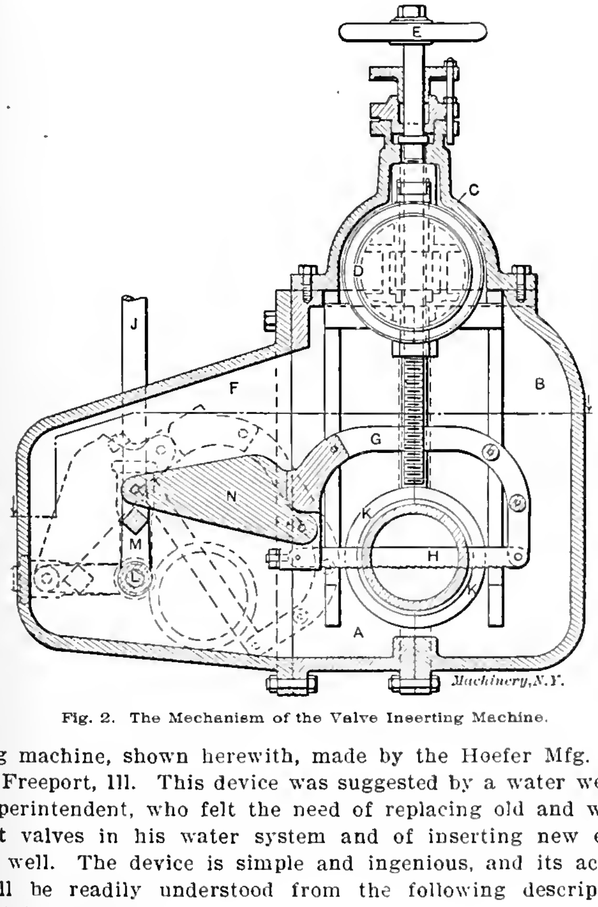


Fig. 2. The Mechanism of the Valve Inserting Machine.

Description of the Machine.

Figs. 1 and 2 show external and sectional views respectively. The casing of the machine is made in two halves, *A* and *B*, which are clamped around the pipe and permanently secured there. The joint between the two halves is made fluid tight by means of the bolts and faced joints shown. The semi-cylindrical flanges which embrace the pipe are calked against the pressure by the usual lead joint. To the rectangular opening at the top of the casing is clamped the valve dome *C*, which contains a valve stem and valve of the double expansion seat, gate variety, made by the Ludlow Valve Co., Troy, N. Y. The two circular valve plates *D* are forced against corresponding faced seats in the valve casing surrounding the pipe.

The pipe cutting mechanism is carried by casing *F*, which is clamped to the permanent valve casing at the left. This member carries a double hack-saw frame *G*, provided with two blades *H* and rocked by handle *J* which extends outside of the casing where it can be operated by the workman. The hack-saw is obviously a suitable tool to use in cutting the pipe owing to its cheapness, the convenience of replacing worn blades, their ease of operation on account of the narrowness of the cut, and the familiarity of the workman with its use. These characteristics have brought the hack-saw into very extensive use for cutting off metal bars and pipes of all kinds.

Fig. 3. Sawing Arrangement Clamped in Place, ready to begin Cut.

The double hack-saw frame *G* carries the two saws *H*, spaced apart about 3/8 inch narrower than the distance between the valve seats *K* in the valve casings. This permits the pipes to extend beyond these seats approximately 1/8 inch when the middle section has been cut out. The cutting is effected by rocking handle *J*, thereby operating rock shaft *L*, which passes through a water-tight stuffing box into casing *F*. Here the crank *M* transmits the reciprocating movement to connecting rod *N* and then to hack-saw frame *G* with its two saws *H*. With the original construction shown in Fig. 2, the feed of the saw was dependent on the weight of the heavy connecting rod *N*. In the later design shown in Figs. 1, 3, and 4, the feed is effected by a weight mounted adjustably on the horizontal arm shown, which is connected to a second rock shaft passing through the casing and carrying an arm with a roller, which bears on top of the hack-saw frame as it is reciprocated back and forth. By adjusting the weight to different positions on the outside lever, the pressure of the

roller on the saw and the consequent rate of downward feed is altered as desired by the workman.

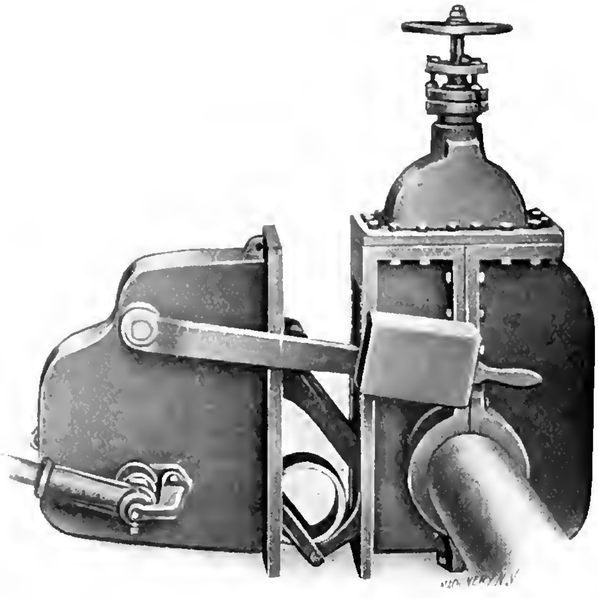


Fig. 4. Removing the Sawing Mechanism and the Severed Section of Pipe.

Use of the Device.

The operation of inserting a stop valve is as follows: After clamping casings *A* and *B* to the pipe and calking them to a tight fit by the means described, casing *F* with saw frame *G* and two sharp saws *H* is clamped into place, with the saws resting on top of the pipe. The workman now rocks the vertical handle *J* back and forth and the two saws begin to cut into the pipe. It is not necessary to fasten dome *C* in place with the valve disks and spindle, until the cut has been properly started, with the saws equally spaced. When this has been done, the dome must be permanently fastened into place, as shown in Fig. 3, before the saws have cut through into the interior of the pipe. The cutting is then continued with the feed weight adjusted properly to suit the conditions, until the section has been cut entirely out of the pipe. By tipping handle *J* back to a horizontal position, the saw will draw the severed section of the pipe back into casing *F*, as shown by the dotted lines in Fig. 2. Then by turning hand-wheel *E*, valve *D* is screwed down into place. This valve is of the type in which the two faces are spread apart to a bearing on flat parallel seats. It is thus possible for them to pass between the sawed edges of the pipe and expand over these onto the valve seats *K* in casings *A* and *B*. When the valve has been thus closed, casing *F* may be removed, as shown in Fig. 4, bringing with it the saws and the separated portion of the pipe. The rectangular opening thus left in casing *A* is closed by a cover plate as seen in Fig. 5, which shows the completed form of stop valve.

Of course, the casing fills with water the minute the saws cut through into the interior of the pipe. To keep this water out of the trench or floors where the workmen are at work, a drain cock is provided which permits the water to be run off into a pail before removing casing *F*. It will be observed that the flow through the pipe is interrupted only for the very few minutes that *F* is being removed and the cover-plate substituted.

The advantages of this device will be readily recognized. It is a comparatively inexpensive machine and can be operated by any competent foreman. It avoids the shutting off of water from customers or from fire hydrants in the case of an unexpected demand for water. It makes possible the installing of new hydrants or the replacing of old pipes with new hydrants having steamer nozzles. Its simplicity, reliability and ease of operation for these uses should make the machine particularly adapted to water works service. The same considerations make the device useful for industrial purposes as well. Not only is it useful for the installation of valves, but it can be employed in every-day shop work for cutting pipe, in which case one saw blade may be removed and special pipe holders attached to the machine.

HART'S "BUCKEYE" RATCHET-DRIVEN DIE-STOCK.

An extended description of the design and operation of the "Buckeye" die-stock, manufactured by the Hart Mfg. Co., 10 Wood St., Cleveland, Ohio, was given in the April, 1908, issue of MACHINERY; a gear-driven, large size die-stock of the same make was described in the January, 1909, issue. As will be remembered from these previous descriptions, the principal feature of the construction of the "Buckeye" die-stock is that the chasers which cut the taper thread on the pipe, and which while not as wide as the length of the thread, will still cut a full length thread of correct taper by means of a mechanism which permits the chasers to recede from the work as they progress along the pipe. Another feature of the die is the provision for automatically releasing the chasers when the full length of thread has been cut. A wide range of sizes may be cut with the same chasers by simply loosening a screw and setting a stop to the required graduation.

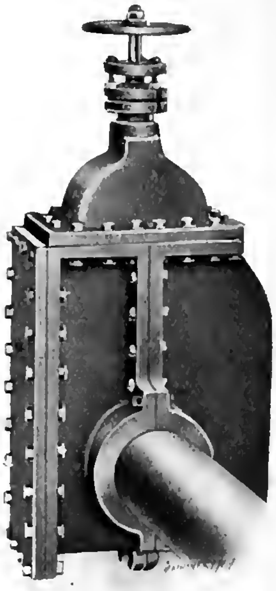
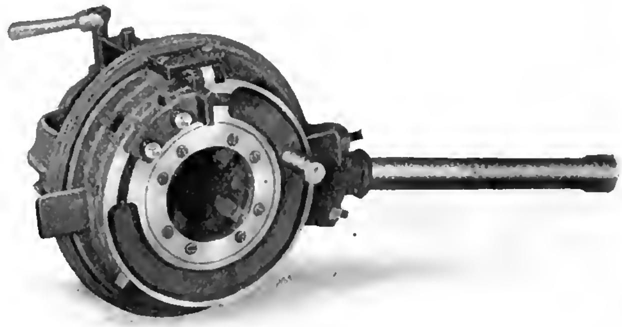


Fig. 5. Cover Plate Clamped in Place, and Valve Ready for Use.

The Hart Mfg. Co. has now brought out a "Buckeye" die-stock provided with a ratchet drive as illustrated in the accompanying engraving. The ratchet is enclosed by a ring provided with a projection into which the handle and two latches are fitted. The latches are so spaced that but one will be in engagement with the ratchet at a time, but the use of the two latches minimizes the amount of lost motion. They can be swiveled around so that the die can be used for cutting either right-hand or left-hand threads. The die-stock provided with this driving arrangement is intended for cutting pipe from one-half inch up to two inches in diameter. It is of especial advantage when it is required to thread pipe in close quarters, as it is not necessary to have more than five inches clear radius around the pipe, and, of course, space enough for working the ratchet handle. All other features of the die-stock are the same as those described in the April, 1908, issue of MACHINERY, mentioned above, where an extended illustrated description was given of the die-stock and the mechanical devices by means of which it is operated.



Ratchet Die-stock for Threading Pipe in Close Quarters.

RANSOM 18-INCH LEVER-FEED DISK GRINDER.

The Ransom Mfg. Co., Oshkosh, Wis., has placed on the market a disk grinder of new design shown herewith. The principal improvements relate to the thrust collars on the

arbor, oiling provisions for the counter-shaft and the use of steel disks in place of cast iron as commonly employed.

The spindle is made of high carbon steel, turned and ground, supported in babbitt lined bearings. The thrust collars have nine square inches of surface, and are made of hardened steel. The disks are also made of steel, and are turned true to within one-thousandth inch on their faces. They are fastened to the collars on the arbor with bolts and nuts, instead of by beveled head screws. These disks are provided with or without grooves, as desired, though it is the builders' belief that better work is obtained with the plain-faced disks.

Improved Design of Ransom Disk Grinder.

The counter-shaft has self-oiling hangers and a ground shaft. The loose pulley has an improved self-oiling bushing fastened to the shaft, drilled full of holes to retain a sufficient supply of oil to last several weeks. This insures lubrication of the loose pulley while the machine is standing still.

With the equipment shown in the engraving, a fixed table is provided at the left having a surface of 6 by 18 inches, square with the face of the disk. The oscillating table at the right has a surface of 7 by 12 inches, provided with two T-slots. The usual adjustments and movements are provided. The disks are 18 inches in diameter by ¾ inch thick. The bearings are 7 inches in diameter by 12 inches long. The counter-shaft, which should make 500 revolutions per minute, has tight and loose pulleys 10 inches in diameter.

DIAMOND DETACHABLE LINK TRANSMISSION CHAIN.

The Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has recently developed the detachable link form of chain shown herewith. It is designed to meet the objection urged at times against the chain drive, on the score that it cannot be conveniently altered in length, and that individual links and blocks cannot be quickly replaced when broken. These difficulties are here obviated by making every link detachable without the use of special tools.

A Chain Separable at Any Point without the use of Tools.

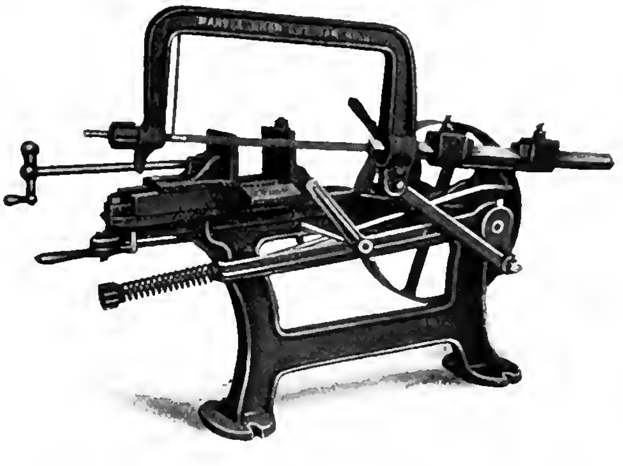
The construction is evident from the engraving. The thin strip steel lock on top of each outside link slips into a groove around a rivet at one end, and, turning about that rivet as a center, enters a similar groove in the other rivet. This thin metal strip is locked in position by being slightly warped inward, and by having at its center a slight projection which snaps into a corresponding depression in the side bar. When so locked, it cannot be removed except by intention.

This new form of chain is being made in all standard sizes, of the same materials and workmanship and at the same price as the makers' regular Diamond riveted chains. The links and other parts of each are interchangeable with each other, and detachable links may be used for replacing those of the older type. The neat appearance and unusually compact design of the new chain are plainly shown in the engraving.

NO. 2 "MARVEL" DRAW-CUT HACK-SAW.

The power hack-saw shown herewith is made by the Armstrong-Blum Mfg. Co., 113 N. Francisco Ave., Chicago, Ill., and is called by its makers the No. 2 "Marvel" draw-cut hack-saw. A number of original features are included in its design. One of these is the method of feed employed; instead of using a weight, as with the usual construction, the saw is pressed down on the work by the action of a compression spring seen projecting from the front of the machine at the left of the engraving. This spring draws on a rod which reaches back to the guiding frame of the hack-saw which is thus forced down into the work. The pressure of the saw on the cut and the consequent rate of feed may be varied by adjusting the thumb-screw against which the spring bears. The pressure of the saw is relieved on the return stroke. This is effected by an eccentric just back of the saw crank, which relieves the compression on the feeding spring as the saw comes back, and stiffens it up again on the draw, or cutting stroke.

Means are provided for raising and lowering the saw frame and holding it in any position. This is a great convenience in measuring. The frame is guided, as shown, by a square bar directly in the line of travel of the saw. The crank by which it is driven is slotted to vary the stroke from 4 inches to 6¾ inches. The wear can be taken up in the bearings of the saw guide rod so as to permit of good work throughout the life of the machine. The drive shaft has bronze bearings. The starting lever and automatic stop are at the front of the machine. This tool has a capacity for work up to 6 by 6 inches on the long stroke, and up to 8 by 8 inches on the short stroke. It takes blades from 12 to 17 inches long.



A Hack-saw with Spring-operated Feed releasing on Return Stroke.

The heavy vise furnished can be swiveled in either direction, so that the cutting of angles is conveniently provided for. The entire vise can be removed, leaving a T-slotted table for holding irregular shapes. The vise itself will be found a useful tool for holding work on the drill press, milling machine, etc.

SEARIGHT COMPOUND-LEVER MECHANICS SHEARS.

The mechanics' shears or snips shown herewith are made by the Detroit Shear Co., Detroit, Mich. They have the advantage, as may be readily seen, of bringing into small space and

convenient form all the power that is obtainable from much larger and heavier instruments. They are designed for small work in all mechanical lines. The tool is 7 inches long, and weighs only 5 ounces, but has the cutting power of a 12-inch tinner's snip.

The arrangement of the levers will be easily understood from the engraving, and it will be seen that a toggle-joint action is introduced which gives a more powerful leverage when the jaws are cutting near their points. In other words, the mechanism is such that the shears cut with equal facility throughout the whole length of the blades. This is a feature not found in other tools of this kind. The blades are curved slightly away from the cutting edges, for cutting circles or square corners. They are made of Ibsen steel, tempered and drawn by the Mallatt process, and nicely finished. These snips will cut tin, soft steel or galvanized iron up to 26 gage, and soft brass or copper up to 20 gage.

A Compact Pair of Snips, with the Power of a much Larger Tool.

MUELLER $2\frac{1}{2}$-FOOT CONE-DRIVEN RADIAL DRILL.

In Figs. 1 and 2 are shown the smallest size of a line of short-arm cone-driven radial drills built by the Mueller Machine Tool Co., Cincinnati, O. These machines are an evidence of a growing tendency to do work on the radial type of machine which was formerly handled on the upright drill press. To meet the conditions of the work for which it is intended, close attention has been given to the matter of providing the greatest possible convenience in operation; in fact, practically all of the conveniences of the builders' line of standard radial drills have been retained. Special effort has been made, however, to produce an inexpensive design, to meet the requirements of purchasers whose work does not require a high-priced radial machine.

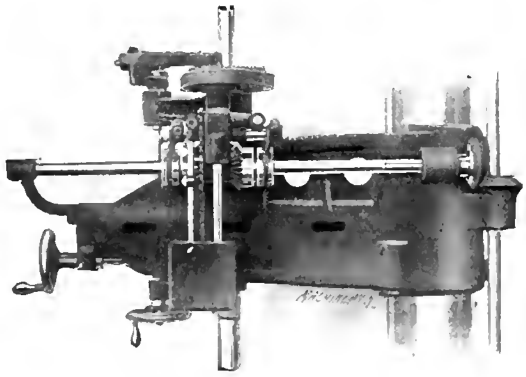


Fig. 1. Rear of Head of Radial Drill showing Feed and Reversing Mechanism.

The framework of the machine is strongly designed and carefully built. The stationary column is of heavy section, bolted to the base by a flange of large diameter. A pipe section arm is employed, which is very rigid against the torsional force produced by heavy drilling. It is clamped to the column by the two handles shown, and is adjusted vertically by a power movement, controlled by an easily reached lever. The head is traversed by a double threaded screw and is equipped with a firm locking device.

Ten changes of speed are provided, immediately available. The correct speeds for all classes of drilling within the range of the machine are shown on a bronze plate attached to the arm, thus enabling the operator to select the proper speeds at a glance and change them while the machine is in motion. A tapping attachment is provided, which is so arranged in connection with an adjustable gage screw as to permit the tap to slip when it reaches the bottom of the hole. The starting, stopping and reversing lever is conveniently located on the head, directly in front of the operator. Four feed changes are provided, so selected as to be especially adapted to high-speed drills. The changes may be made while the drill is at work, the mechanism being similar to that described for another machine by the same builders, in the August, 1907 issue of MACHINERY. Either a positive or a friction feed may be employed as desired. All gears, both spur and miter, are planed to theoretically correct outlines. All shafts as well as the column itself are ground to size.

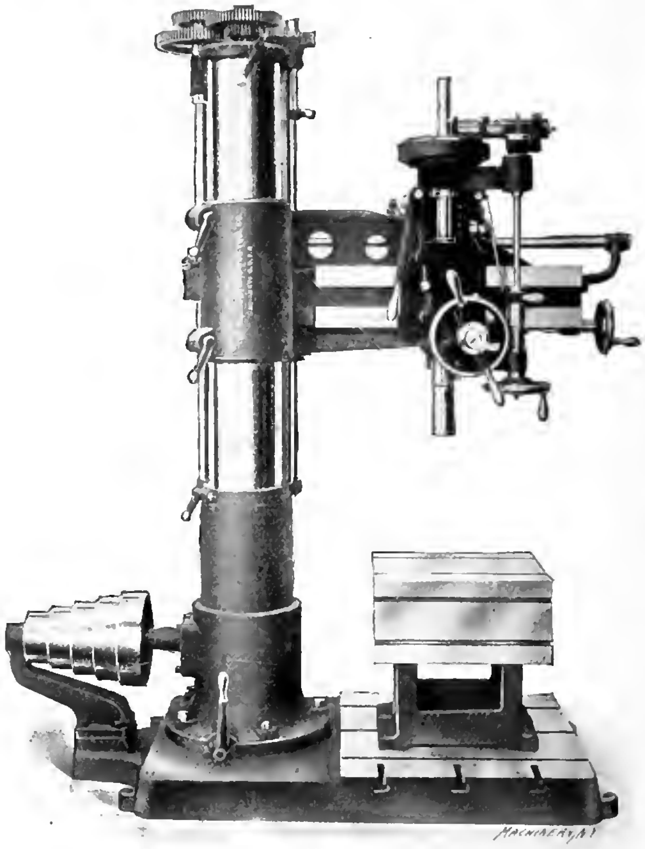


Fig. 2. A Small Radial Drill of Simple and Convenient Design.

Any style of table desired will be furnished. These machines are made in $2\frac{1}{2}$, 3 and $3\frac{1}{2}$ foot sizes.

BLISS DOUBLE CRANK TOGGLE DRAWING PRESS.

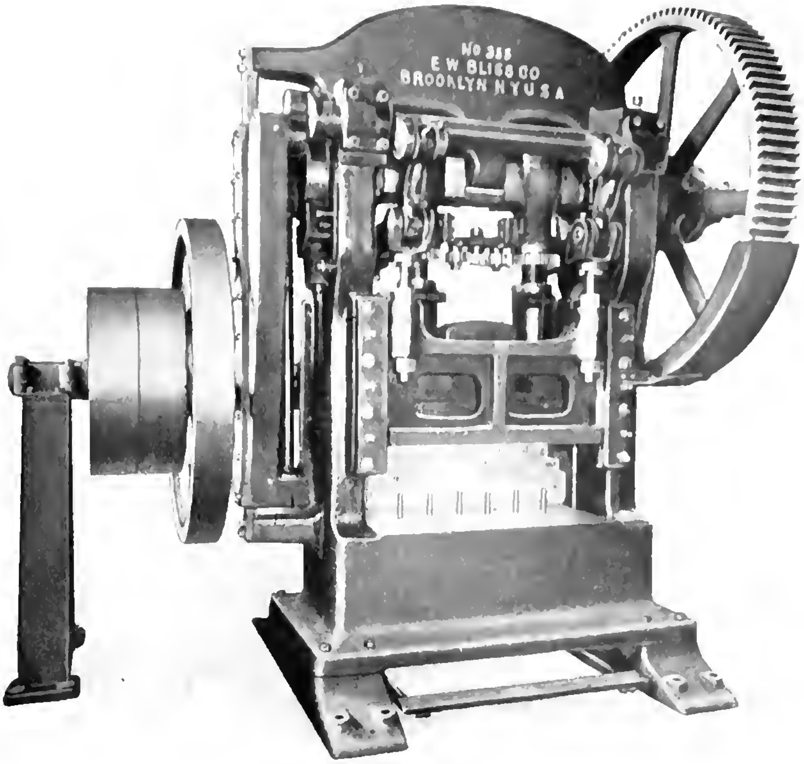
The machine shown herewith, built by the E. W. Bliss Co., No. 5 Adams St., Brooklyn, N. Y., is designed for the simultaneous drawing and stamping of large forms of irregular shapes, such as required for trays, stove tops, seamless roasters and an extended line of similar work. The usual press for work of this kind is of the double crank type, with a spring-actuated blank holder. Where work has to be drawn to any considerable depth, the use of blank holders of this kind is objectionable, since there is a varying pressure on the work, increasing from the beginning to the end of the operation. This means also a larger power consumption than would otherwise be necessary, since the pressure on the blank, if of the proper degree at the beginning of the operation, is much greater than necessary at the bottom of the stroke. In the press shown herewith a toggle mechanism is used which gives an even holding pressure and a consequent reduction in power consumption.

The original design of this press was brought out three years ago. It has been redesigned, however, embodying such changes and improvements in detail as recent experience has indicated to be advantageous. The frame is heavy, and cast in one piece. The crank-shaft is of high carbon, hammered steel, and of very large diameter. The punch slide has its pressure applied by two cranks, which may be adjusted for length simultaneously by means of screw connections which are geared together and work in unison, assuring accurate alignment at all times. This adjustment is effected by the operation of a ratchet lever.

The blank holder slide surrounds the punch slide, and receives the pressure evenly distributed on four points through the heavy steel screws shown. This slide is operated by the makers' patent toggle motion, which has been used with satisfactory results for many years. The toggles which are of steel, are operated from rock-shafts through an outside slide, which is operated by a crank connection on the end of the main crank-shaft. The blank holder slide mechanism is balanced, to avoid undue strains. The construction gives assurance that all the strains borne by the blank holder will be taken up by the press frame. A knock-out is provided, actuated by the blank holder slide.

The press will receive and work a 42- by 22-inch blank of No. 14 gage steel, or smaller blanks of heavier stock in proportion.

It will take a drawing punch 12 by 36½ inches. The press makes 30 strokes per minute, with the driving shaft running at 205 revolutions per minute. The stroke of the punch is 8 inches, and that of the blank holder is 6 inches. The floor space occupied is 12 feet 2 inches, by 7 feet 3 inches over all, and the weight of the machine complete is approximately 42,000 pounds.



A Press for Simultaneously Drawing and Stamping Large Work.

MUMMERT, WOLF & DIXON HIGH-POWER PLURALITY DIE BOLT-CUTTER.

In the August, 1907, issue of MACHINERY, in the department of New Machinery and Tools, we described a plurality die bolt-cutter built by the Mummert, Wolf & Dixon Co., Hanover, Pa. This firm has recently developed a single speed pulley gear-driven machine, illustrated and described herewith, working on the same principle but incorporating a number of improvements in design, especially fitting it for the use of high speed steel chasers.

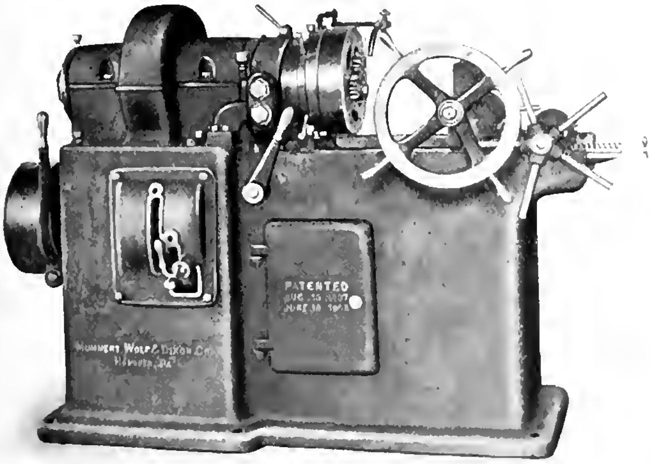


Fig. 1. A Plurality Die Bolt-cutter, adapted to the Use of High-speed Steel Chasers.

The principal feature of novelty in this machine, it will be remembered, is the construction of the die-head. This carries three multiple chasers as shown in Fig. 2. Each of these has six cutting faces, and they may be adjusted so as to cut any one of six pitches of thread. The head in which they are mounted permits adjustment for size without stopping the spindle, by turning the internal threaded collar *A* (Fig. 3) by means of handles *B* with which it is provided. The head is operated either automatically or by hand. The adjusting collar is graduated so that it can be set to the required diameter without the usual cut-and-try operation. The head when closed for threading is positively locked. The multiple chasers shown in Fig. 2 differ from those previously illustrated, in that inserted blades of high-speed steel are employed, set in soft steel bodies.

The driving gearing is plainly shown in Fig. 3. A constant speed driving pulley may be connected or disconnected from driving shaft by the operation of the clutch shown. This makes the use of a counter-shaft unnecessary. The triple tumbler gear arrangement, shown at *C*, operated by the handles seen projecting through the base in Fig. 1, is employed for giving the various speed changes. Any one of the three gears on stud *C* may be set to engage with the driving gear *D* on the spindle. It will be seen that this mechanism is simple and direct. All the gearing is enclosed within a frame. The base has a solid bottom, and is so constructed that all the oil drains to the suction pipe of the pump, which is enclosed within the frame. The oil tank at the bottom is provided with an overflow division, which serves to catch particles of metal which may be carried with the oil past the chip pan *E*. These metallic particles naturally settle to the bottom of the first compartment, while the top oil is delivered to the pump in a fairly well filtered condition, thus reducing the wear on the pump, as well as delivering a clean stream of oil on the dies when cutting. As this oil naturally permeates the mechanism of the head when in

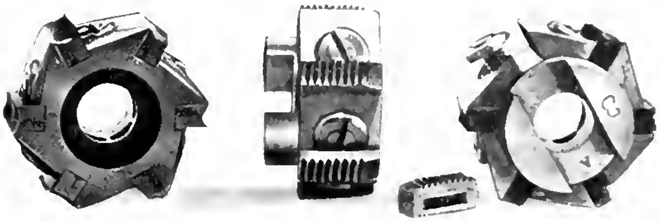


Fig. 2. Style of Chasers used, having Inserted Teeth

use, the grit would otherwise work into the wearing parts and reduce the life of the mechanism to some extent. The vise jaws on the carriage can be adjusted off the center, sidewise, when an irregular-shaped piece is to be held. A dowel pin locks it in the central position.

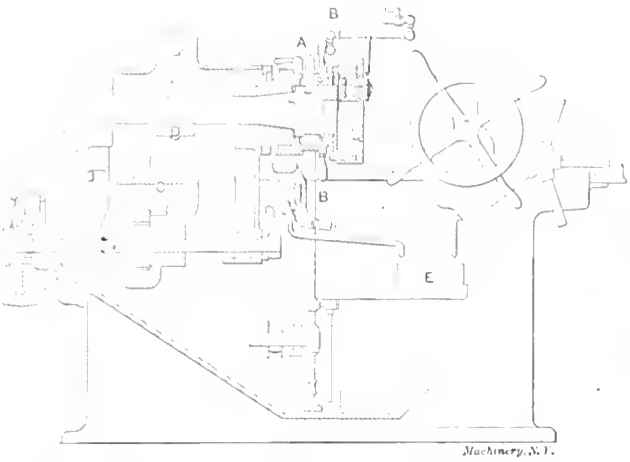


Fig. 3. Section through Machine, showing Driving Mechanism.

MOTOR-DRIVEN GUN BARREL DRILLING AND RIFLING MACHINERY.

The Pratt & Whitney Co., Hartford, Conn., has been known from the beginning of its existence for its line of machinery adapted to the manufacture of fire arms. It has, in fact, done much in the way of completely equipping armories in all parts of the world. The well-known Lincoln milling machine was first developed for this work, and other machine tools now in common use for other purposes were first particularly applied to the making of fire arms. Two most important machines for such work are the gun barrel drilling machine and the rifling machine. The former of these has been adapted to the general drilling of deep holes in ordinary shop practice, as well as for the special work for which it was originally designed. The rifling machine is, of course, still a special tool not used outside of fire arm factories. While retaining their original principles, these tools have been recently redesigned, particularly in the largest sizes, and have been adapted to the motor drive.

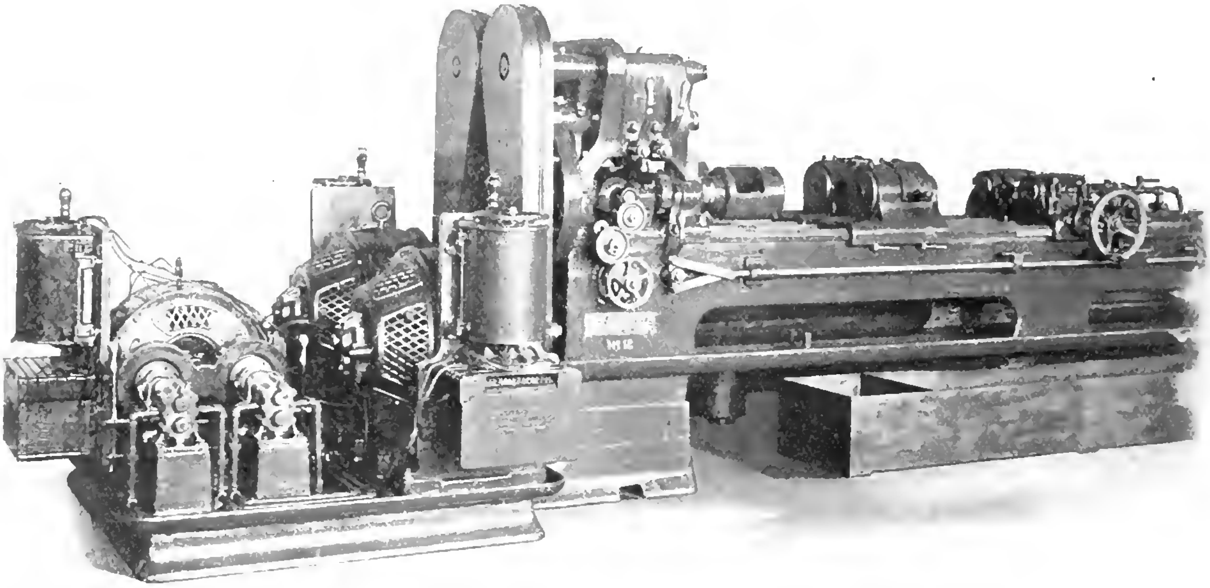


Fig 1. Large, Motor-driven, Pratt & Whitney Gun Barrel Drilling Machine.

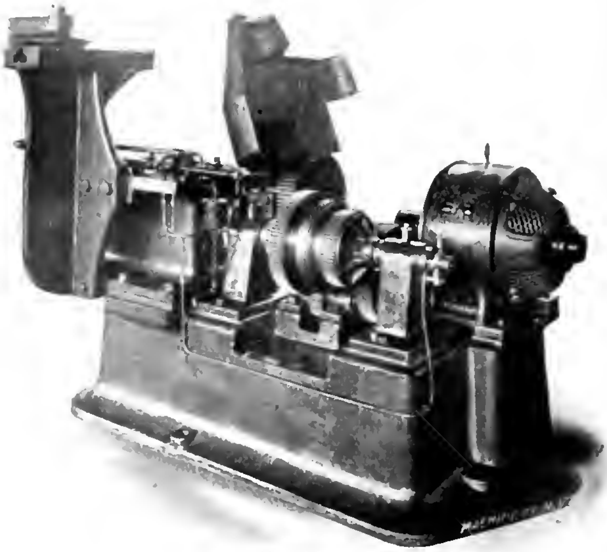


Fig. 2. Driving Mechanism of Rifling Machine.

In Fig. 1 is shown the largest size of the gun barrel drilling machines, called by the makers the No. 12. It is motor-driven, as may be seen, there being a separate drive for each of the two spindles and a third for the oil pumps which form a very important part of the mechanism. The separate drive for the spindles allows the work to be done to the best advantage, as they may be operated as two separate machines. The general arrangement of the mechanism is well-known. On the outer end of the spindles are chucks for holding and revolving the gun barrel, or other part to be drilled. The outer ends of the work are supported by bushings in the brackets shown, which are adjustable to any desired point on the bed. The drill holding carriages are provided with chucks for holding the drills by their shanks. These carriages have independent hand and power feed, driven from the spindles, with automatic knock-off. The mechanism is such that any abnormal resistance to the full cutting action of the drill arrests the feed. Two rotary oil pumps are provided, one for each drill. These continuously force oil from a large tank underneath the machine through telescopic tubing into the drill. The oil not only cools the cutting edges, and gives a fine finish to the work, but serves also the very important office of carrying off the chips from the deep holes. The oil carrying the chips flows into a basin in the tank, where the chips are separated; the oil then returns to the reservoir for use again. In large installations, it is often considered best to install a single high-pressure pump to supply oil to all the machines, doing away with the individual service for each tool. The drill used is of the single lipped type, with a spiral closed channel in its periphery which leads the oil to its cutting edge. This cutting edge is in the form of a series of steps which break the chip and make it more easily

removed by the flow of oil. This is especially useful on large drills, and provision is made for grinding these steps in the grinding machine furnished with the equipment.

Four sizes of rifling machines are made, of which the largest (the No. 5) is shown in Figs. 2 and 3. This has a head for holding and indexing the gun barrel, and a sliding carriage, provided with a spindle for carrying the rifling bar. Over the carriage is a bracket, as shown, carrying an adjustable taper bar, which, in combination with the longitudinal movement of the sliding carriage controls the rotation and pitch of the rifling bar, by means of a transverse movement given to a cross-slide, carrying a rack; the latter is in mesh with a gear on the rifling bar spindle. The taper or former bar is pivoted at the central point, and may thus be adjusted to give a true helix of any desired twist. Where an "increased twist" is required for the rifling, the form bar is curved to suit the requirements.

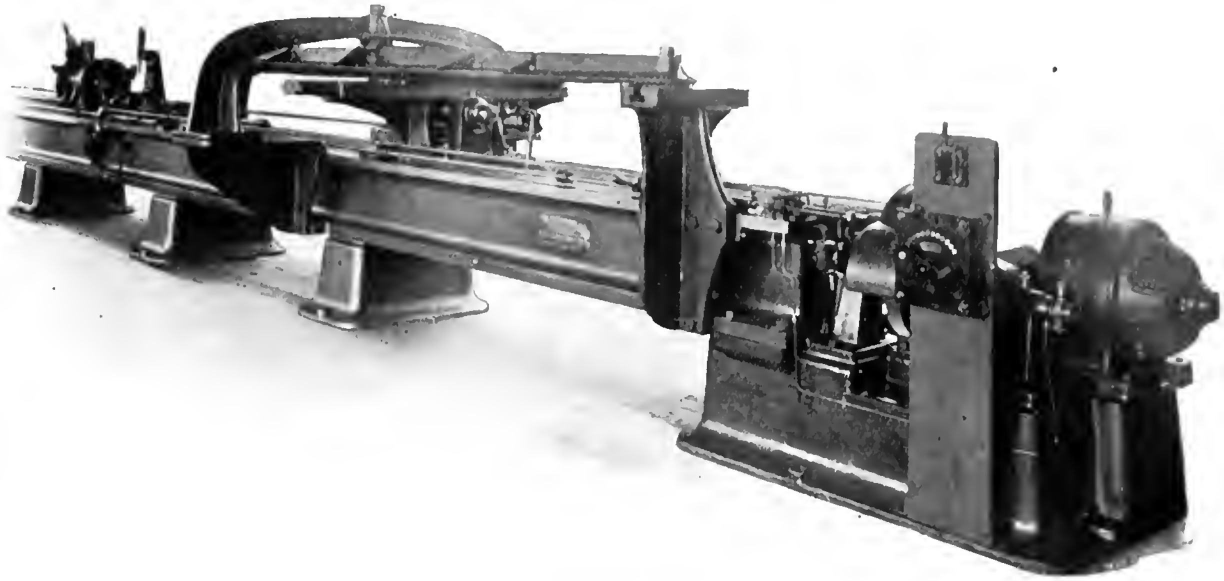


Fig. 3. No. 5 Rifling Machine.

The carriage travels backward and forward continually, being controlled by an automatic reversing mechanism. In the case of this large machine a pneumatic control is employed. A stop rod which extends along the front edge of the bed in Fig. 3, operates a valve at the upper left of Fig. 2, controlling the air pressure in pipes leading to each end of the reversing spindle shown in the foreground. This reversing spindle has two loose gears mounted on it, driven directly and through intermediate gearing from the motor, so as to run in opposite directions. The friction clutch pneumatically controlled by the valve just mentioned, connects either of these gears with the shaft, which, in turn, carries a pinion meshing with the driving gear of the lead-screw which operates the sliding carriage.

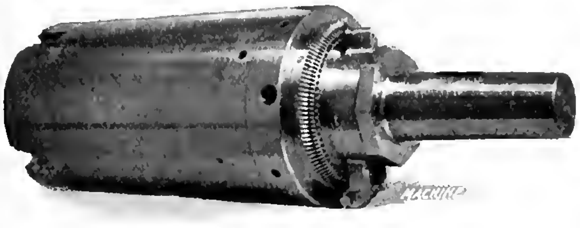


Fig. 4. A Large Rifling Head, showing Rotating Adjustment.

Fig. 5. End of Rifling Head, showing Adjustment for Depth of Cut.

In the smaller machines, the work is indexed automatically at the end of each stroke. On the larger machines this indexing is done by hand. Suitable provision is made for getting rid of backlash in the indexing device. The smaller machines also are completely automatic, to the extent that after the carriage reversing dogs and stock nuts are adjusted, and the barrel is placed in the head and clamped, the machine, being started, causes the carriage to travel backward and forward continually, indexing the rifling bar head at the end of each stroke, and feeding out the cutters automatically until the grooves have been cut to the proper dimensions. The feed is then discontinued, and the machine is stopped by the operator for the removal of the work.

Figs. 4 and 5 show the form of rifling tool used for large work. The whole tool may be rotated for adjustment around the bar, to match grooves previously cut. The tool cuts on the draw stroke, producing grooves free from chatter marks. The blades are automatically withdrawn from contact with the work on the return stroke, so that the slot and the keen edge of the cutters are preserved from damage. In smaller work, of course, a single bladed cutter is used, in which the automatic feeding and relieving provisions are retained. Mechanism is provided to automatically remove any chip that may lodge in front of the cutter.

LYON EXPANSIBLE STEEL RACKS WITH ADJUSTABLE SHELVING.

The Lyon Metallic Mfg. Co., Aurora, Ill., has developed a system of steel rack construction, combining to an unusual degree the qualities of strength, convenience, adjustability and simplicity. The manner in which the details of the design have been worked out, as shown in the accompanying illustrations, gives evidence of careful thought, and full appreciation of the requirements which shop furniture of this kind must meet.

As is shown in Fig. 1, the rack is built up of upright partitions, tie-rods and shelving. The shelving rests on the tie-rods which are made in separate lengths for each section, but are threaded together onto continuous rods for all shelving on the same level. The tightening of the rods puts them in tension, and the flanged edges of the shelving in compression, making as rigid a construction as is possible for any structure built of members placed at right angles to each other. The strength of the various members and their method of holding permits each section to take care of its own load, without requiring the additional stiffening effect of adjoining members. When a number of units are bound together, how-

ever, the carrying capacity is increased above that guaranteed. The stated capacity of the shelves makes provision for uneven loading, so that care does not have to be taken in this particular. No diagonal braces are required, thus making the shelving equally accessible from front and back.

The upright partitions are made of 20-gage cold-rolled sheet steel of special manufacture. The edges are faced and bound on each edge with doubled and beaded strips of 12-gage steel, which greatly increase the stiffness of this member, which is specially rolled from a metal high in carbon. The upright partitions are alike on each face and each end, so that they may be assembled either side to, or either end up. The face strips are all punched with holes spaced on 3-inch centers, thus permitting the adjustment of the shelving to 3-inch dimensions.

The shelves are each made of a single piece of No. 16 gage, patent leveled, cold-rolled steel. The front and back of the shelf is given three continuous right-angled turns, each, as is shown in Fig. 3, leaving a smooth 1-inch surface at the front of the shelf, an equal parallel surface underneath, and an inner flange projecting upward inside. This makes a smooth finish and strengthens the shelf, as well, at the points where strength is most required. This strength at the front and back of the shelf is increased by the tie-rods which pass through and immediately in back of this flange. This is the place where an overload is likely to occur, as it is natural when hoisting a heavy weight into position to raise it a little above the shelf and drop it on the edge of the shelf for a rest before it is pushed into place. The shelves are reversible, and fit snugly against the partition so that even the smallest materials are prevented from dropping through.

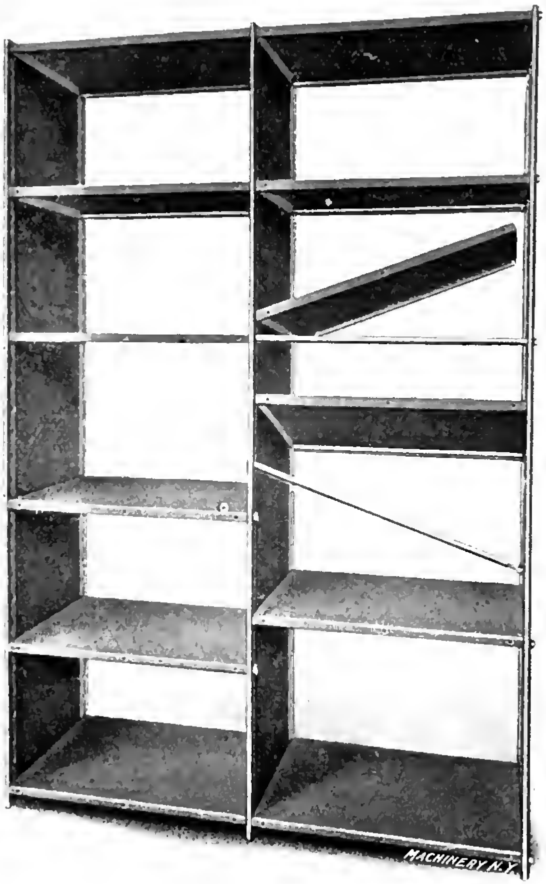


Fig. 1. Sectional and Expansible Steel Rack.

The connecting rods, shown in Fig. 2, by which the vertical sections are tied together and the shelves supported, are made, as explained, in lengths to suit the width of each section. They are made of No. 16 gage, but jointed steel tube, 7/8 inch in diameter. Each tube is fitted at the end with a threaded stud-bolt, which is brazed in place. At the other end is a steel bushing, which is tapped to receive the stud-bolt of the adjoining rod. At the outside of the partitions, tap bolts are used at one end and nuts at the other, as is also the case where a shelf is at a different height from those in the adjoining section. Making each rod the length of the shelf permits independent adjustments. A simple pin wrench entering the holes shown in the tubing is used for screwing the parts together.

Numerous special conveniences are provided for adapting this shelving to the varied work of the customer. Fig. 3 shows an attachment which converts the shelf into a bin, when it is desired to store loose materials. This can be fitted to flat shelves already in position, without making any alterations whatever. It is locked over the front flange of the shelf, as shown, thus forming a tight joint for the whole length of the front. Adjustable angle clamps fasten it to the vertical partitions at the ends. This attachment makes the shelves so tight that leakage is prevented even when such materials as seeds and other fine stuff are placed therein. The interlocking flange at the bottom prevents the attachment from bulging out, even when subjected to pressure from within. At the same time it strengthens this shelving against both vertical and lateral strains.

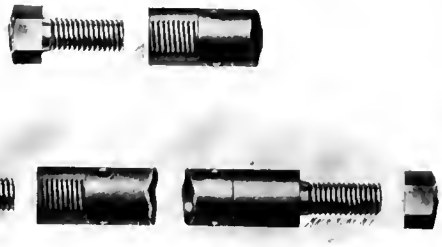


Fig. 2. Design of Tie-bolts used for Holding Rack together and Supporting Shelves.

A shelf extension is provided which may be used on the lower portion of the rack after the regular shelves have been installed, to increase their capacity, or to convert them into large bins. They consist of upright partitions of the same construction as the uprights, which are attached to the facing strips of the racks already in position by means of clips. The shelves can then be installed on a line with the rack shelving, making one continuous shelf throughout.

A number of minor conveniences are provided. Label holders are furnished for attachment to the front of the shelves. They are held in place by three longitudinal clips or tongues punched on the metal, which register with corresponding square holes in the face of the shelf. They are fastened in place by pressing them backwards with a special tool provided for the purpose. When it is desired to use boxes in the shelving reaching approximately half the depth of the shelf, a box stop is fastened to the center of the shelf, which prevents the box when being pushed into position from displacing another immediately back of it. A back stop for the rear side of the shelf may also be provided when large boxes are to be stored from one side only; or, if desired, complete backs may be fastened to each section of shelving by means of clips.

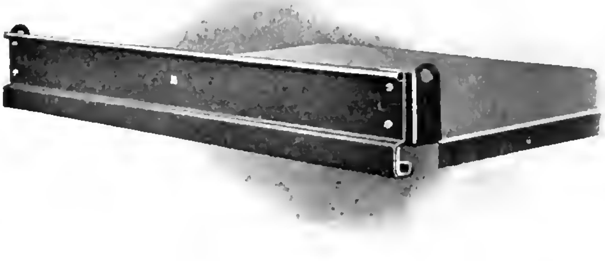


Fig. 3. Rim Attachment for Converting Shelf into Storage Bin.

Removable partitions are provided by means of which shelves may be divided lengthwise from end to end. The shelves are punched with holes every six inches for this purpose. The partitions are the same depth as the shelves, and are furnished in heights to fit into the clearance permit-

ted by the 3-inch height adjustment. Bracket shelves may be attached to any sections or to all the sections in a series. They are fastened to the uprights, and are convenient for resting boxes when desired, or as a counter for sorting material. They are strong enough to hold the weight of a man should it be desired to use them for a step for reaching shelves higher up.

These shelves are furnished in a wide variety of sizes to fit every imaginable requirement on the part of the customer. While no effort has been made in the way of ornamentation, the simplicity of the design and the general smoothness of finish give the whole arrangement a strong and pleasing appearance. All the parts are regularly finished in a good durable quality of black enamel, which protects the metal as well as adding to its attractiveness. Other and lighter colors may be used if it is required. This is advisable where the room in which the racks are to be used is dark, as the light will be increased by reflection.

FILING ATTACHMENT FOR THE POWER HACK-SAW.

In the department of New Machinery and Tools of last month's issue of MACHINERY, we illustrated the "Royal 1909" power hack-saw made by the Robertson Drill & Tool Co., 1848 Niagara St., Buffalo, N. Y. It will be remembered that in this machine, the drive is carried in a frame *A*, pivoted about the driving shaft. As this frame also carries the guides *B* for the saw holder, it is possible to tip the whole mechanism to any position about the axis of the driving shaft. This peculiarity of construction allows the saw, with suitable attachments, to be used as a filing machine in the way illustrated in Figs. 1 and 2.

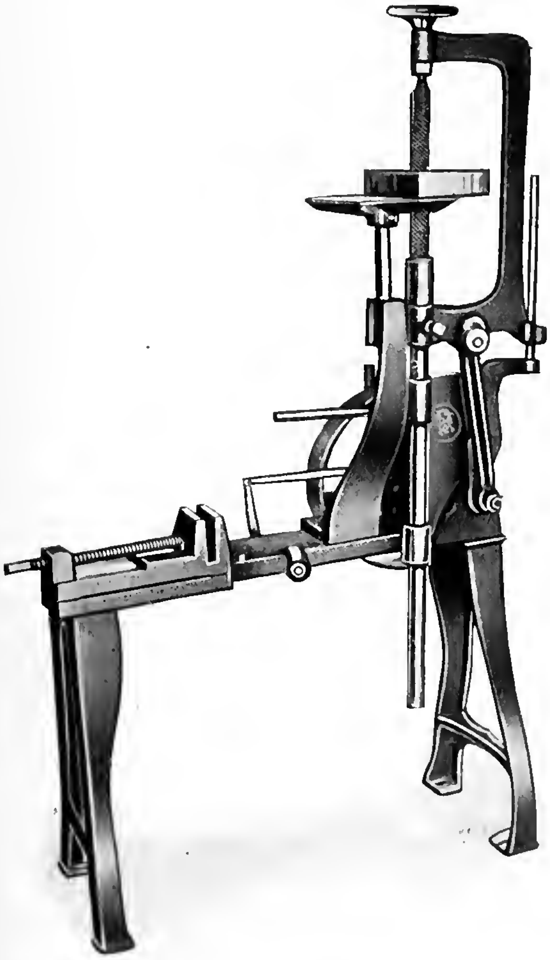


Fig. 1. Robertson's "Royal" Power Hack-saw arranged to be used as a Filing Machine.

The filing table *D* and supporting arm *C* are mounted on the bed. The file *E* is supported at its lower end in a cone-shaped cup *F* set on a stud where the saw is ordinarily connected. On the upper end is a special threaded socket *G* having a hole to receive the file tang, on which it is tightened by a knurled nut. The swivelling adjustment of the hack-saw frame provides for the filing of any desired angle, or relief for die work. It can be used for the regular work of the filing machine for cutting out the centers of dies, etc. This device can be applied to the machine at any time, as proper provision for attaching it is made in the original design.

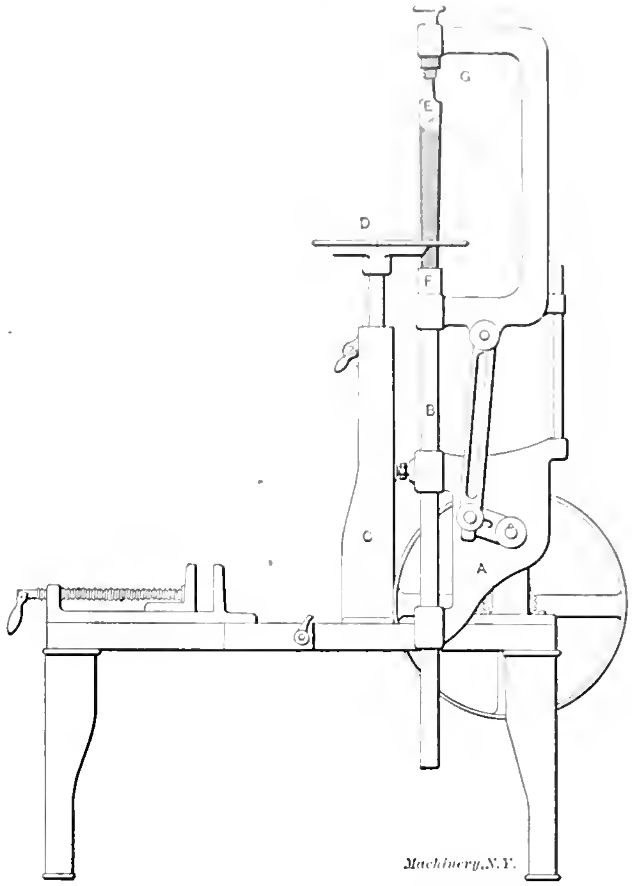


Fig. 2. Details of Mechanism of Filing Attachment.

GRAHAM KNURL HOLDER FOR TURRET MACHINES.

The Graham Mfg. Co., Providence, R. I., is making the knurl holder shown herewith. It is adapted to be used in the turret heads of lathes, screw machines, chucking machines, etc. The advantages of this tool are, first, that it is adjustable to any size within its range (that is, for work up to 2½ inches in diameter by 2½ inches long); second, the knurls work on opposite sides of the material, so the pressure is equalized and there is no tendency to push light stock to one side, and it is thus possible to knurl to a very small diameter; third, it leaves the cross-slide tool-post free for the use of any special tool that may be required, not suitable for the turret head itself.

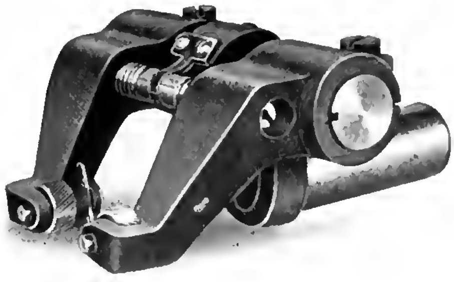


Fig. 1. An Adjustable Knurl Holder.

The knurl holder is held by the usual round shank *A*, of a diameter to fit the hole in the turret. This shank is bored to permit the passage of long work, and has an offset boss holding a finished bar of stock *B*, on which slide two projecting arms *C*, to which the knurls *G* are pivoted. Bar *B* is splined to engage a key on each arm *C*, thus holding the

knurls in line with the axis of the shank. A right- and left-hand screw *D* is threaded in tap holes in the two arms. It is locked against endwise movement by clip *E*, which engages a recess turned in its shank. By turning this screw with an ordinary screw-driver, the arms are adjusted to suit different diameters of work. When the correct size is obtained, the clamping screws *F* in each arm lock the adjustment.

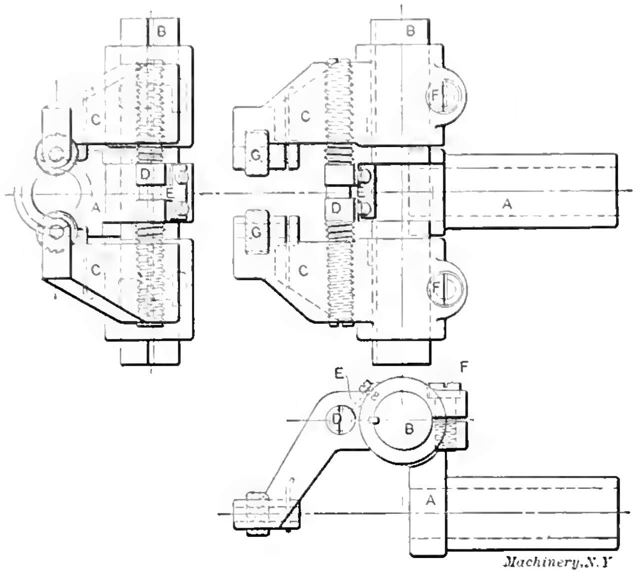


Fig. 2. Construction of Knurling Tool.

The peculiar shape of the tool is the result of experiment in giving a construction which would clear the other turret and cross-slide tools, and would at the same time be simple to manufacture. The device may be fastened in the turret at any angle that may be necessary for clearance, or to bring it to a position where its work can be watched by the operator.

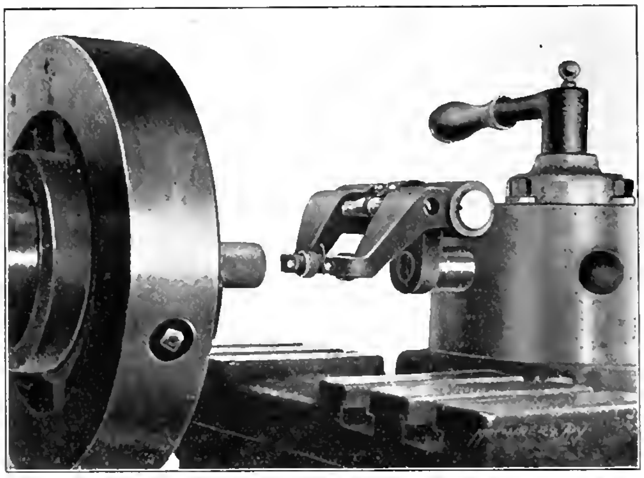


Fig. 3. Tool in Use in Turret Lathe.

The knurls *G* are mounted on pivots, which are held in place as shown by wire springs with projecting ends, which enter notches cut in the pivots. These notches are provided at each end of the pivots, so that the latter may be reversed, doubling their life so far as wear is concerned.

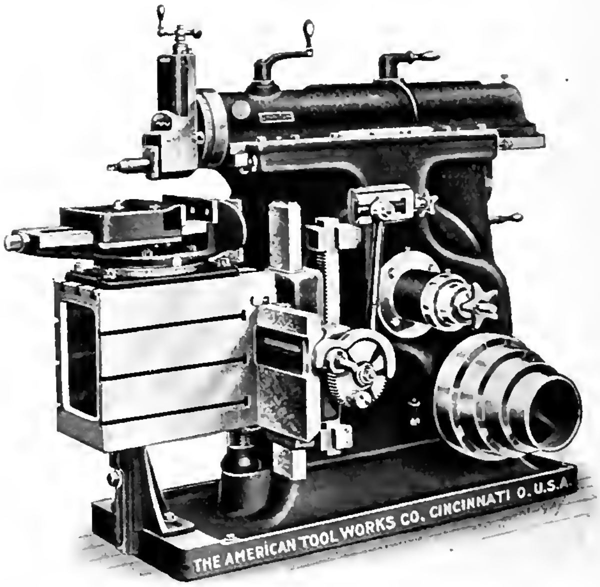
AMERICAN TOOL WORKS BACK-GEARED CRANK SHAPER.

The accompanying engraving shows the 21-inch size of a new line of back-geared crank shapers built by the American Tool Works Co., Cincinnati, O. These tools are of new design throughout, based on the results of investigation into the needs of shaper users, and experience of these tools in the shops of builders. They are intended to combine the accuracy required in tool-room work with the qualities demanded of a machine which is to be used for manufacturing purposes.

An inspection of the illustration shows that much care has been taken in the design of the column and other main members of the structure. The column, base, ram and table are all of heavy section and internally braced. The column projects both front and rear at the top, providing a very long bearing for the ram. The latter is designed to give uniform rigidity as nearly as possible throughout the length of the stroke. Its bearing on the column is taken up by a continuous taper gib, with end-screw adjustment for wear. The apron is similarly gibbed to the cross-rail, which is of box form and strongly ribbed. An improved arrangement of the bearing on the column prevents the cross-rail from dropping when the binder bolts are loosened. A telescopic elevating screw is provided to obviate the necessity for boring holes in the floor.

The stroke of the ram can be varied from 7.7 to 96 per minute with eight changes. The length of the stroke can be adjusted without stopping the machine, as can also the positioning of the ram, effected by turning the crank shown just back of the head. The rocker arm is heavy and thoroughly braced, and operated by mechanism so proportioned as to give a nearly uniform rate of speed throughout the entire stroke. A convenient self-locking lever at the rear of the machine throws the back gears in or out. The driving ratio with back gears is 24, 3 to 1, which, with the large cone pulley used, gives great driving power.

The cross-feed, as may be seen, is of the planer type, which does not have to be adjusted in any way when raising or lowering the table. It can be set to give from 0.008 to 0.200 inch when the machine is running, by means of the slotted crank shown. The feed is thrown in or out or reversed by a knurled knob on the large feed gear.



A Back-geared Shaper designed for both Accuracy and Output.

The gears are of coarse pitch and wide face, with pinions cut from bar steel. The bevel gears are planed from solid. All the shafts are of high carbon crucible steel, ground to accurate size. All the points of danger are protected, while easy access is provided to the working parts by a large door on the rear side. Special attention has been given to the matter of lubrication, for the sake of insuring long life and service from the machine. The ram slides are protected and provided with felt wipers, and are oiled from central pockets. The distribution is effected from the wipers, which distribute the lubricant throughout the whole length of the slides, thus doing away with oiling through a multiplicity of holes. Waste oil is received in a pocket at the rear of the column, where it may be drawn out from time to time. A large quantity of oil is stored in a pocket in the arm, which is distributed for the crank-pin and sliding bracket in the rocker arm.

These shapers are made in six sizes, the 15, 16, 18, 21, 25, and 30 inch stroke respectively, all being back-geared with the exception of the 15-inch stroke. The machines are regularly furnished with the heavy vise shown and with all necessary wrenches. At extra cost, the makers will provide a table support, an automatic feed stock for the cross-rail, power down feed, circular attachment, special vise and table

for mold-makers, tilting top for box table, universal table with tilting side, four-speed gear box, and electric motor drive.

CHICAGO BENCH FILING MACHINE.

The bench filing machine shown herewith (built by the Chicago Filing Machine Co., 5-17 West Madison St., Chicago, Ill.) is particularly adapted to small die work. It has a number of advantages in the way of simplicity, improved methods of holding the file, and ease of operation.

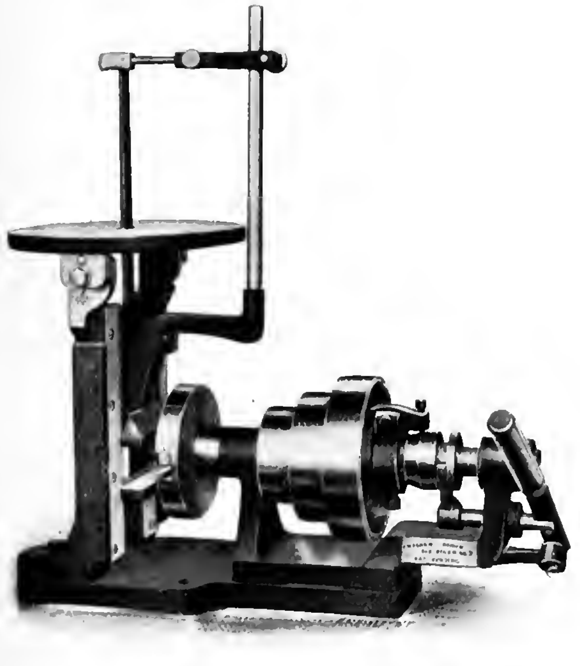


Fig. 1. Bench Filing Machine, suitable for Die Work.

The file holder is shown in Fig. 2. It consists of a tilting base *A*, against which the tang of the file *C* is clamped by two knurled screws *B*. This operation permits the file to be adjusted to bring it to the proper position for the top clamp, without danger of springing it. It will also grasp the outer end of the file as firmly and safely as the tang, so that the machine may be arranged to cut on the down stroke as well as the up stroke, where this is found desirable. It will be seen that the matter of changing the file is one of the greatest simplicity. The upper support may be swung out sideways, to remove the work for inspection without affecting the adjustment of the file.

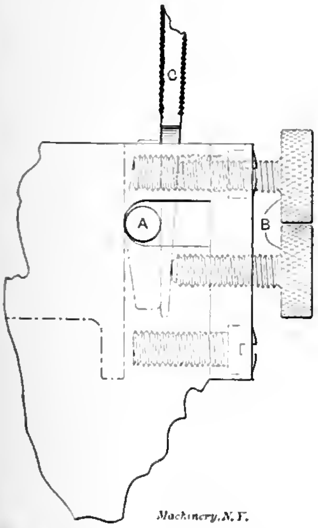


Fig. 2. Clamp for Gripping File.

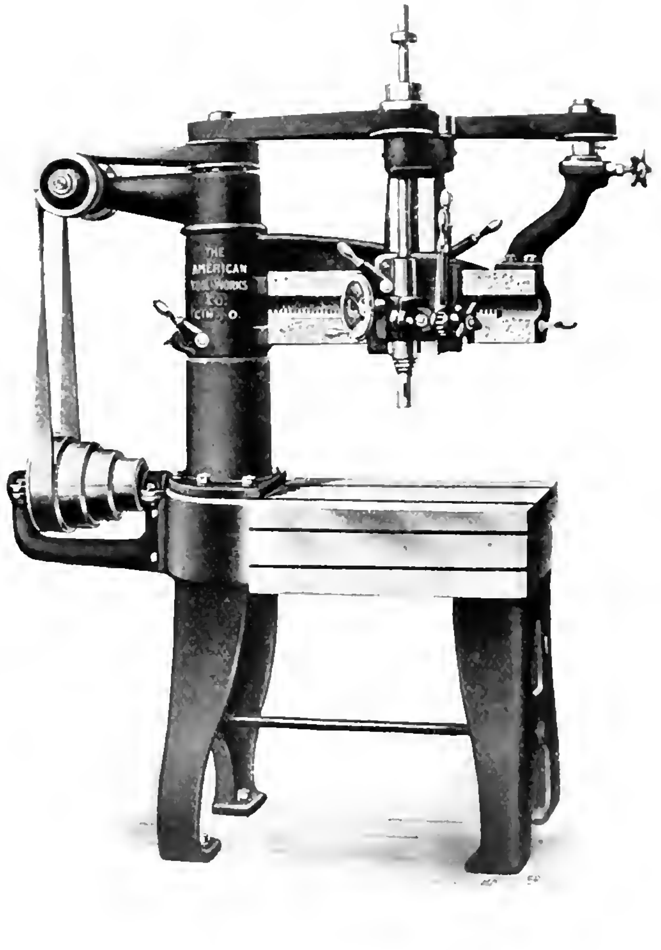
As shown in Fig. 1, the machine is provided with a clutch for quick starting and stopping. The counter-shaft furnished carries a three-step cone and tight and loose pulleys. The file slide has V-bearings, with adjustment for wear. The table is 8½ inches in diameter and tilts 10 degrees either way. The height to the top of the table is 11 inches. The weight of the machine and counter-shaft is 70 pounds.

AMERICAN TOOL WORKS SENSITIVE RADIAL DRILL.

The half-tone illustration shows what we believe to be the first sensitive radial drill, of the standard radial form, made in America. As may be seen, the spindle is carried on a head adjustable in or out on a swinging arm, while the work is supported on a stationary table. This tool is particularly adapted to the use of small size drills up to ¾-inch, on parts of small or moderate size. This includes such work as the drilling of switchboards, automobile chassis, cash registers, harvesting machinery, etc. The machine combines the sensitiveness of the high-speed drill with the convenience and effectiveness of the radial type.

The general design of the machine provides for locating all levers directly at the operator's hand, so that the movement of the head and arm and the feeding of the spindle are quickly and easily accomplished. The arm is of parabolic beam and tube section, to give the proper resistance to bending and torsional strains. It is unnecessary to raise it and lower it, as provision for variable heights is made on the head. This latter consists of a main saddle, sliding on the arm, which carries an auxiliary sliding-head on a vertical dove-tail. The adjustment for the height of work is made by raising and lowering this supplementary head. The adjustment along the arm is effected by a rapid-action rack and spiral pinion. Suitable clamping handles are provided for all adjustments, and full provision is made for taking up wear.

The driving mechanism obviates the use of gears entirely. A double, loose pulley revolving on a vertical stud at the top of the column, is driven from the cone by a belt, and in turn drives the spindle by a flying belt arrangement, giving a constant tension at all positions of the arm. This tension is adjusted by shifting the position of the idler at the extreme right of the arm. The spindle has six changes of speed, ranging from 300 to 900 revolutions per minute in geometrical progression. It is fed by a long hand-lever and a ratchet wheel, whose latch is self-releasing when in the vertical position. An adjustable stop collar is provided which can be used as a depth gage. A convenient star wheel gives a quick return movement. The table is of the height to enable the average operator to conveniently stand to his work. Both top and front sides are fitted with T-slots planed from the solid, and the back end is planed for convenience in squaring up work, etc. The column is of tubular section, internally ribbed, and extends through the arm to the back at the top of the machine. It is firmly bolted to the top of the table.



A Sensitive Drill of Standard Radial Construction.

Experiments with the smaller sizes of this machine have shown that in ordinary shop practice a ¾-inch drill, making

375 revolutions per minute (73.7 feet per minute cutting speed) will feed at 0.028 inch per revolution in cast iron, drilling at the rate of 10½ inches per minute and consuming 3¼ H.P. The drill is made with either a 2-foot or 3-foot arm, having the same general dimensions, except that the latter machine has a longer table, giving a working surface on top of 20 by 40½ inches. The maximum distance from the end of the spindle to the top of the table is 19 inches, while the maximum distance from the spindle to the floor is 54 inches, the table being 35 inches high. The regular equipment includes a 2-speed counter-shaft without the belts. This machine is built by the American Tool Works Co., Cincinnati, Ohio.

REYNOLDS MACHINERY CO.'S GEAR-HOBBING MACHINE.

In the August, 1908, issue of MACHINERY, we illustrated a spur gear hobbing machine made by the Moline Tool Co., which involved the very interesting and valuable principle of a fixed angular position of the work spindle with relation to the cutter spindle. This resulted in an unusually simple design of machine. The rights to this machine have been acquired by the Reynolds Machinery Co., of Moline, Ill., which has redesigned it and taken, it would appear, very full advantage of the possibilities offered by the original principle involved.

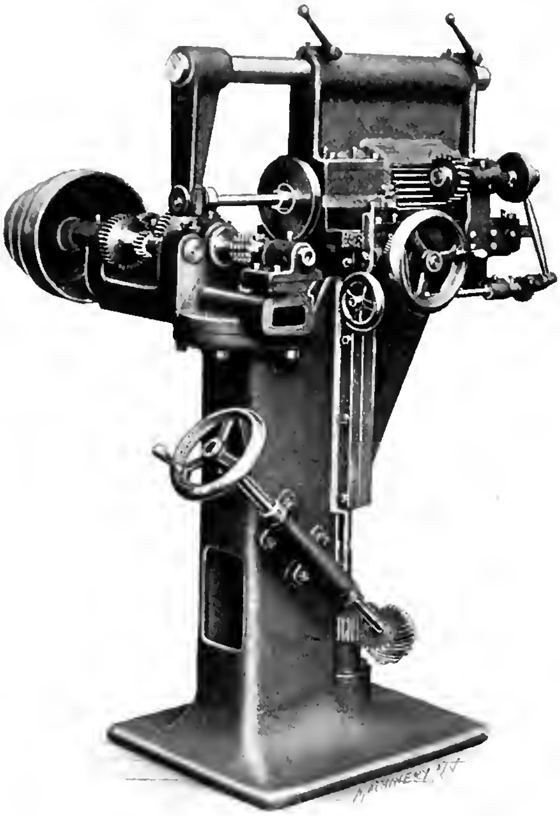


Fig. 1. Gear-hobbing Machine for Hobs of Fixed Helix Angle.

As has been explained in MACHINERY,* in a gear-hobbing machine the cutter spindle has to be set at an angle with the work spindle to agree with the helix angle of the hob, it being necessary for the teeth of the latter to mesh with the straight parallel teeth of the gear to be cut. In this machine this angle is kept constant by varying the pitch diameter of the hob in direct ratio with the circular pitch of the gears being cut, thus making the angle of all the hobs the same. In fine pitches, when this would bring the diameter too small, multiple threaded hobs are used to bring them up to reasonable dimensions. It will readily be seen that the avoiding of the swiveling adjustment of the cutter slide makes possible a simplification which is radical, to say the least.

Figs. 1 and 2 show right- and left-hand views of the machine, respectively, while Fig. 3 gives a top view, indicating the driving and feed connections somewhat more clearly. The work spindle is mounted on a carriage which is fed horizontally along the top of the knee during the cutting action. The knee on which this work-slide travels is vertically adjustable on the column for diameter of work and depth of cut, by the operation of the inclined hand-wheel shaft at the right of the column. The head carrying the hob is fixed in position at the constant cutter angle on top of the column. This makes the problem of bringing the power to the hob as simple as that of driving a milling machine spindle, as there is no need of bevel gears, splined shafts, universal joints or any other similar devices to compensate for the adjustment it is usually necessary to provide. It will thus be seen that the machine is, structurally, of great simplicity.

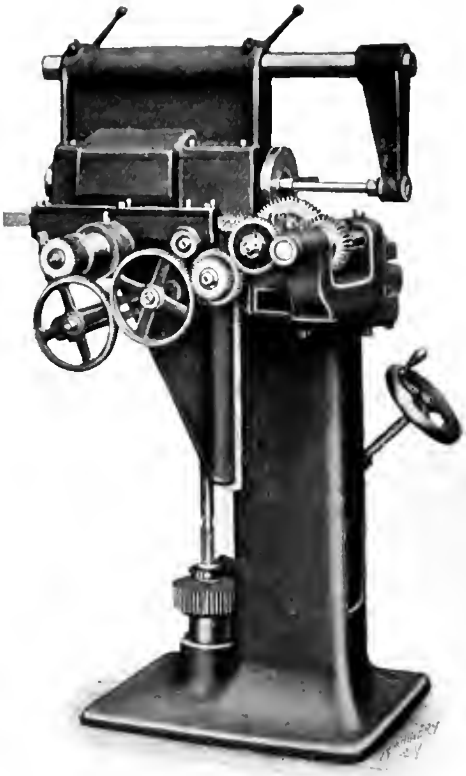


Fig. 2. Left Side of Machine, showing Spindle and Work Drives.

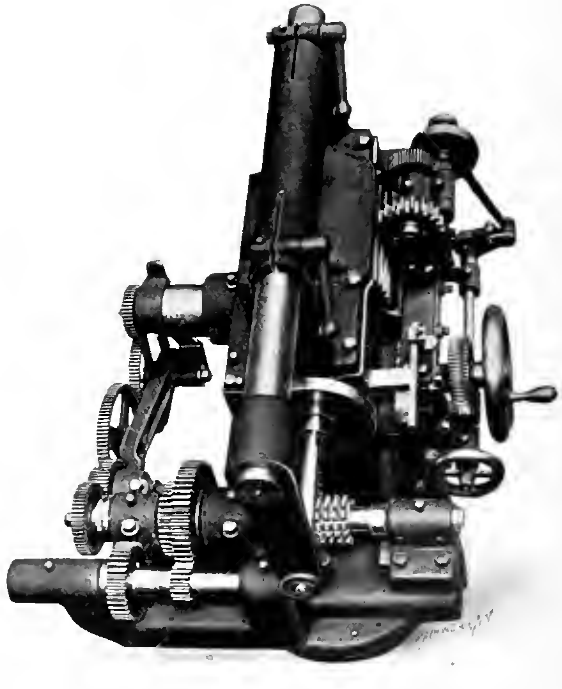


Fig. 3. Top View, showing Back-geared Spindle Drive, Automatic Feed, etc.

That the machine is also simple in its mechanism will be realized by tracing the connection between the hob-spindle and the work, and comparing it with the complication usually

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* Article on "Gear Cutting Machinery," March, 1908, Engineering Edition.

found necessary for this. The broad face spur gear to which the work-spindle is keyed, is driven by a worm of the same thread angle as the hob. Setting this worm to mesh properly with the parallel teeth of the work-spindle driving gear, brings it into parallelism with the cutter spindle, so that the matter of connecting them to secure the proper rotary speed of the work is as simple as that of gearing the lead-screw of a lathe. The change gearing is mounted on a swinging arm, pivoted to the cutter spindle head at one end, and suspended from the vertical adjustable knee at the other, so that it is possible to adjust the latter for the depth of cut without throwing the gears out of mesh.

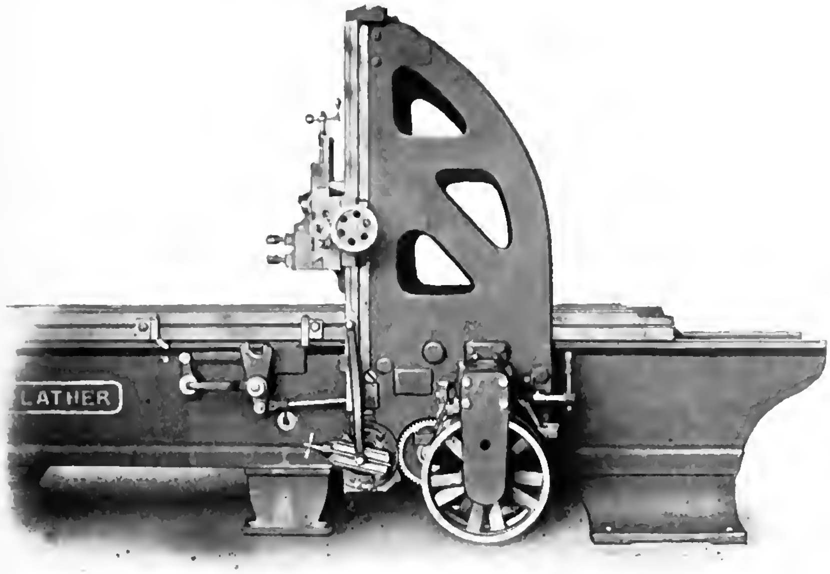


Fig. 1. Thirty-inch Flather Planer, with Two Forward Speeds and Constant Quick Return.

The feed of the work-slide or carriage is effected by two racks on the under side, driven by pinions in a shaft fixed in the knee, and terminating in the hand-wheel shown at the right in Fig. 2. This feed is operated through the worm gearing shown, from a ratchet mechanism, driven by an adjustable slotted crank connected with the work driving gear. An automatic stop is provided for the feed. This, as is plainly shown in Figs. 2 and 3, operates by dropping the feed worm from engagement with the wheel on the pinion shaft. The broad face of the work driving gear permits the full travel of the slide without disturbing its proper mesh with the worm by which it is driven from the hobbing spindle. The racks by which this slide is fed are approximately in line with the thrust of the cut, being a little below on small gears and a little above on large gears. This reduces the wear on the carriage and equalizes what wear there is, so that there is little tendency for the bearings to wear loose in the middle.

The work arbor has a substantial outboard support, as shown, which greatly increases the capacity of the machine and the quality of the work, since it avoids the chattering which often limits the output on work of this kind. The machine is driven by a three-step cone and a 3-inch belt. The hob spindle is back-geared with the driving shaft througn the sliding gear connection shown, giving six changes in geometrical progression. The drive has been proportioned with special reference to high-speed hobs, which it is guaranteed to be capable of driving to their limit. The size shown will cut up to 6 diametral pitch in steel and 5 pitch in iron. The dimension limits are 12 inches pitch diameter and 6-inch face. The machine weighs about 1,400 pounds. It is expected soon to place other sizes on the market.

FLATHER TWO-SPEED PLANER WITH CONSTANT RETURN.

The Mark Flather Planer Co., Nashua, N. H., is building the two-speed planer shown herewith, which is designated as the "Rapid Action" type. In the minds of the builders, there are serious objections to many of the methods which have been tried for increasing the ouput of the planer Some of these designs have been commercially successful, while others have not held their places as factors in the field. Among the new constructions which have been tried are: Accelerating mechanisms for the forward stroke and for the return stroke; and planers with 2-, 4- and 6-speed drives, some mounted in the countershaft, others on top of the housings, and still others in the bed. In bringing out the design, shown in Figs 1 and 2, it has been the aim to avoid some of the objections of the other plans mentioned above. Particular attention has been given to reducing mechanism, too much of an opportunity for wearing, a tendency towards vibration and other similar drawbacks.

It was considered in designing this machine that two speeds for the cutting stroke would practically cover all conditions, since the planer, while requiring a variable cutting speed, does not demand so wide a variation as other machine tools. In practice, it was concluded that a slow speed for roughing and a higher one for finishing, cover the requirements satisfactorily. The planer here shown has been provided with a new shifting mechanism, and has two speed changes in the bed, as shown plainly in the line drawing in Fig. 2.

The usual belts and driving pulleys are retained. *A* and *B* are the loose and tight forward-stroke pulleys, while *C* and *D* are the loose and tight quick-return pulleys, respectively. The loose pulleys are of wider face than the tight pulleys, and unlike the latter, which are made as light as possible, are provided with heavy balance wheel rims. The purpose of this is to assist in the reversing of the machine without throwing the usual destructive strain on the high-speed belting. Light, double 2¾-inch wide belts are used, without slipping or flapping. It will be noted that these belts are wider than the tight pulleys *B* and *D*. This means that they are constantly in contact with the balance wheel pulleys *A* and *C*, so that the effect of these heavy revolving rims is applied directly to reversing the planer table.

Fig. 2. Speed Change Mechanism in Bed.

The gearing connections will be easily understood from a study of Fig. 2. Driving pulley *B* is keyed to the driving

shaft *F*, which carries, inside the bed, pinions *L* and *M*, which mesh with corresponding gears *N* and *O* on intermediate shaft *K*. These latter gears can be shifted so that *O* will be driven by *M*, or so that *N* will be driven by *L*, thus giving the two rates of cutting speed for the forward drive. The reverse is operated by tight pulley *D*, which is keyed to the hub of pinion *H*, meshing with gear *J* on intermediate shaft *K*. The speed of the return is thus constant, irrespective of the position of sliding gears *N* and *O*. The latter are shifted by a block fastened to a rod, which has rack teeth at its outer end engaging a pinion on a rock shaft, operated by the handle shown at the right of the shifting mechanism in Fig. 1.

An ingenious and effective point in the design of this machine relates to the mounting of the four pulleys *A*, *B*, *C* and *D*. The loose pulleys *A* and *C* are each independently mounted on stationary bearings of their own. The forward loose pulley *A* revolves on a stationary journal *E*, which is a part of the heavy overhanging cast iron arm, which contains the shifting mechanism, as shown in Fig. 1. It has no connection whatever with drive shaft *F*, so that the latter is relieved from the belt pull, except when it is itself being driven. Loose pulley *C* is likewise supported by a stationary bearing; in this case, quill *G*, which is seated in a bored hole in the frame as shown. On this quill also revolves pinion *H* and pulley *D*, keyed to it, as previously described. Since the loose pulleys are provided with stationary bearings, excessive wear, heat and friction caused by the customary practice of having pulleys revolved in one direction on shafts rotating in the other, are eliminated. This amounts to a cutting down of the number of revolutions of the loose pulley on its bearing by almost a half a million revolutions per day, and brings, consequently, an appreciable reduction in the friction loss. Bearings of both loose pulleys are of large diameter and are very rigid; they are provided with suitable arrangements for oiling.

Another change incorporated in this design relates to the belt shifting mechanism, which has here been designed to employ the drum type of cam. This has been found to operate more easily and give a quicker action than the plate cams formerly used. The planer herewith shown was arranged for giving cutting speeds of 26 and 45 feet per minute, with a constant return of 120 feet per minute. Its operation has been very satisfactory.

BAIRD FOUR-SLIDE AUTOMATIC WIRE FORMING MACHINE.

The Baird Machine Co., Oakville, Conn., has placed on the market the four-slide automatic wire forming machine illustrated herewith. Machines of this type have become the standard for general work in wire bending, being adapted to the shaping of all except unusually complicated or special forms. This type of machine may be fairly considered as universal in its range, since by means of the various adjustments provided, and by the use of suitable formers, work of great variety may be produced. The makers of the new design shown herewith have had the benefit of long experience in the operation of wire machinery, and have thereby been enabled to include in this design many features that make for increased efficiency. The machine has the advantages of few and simple adjustments, accessible mechanism, easily acting cams, ample bearings and rigid construction.

The general design of the four-slide automatic wire forming machine, as best seen in Fig. 2, provides for a working table with shafts on its four sides, carrying cams operating corresponding slides, which approach the work from four different directions. The left-hand cam-shaft also operates an automatic feeding mechanism, which draws the wire through the straightening rolls, and feeds it so as to be cut off to the proper length to suit the work. The wire straightening rolls shown at *A* are so arranged as to face the front, leaving the wire in plain view of the operator while it is being straightened.

A simplified feed mechanism is used. As plainly shown in Fig. 1, it is operated by a slotted crank whose length of stroke is varied by the knurl-headed screw shown at *B* in Fig. 2. For accurate feeding, positive stops *C* are provided for the feed slide. These stops are quickly and easily set. This mechanism is designed to be an improvement over various geared and slotted lever arrangements previously used, or the friction device sometimes employed. The adjustments for length of feed are operated independently of the feed grip. Neither the latter nor the binding cam requires any adjustment, as the time for gripping and releasing is practically the same for all lengths. The feed throw-out is shown at *L*.

The cut-off is quickly and easily adjusted by the loosening of cam bolt *D*, and the turning of stud pinion *E*, which engages a rack by means of which the proper change is more easily and delicately effected than by the more common method of tapping the bracket in either direction until the right adjustment is reached.

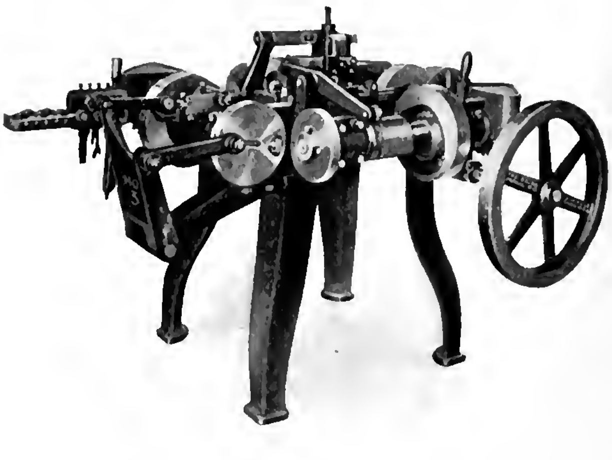


Fig. 1. The Baird Four-slide Automatic Forming Machine for Wire Goods.

Another advantage of the machine is the employment of a swinging former *F*, which permits the use of either a stationary or moving form without change of bracket. The form-holder is suspended from a pivot, and held in line with the wire by a spring; it is carried back by the front tool against the abutment of the heavy, solid bracket. This arrangement permits higher speed and easier movement than is possible when a heavy slide is used in place of the swinging former. The adjustments of the form bracket are shown at *K*.

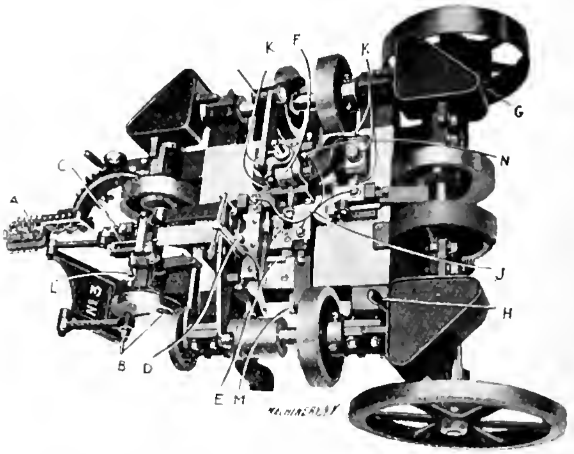


Fig. 2. Top View of Machine, showing Mechanism and Adjustments.

The form holder can be held back by a set-screw when using a stationary form, or it may be taken out and a solid form put in.

The machine is driven by the friction clutch pulley at *G*, controlled by the lever *H*, which is convenient to the operating position. This does away with the necessity for a countershaft, and enables the operator to try the operation slowly and to watch it closely at the same time. The friction can be so set that any undue strain will stop the machine, and prevent the breaking of tools. All the adjustments, as may be plainly seen in Fig. 2, are at the top of the machine and can be reached from the operator's position at the front. Adjustments for the tools are shown at *J*, for the form bracket at *K*, and for the stripper at *N*. These machines are made in six sizes, from No. 0 to No. 5, working wire up to ⅜ inch in diameter and 15 inches long.

PRECISION BORING TOOL.

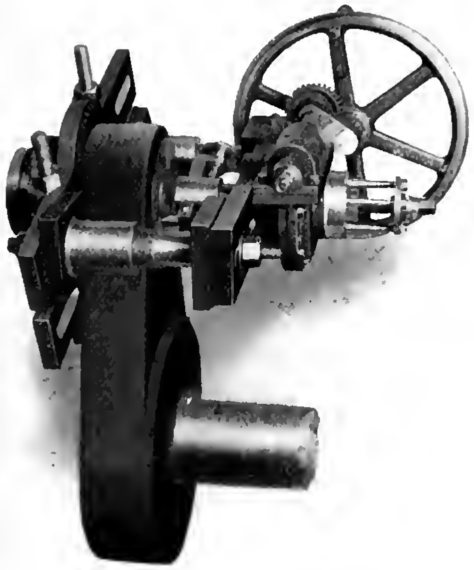
The illustration shows a boring tool adapted to be held in machines with rotating spindles, such as drill presses, milling machines, lathes, etc. It is provided with means for adjusting the diameter of cut made by the rotating tool, so that the workman may know the amount he is removing with each chip. As shown, the main member is a sleeve having a solid shank at right angles to it, by means of which it is held in the spindle of the machine. In this sleeve is carried a tool-holder, adjustable for different diameters by means of a screw having a knurled and graduated head. These graduations read to thousandths of an inch, permitting a high degree of accuracy in operation. The adjustment, when made, is locked by the upper nut shown on the tool-holder shank. The boring tools themselves are held in the split end of the spindle by tightening the lower of the two nuts.


Rotating Boring Tool with Micrometer Adjustment for Diameter.

The body and holder of this tool are made from drop forgings. The cylinder, tool-holder and lock-nut are carbonized to increase their durability. The device will bore holes up to 3 inches in diameter. It is made by the Precision Boring Tool Co., 210 Wetherbee Building, Detroit, Mich.

UNDERWOOD PORTABLE BORING, TURNING AND FACING MACHINE.

The latest addition to the line of portable tools made by H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., is shown herewith. It was originally designed for the special work of cutting out the countersink for removing riveted crank-pins. This is a laborious and time-consuming operation when done with a hammer and chisel. The mechanism is mounted on a solid cross-head which carries a casing containing a worm-wheel, journaled on large integrally formed hubs.


Machine designed for Cutting out Riveted Crank Pins, but adapted to General Facing, Turning, etc.

The cutting spindle has a sliding movement of 4 inches through the worm-wheel, the feed being operated by hand. The end of the spindle carries a steel slide for the cutting tool. This is adjustable for different diameters by the screw shown, the maximum diameter being about 12 inches.

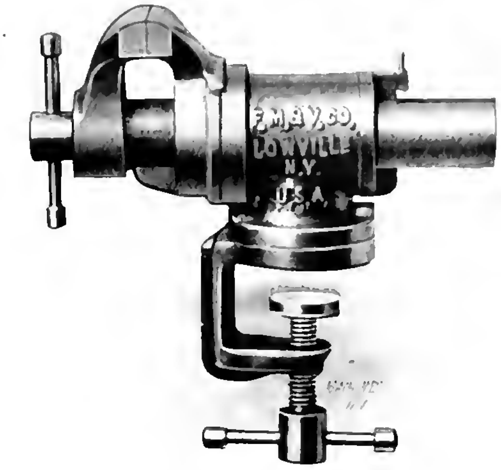
Two clamping plates, with centers cut to a V-shape, which will take a wide range of sizes, clamp the device to the work, being tightened together by 1-inch through bolts. Separate adjustable spacing blocks, or studs threaded to receive each other, may be used for straddling cranks, the spokes of locomotive drivers and other work of varying dimensions. Bolts passing through these blocks clamp the machine proper to the cross-heads. The entire arrangement is very firm and solid, and each piece is light enough to be easily handled by one man. The machine is quickly centered

Three changes of speed, for heavy, medium or light work, are provided. These speeds are obtained by interchanging the gears shown on the driving shaft, or by driving direct without them. The spindle is at right angles to the base or cross-head, and by means of an extra facing attachment can be used for facing off pump or engine valve seats, it being immaterial whether or not the steam chest is solid, or the valve seat several inches below the face of the chest. The machine may be driven by hand or any other suitable power.

As may be seen, the range of usefulness of this device is much greater than the operation of removing riveted crank-pins, for which it was first designed. It may be employed, for instance, in facing up a pipe flange that is out of true. It is practically a universal boring, turning and facing machine for work within its range.

PORTABLE DOUBLE-SWIVEL VISE.

The Fulton Machine & Vise Co. of Lowville, N. Y., builds the universal, vertical and horizontal swivel vise illustrated herewith. It is of a size which is particularly suitable for motor boat and auto equipment, though of course it may be used wherever a small swivel vise is required. A special adaptability to automobile use is given by the universal adjustment, as it is otherwise often impossible when working in a small space, to hold the work with the full length of the jaws. Both swivels are clamped tightly by the gripping of the work, which will slip before the swivels will change position. When the work is gripped, all lost motion is taken up, and the whole tool becomes as rigid as a solid jaw vise. It is claimed by the makers to be stronger than any solid jaw design of the same capacity, having nearly twice the weight.



A Vise adapted to Motor Boat and Automobile Use.

The jaws are steel faced and tempered, the finished parts are nickeled, and other parts are painted with best black enamel. The nut is of malleable iron, and is of the same diameter as the body, having a bearing around the entire outer edge. There are no levers or pivots in the adjusting mechanism to break or wear out. The jaws are two inches wide, and open two inches, and the tool weighs 7½ pounds. It is adapted to be fastened by the clamp shown, to the running board, or any other suitable support.

* * *

In a letter to the Department of Commerce and Labor, Consul-General S. Listoe states that the ancient Dutch windmills are slowly giving way to more modern prime movers, and that gas engines are being introduced in many places, to take the place of the windmills. The reason for abandoning the windmill is the uncertainty of its motive power. At the same time, however, it should be noted that in Denmark, extensive experiments have been made with windmills as motive power for electric machinery, and that plants provided with supplementary gas engines for use when the wind fails, have proved satisfactory. Some small Danish towns have built electric lighting plants operated in this manner.

NEW MACHINERY AND TOOLS NOTES.

Double Stroke Open Die Header. E. J. Manville Machine Co., Waterbury, Conn. This is a new size of the builders' well-known machine design, for the cold heading of parts made from wire up to ½ inch diameter.

Electricians' Screw-Driver. L. S. Starrett Co., Athol, Mass. This tool is similar to the makers' telescopic pocket screw-driver, except that the handle is made of insulating material, fitting it particularly for electricians' use.

Solder File. Hayes File Co., Detroit, Mich. This firm has recently commenced the making of files of a special cut, particularly adapted to work on solder, babbitt and other metals of a similar character, which rapidly fill the teeth of the ordinary file.

Combined Triangle, Scale, Protractor and Erasing Shield. D. J. Kelsey, New Haven, Conn. This drafting instrument is a combination of the various tools mentioned, being an extension of the maker's well-known combination 30, 45 and 60 degree triangle.

Foot Press. La Salle Machine & Tool Co., La Salle, Ill. This foot press is mounted on a table supported on legs, which allow free movement for the operator. It is solidly built and provided with adjustments which maintain its proper action for an indefinite period.

Duplex Die Stock. Borden Co., Warren, O. This tool, which the makers call the No. 6 Beaver die stock, is provided with two sets of chasers, either of which can be used as desired. A single cam changes from one set to the other, and adjusts each set to the proper size.

Pneumatic Chipping Hammer. Pittsburg Pneumatic Co., Canton, O. This is a compact chipping hammer, provided with an air cushion arrangement which reduces vibration to a minimum. It is made in six sizes, weighing from 4½ to 10 pounds, with strokes ranging from ½ to 4 inches.

Radius Gage. L. S. Starrett Co., Athol, Mass. These tools are provided with both concave and convex radius gage surfaces ranging from 1/16 to ½ inch radius for the small size, and from 17/64 to 1 inch for the larger size. They are intended for general use of tool-makers, pattern-makers, etc.

Steel Drafting-Room Table. The Century Mfg. Co., Columbus, O. This is made of angle, flat and round stock throughout, and is so braced as to be very rigid. It can be folded up and adjusted to various positions as may be required. Parallel ruler, and a bracket and tray will be furnished when desired.

Monorail Electric Hoist. Alfred Box & Co., Philadelphia, Pa. These hoists are designed to run on I beams, and are furnished in either the hand- or power-traverse styles, the hoist being operated by an electric motor. Two brakes are furnished, one mechanical and the other electrical, to prevent accident while under load.

Emery Wheel Stand. George H. Calder, Lancaster, Pa. This stand is made in five sizes, for maximum diameter of wheels from 6 up to 15 inches. Special attention has been given to rigid construction; a feature of the design is the placing the table low enough to avoid the danger of breakage, by getting a casting between it and the wheel.

Engineers' Gage. L. S. Starrett Co., Athol, Mass. This gage is of the familiar swinging leaf type employed for various forms of gages. This particular instrument comprises a taper gage reading 64ths per foot, nine feeler gages from 0.002 to 1/16 inch and a wire gage graduated in numbers on one side and decimal measurements on the other.

Tilting Tumbling Barrel. Clark Novelty Co., Rochester, N. Y. This barrel is of the open-end type, provided with a mechanism for setting it at any angle, and thus emptying it and refilling it while in motion. The barrel will be furnished either in cast iron, sheet steel or wood. The machine was developed for use in the shops of the makers.

Tilting Vise For Drill Press, Planer, Shaper, Etc. Blissfield Motor Works, Blissfield, Mich. This tool, called the "Davenport" tilting vise, can be adjusted to any position from the horizontal to the vertical, being supported by diagonal braces at the desired angle. The jaws are 2 inches high and 5 inches wide, and open 6 inches.

Bench Drill Press. Blissfield Motor Works, Blissfield, Mich. The "Davenport" bench drill has the form of the standard drill press on a small scale. It is furnished with a two-step or three-step pulley, as required by the purchaser. It will drive drills up to ¼-inch diameter to the center of a 7½-inch circle.

Combined Forming and Bending Machine. Royal Mfg. Co., Lancaster, Pa. Intended for forming and bending light shapes for general steel work. It will bend small rings or circles of various sections up to the equivalent of ½ inch square stock. A plating and crimping attachment is furnished for ornamental work.

Twelve-Foot Boring Mill With Slotting Attachment. Betts Machine Co., Wilmington, Del. This is a regular boring mill except for the fact that it is provided with a 12-inch boring bar and a slotting attachment, which fit it for the economical finishing of central holes in pulleys, etc., and the splining of the keyways without removing the work from the boring mill table.

Elgin Counter-shaft for Precision Lathes. Elgin Tool Works, Elgin, Ill. This self-contained counter-shaft may be mounted on column supports on the work bench, or on brackets attached to the wall. Convenient provision is made for forward or reverse speeds, and for driving milling attachments, grinding attachments, etc., at any point in the length of the lathe bed.

Centering Device. Patterson, Gottfried & Hunter, New York City. This device consists of a series of blocks, so connected by sliding shafts that they move together simultaneously toward the central bushing, which is thus centered when the blocks are brought down around a piece of square or round stock. The center is then marked by a prick punch, guided by the bushing.

"Perfect" Power Hammer. Macgowan & Finigan Foundry & Machine Co., St. Louis, Mo. This hammer is of the direct action type in which the crank is mounted directly above the ram. It has an adjustable connecting rod and adjustable spring tension. It is made in three sizes, the rams weighing from 30 to 80 pounds. The largest of this line of hammers will work iron up to 3½ inches thick.

Self-Contained Gear Reduction Mechanism. Newark Gear Cutting Machine Co., 66 Union St., Newark, N. J. This device as furnished is formed of an oil-tight casing, containing a train of worm and spur gearing giving four speed changes. It is particularly adapted to direct connection with a motor for driving slow speed machinery, such as annealing and hardening furnaces, etc., at varying rates of speed.

Universal Joint. Michigan Wheel Co., Grand Rapids, Mich. This joint is ordinarily designed for propeller shafts, but can evidently be applied to other purposes. Center blocks, forks and journal pins are of steel, the latter being hollow to serve as a reservoir for oil, supplying enough for an ordinary season's service without refilling. The forks are bronze bushed under hydraulic pressure, and are ground to fit the journal.

Roller Relief Bearings. Pickering Governor Co., Portland, Conn. These bearings are intended for supplementary or emergency use, to relieve the strain on overloaded bearings wherever necessary. Each consists of a roller supported on internal roller bearings, and provided with adjustable mountings for jacking up and supporting the shaft. They are made in sizes to be used for all purposes from light counter-shafts to engines of moderate size.

Ball Thrust Bearing. International Engineering Co., 1779 Broadway, New York City. The "R. B. F." ball bearing has been placed on the market in a style to operate as a double acting thrust bearing. These bearings are self-contained units, and may be handled as one piece. The races are held in spherical seats, which permit change of alignment without disturbing the accuracy of its action, and without disturbing the distribution of the load on the balls.

Combined Steel and Hemp Belting. Massachusetts Belting Co., 207 Congress St., Boston, Mass. This belting consists of interwoven strands of steel wire served with specially prepared hemp marline. The belt thus formed is protected at the edges by solid steel wire to make it proof against wear from belt shifters, etc. The purpose of this construction is to combine the strength of the steel with the durability and high coefficient of friction of the hemp.

Supplementary Turret for Boring Mills. Bullard Machine Tool Co., Bridgeport, Conn. This turret tool-holder fits in the tool-slide in place of the regular tool head, and may be rotated about a vertical axis to bring a succession of cutting tools into action. There are four faces to the device, permitting the holding of four tools in each head. The saving is considerable as compared with the taking out and replacing of tools in manufacturing work with the regular tool head.

Universal Attachment for Milling Machines. Porter-Cable Machine Co., Pearl & Canal Sts., Syracuse, N. Y. This attachment is universally adjustable to fit any commercial milling machine having an overhanging arm. It is intended particularly for high-speed milling. The spindle is driven by bevel gears and belting from the main spindle of the machine, and may be set at any angle about two axes at right angles to each other, thus giving it a full universal adjustment.

Centering Lathe. Climax Co., Hyannis, Mass. This is a specialized form of lathe, having a large hollow spindle, with a chuck at each end for supporting the stock. The centering drill is operated by a second revolving spindle on the tailstock. For accurately centering finish work, a steady rest is provided; in this case only one of the chucks is used—either the one on the inner or the outer end of the hollow spindle, as is required by the work. The drill runs at 600 revolutions per minute, and the chuck at 25 revolutions per minute.

Internal Grinding Machine. Bath Grinder Co., Fitchburg, Mass. This grinding machine is unique in being provided with two spindle heads, and in having the work mounted in a revolving sleeve. This makes it possible to mount the wheel in the middle of a separable spindle, driven at both ends, thus giving a far stiffer support than is usually obtained and resulting in an increased output. The machine is heavily made, to minimize trouble from vibration, and is fully provided with the various adjustments and attachments necessary for the work it is called on to perform.

Automatic Air-Controlled Nut Tapping Machine. Pneumatic Nut Machinery Co., Cleveland, O. In this machine a horizontal six-sided turret is provided, carrying six revolving taps. Automatic magazines and pneumatic feeding mechanisms on each side of the turret feed nuts into the taps as they are successively indexed into position in front of them. An automatic stopping mechanism pulls the tap clear off the chuck and removes the nut from the shank, replacing the tap ready to receive a new nut when it again arrives in front of the feeding mechanism. The machine faces the nuts as well as threads them.

Threaded Adjustment for Micrometers, Drill Spindles, Screw Jacks and Other Uses. F. E. Bocorselski, Supt., Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. This form of adjustment comprises a nut, threaded to a hollow sleeve, which is provided with a slot through which passes a cross-arm; on this the inner member is supported, so that by the turning of the outside threaded collar or nut the entire member is adjusted longitudinally. This construction has been applied by the inventor to ratchet drills, micrometers, screw jacks, etc., and to the individual adjustment of drills for multiple spindle machines.

Single Crank Power Press. Toledo Machine & Tool Co., Toledo, O. This press is unusually large for its type, and is intended for making stampings from heavy gage metal. It is provided with an automatic releasing clutch for stopping the press at the high point of the stroke, and a hand lever control for stopping and starting the press anywhere at will. The press frame is of the four-piece construction, reinforced by four heavy steel tie-rods. The stroke is 24 inches, and the pressure capacity about 1,250 tons. The friction drive releases instantly when the press is subjected to an overload of 25 per cent greater than this amount.

Multiple Spindle Drilling Machine. Cummings Machine Co., 238 William St., New York City. This drilling machine is of the type in which a multiplicity of spindles are mounted so as to be set to any required layout. A number of new features are provided, not common in machines of this kind. Methods of holding the various spindles and adjusting them to the required position have been carefully worked out, and are unusually convenient. The center-to-center distance has been reduced to a very small dimension, it being possible to drill four 29/32 holes with the centers at the corner of a 1 1/32 inch square. Each drill spindle is driven through a flexible jointed shaft from an independent, self-contained spiral gear drive. These drives may be readily changed to give different speed ratios, thus driving drills of various sizes in a given layout at the various speeds required for effective work.

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THE CLERMONT REPLICA FOR THE HUDSON-FULTON CELEBRATION.

The officers of the Hudson-Fulton Celebration Commission have let the contract for building a replica of Robert Fulton's *Clermont* to the Staten Island Shipbuilding Co. Work has already begun on the copy of the first boat to steam up the Hudson, and the contract calls for its completion by August 1. The boat will be a duplicate of Fulton's first boat, will run under its own steam with a boiler and engine exactly like those which Fulton had built, and will be able to attain the same speed as the *Clermont*—four to six miles an hour! The only differences between Fulton's boat and that which is being built for the celebration next September are those which the steam boat inspection laws make necessary. If the steamboat inspection department had been in existence when Fulton started on his first trip up the river, he probably would not have been allowed to proceed without stopping to put on safety valves, life preservers and other appliances which the present steamboat laws require.

Except for these differences and a slight change in the width of the boat which the steamboat inspection laws require the *Clermont* which is building now will be exactly like that which made the residents along the Hudson in 1807 believe that the earth was coming to an end. She will have the same uncovered side paddle wheels which splashed water on her first passengers, the same little square cabin forward and the same awkward engine and machinery which, however, made practical the navigation of the Hudson without the necessity of waiting for a favorable wind. To be sure, the average speed of the *Clermont* on its first trip was only 4.6 miles against the wind, but this was such an improvement over the average speed of the sailing vessels that it was the cause of great rejoicing.

The search for accurate data on Fulton's first boat by the committee in charge was a long and arduous one. There was plenty of data concerning his subsequent boats, but there appeared to be very little concerning the first boat that steamed up the Hudson. Drawings of her engine were finally found, and from a letter of Hudson's which was unearthed it was learned what the hull of the boat looked like.

The original *Clermont* was 150 feet long and 13 feet wide, with 7 feet depth of hold. She drew 2 feet of water. Her hull (below the deck) had wedge-shaped bow and stern, cut sharp to the angle of sixty degrees. In horizontal plan the sides were parallel and she was almost wall-sided, being a very little wider on deck than on the bottom, which was flat and without a keel. She had two steering-boards or leeboards to prevent drifting sideways. She had two masts, but no bowsprit or figurehead. There were two cabins, one forward and one aft. The tiller was at the back end of the after cabin, so that it was difficult for the helmsman to see what lay ahead. The engine, built in England, was amidship between the two cabins and was uncovered. The boiler was of copper. The paddlewheels, 15 feet in diameter, were uncovered, which resulted in drenching the passengers, and no guards protected the wheels from collision. Later the paddlewheels were covered. To turn the vessel around one paddle-

wheel was disconnected. The flywheels of the engine were outside of the hull forward of the paddlewheels, and revolved the same way. On one occasion, when one of the paddle-wheels was disabled, it is said, paddles were attached to the flywheel and the voyage continued.

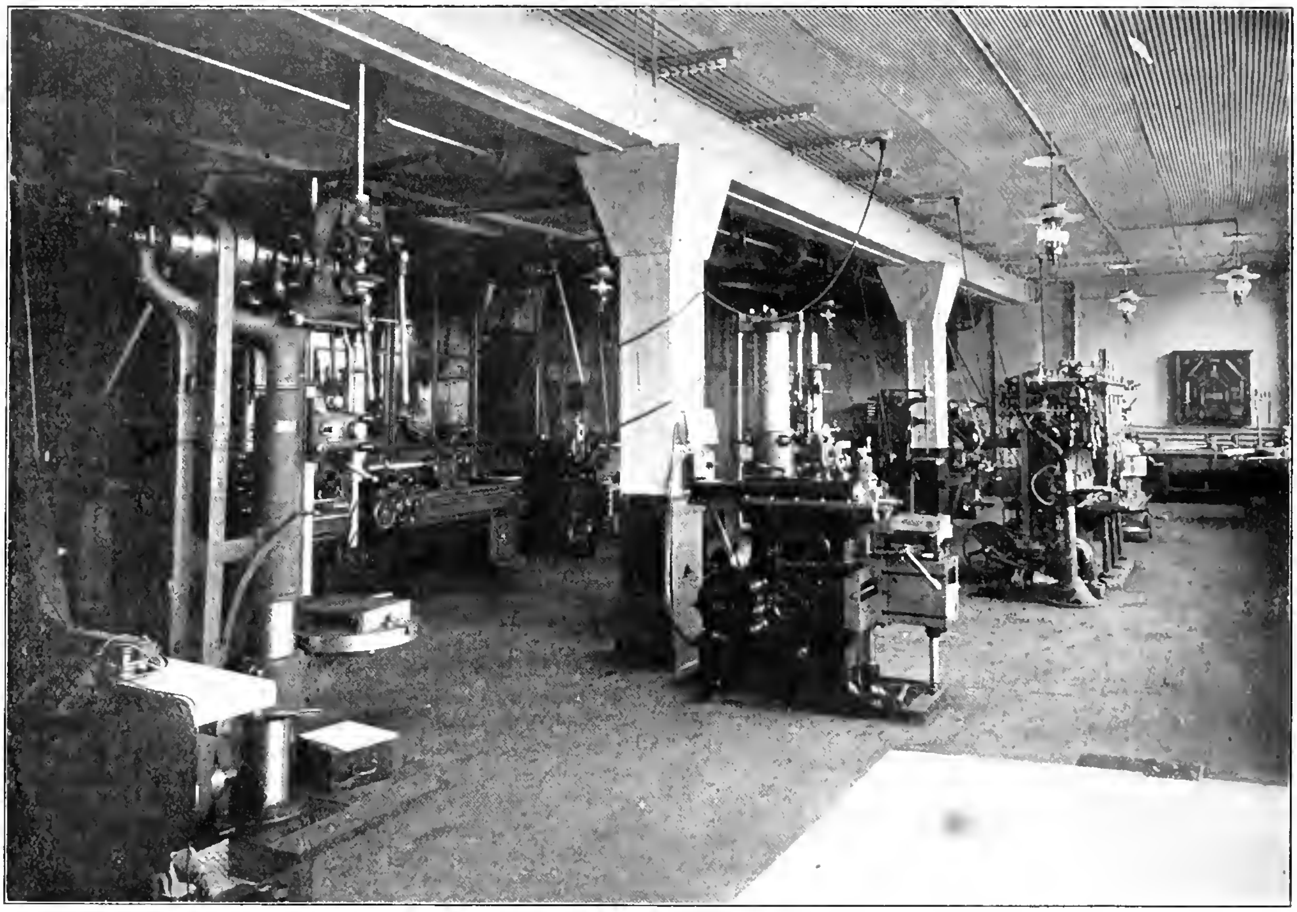
The *Clermont*, with the replica of Hudson's *Half Moon*, which is being built in Holland, will be the center of the great naval parade which will start from New York and steam to Newburgh on Friday, October 1. To convoy these two little vessels there will be fleets of American and foreign warships, great river craft and ocean steamships that have evolved from Fulton's awkward little steamboat.

* * *

A NEW MACHINE DEMONSTRATING ROOM.

On Saturday evening, February 20, the Marshall & Huschart Machinery Co., of Chicago, opened its new demonstrating room and many men prominent in the machine world were present. The speakers of the evening gave some very interesting and instructive talks, illustrated by practical examples on the machines. Chas. S. Gingrich, of the Cincinnati Milling Machine Co., spoke on "Milling Machines"; S. H. Peck of the Rockford Drilling Machine Co., spoke on "Multiple Drilling"; E. P. Bullard, Jr., of the Bullard Machine Tool Co., talked on "Boring Mill Practice," and J. W. Carrel of the Lodge & Shipley Machine Tool Co., completed the list of speakers with his talk on "Lathe Practice."

The new demonstrating room was fitted up to actually show what the various machines can do. No set pieces are kept in the machines, but they will be set up and tried out on any job that a prospective purchaser calls for, and as the equipment of the room is unusually complete in machines, tools and material, the demonstrations promise to be very valuable to the "man from Missouri." E. V.



New Demonstrating Room of the Marshall & Huschart Machinery Co., Chicago, Ill.

* * *

NEW PACKING MATERIAL FOR ANNEALING STEEL.

It is commonly known that steel gains in strength and uniformity of its structure by slow heating to a certain high temperature, followed by slow cooling, but it is only recently that the requisites for successful results have been well understood. Most important among them are the correct ultimate maximum temperature and the very slow and uniform heating and cooling. To secure this latter, some sort of covering must be given to the steel to be so heated, to prevent rapid cooling and oxidation of the surface. Such a protecting packing must be a good heat insulator, that is, allow heat to pass through it but slowly, and also must contain no constituents liable to affect the quality of the steel, either through fusing or oxidation. This requires that the packing shall be infusible at the temperatures used and shall not be capable of absorbing gases.

There are numerous packings which have been used for this purpose with more or less success. Some compositions are secret and highly expensive, others are lacking in uniformity and hence unsatisfactory, while others are satisfactory within certain limits. The Laurentide Mica Company, Ltd., Box 911, Pittsburg, Pa., has just placed on the market a product known as "Micanneal," which has proven itself to be the superior of the packing ordinarily used for this purpose. It is infusible, will not absorb gas and is a remarkably good heat insulator. Therefore it prevents the steel from being heated or cooled too rapidly, and also protects it from oxidation. The specimens come out clean when packed in Micanneal, whereas such combinations as are ordinarily used are scaly. Under the same circumstances specimens packed in Micanneal will require from 25 to 150 per cent longer to heat and to cool than with any other packing, which insures greater uniformity of the steel. Micanneal is prepared in different degrees of fineness from the coarsest to the finest mesh. It is ordinarily sold in lots of approximately 100 pounds.

* * *

An alloy made of 70 per cent nickel and 30 per cent copper, and known as monel metal, has recently been placed on the market by the Orford Copper Co., Bayonne, N. J. According to the *Engineering and Mining Journal*, the tensile strength of the material is about 108,000 pounds per square inch, and the elastic limit of rolled, annealed and cold drawn material is 98,000 pounds per square inch. It is stated that the roof of the new Pennsylvania Railroad station in New York City will be covered with sheets of this alloy.

PERSONAL.

A. J. Dinkel is now the superintendent of the Lisle Mfg. Co., Clarinda, Ia.

Walter B. Snow, Boston, Mass., has been elected a member of the corporation of the Massachusetts Institute of Technology.

John D. Powers, for some years past in charge of the hacksaw department of H. Disston & Son, Inc., Tacony, Pa., severed his connection with that concern on March 31.

James W. Ogden, formerly superintendent of the Bridgeport Foundry & Machine Co., Bridgeport, Conn., is now superintendent of the Wolverine Motor Works, Bridgeport.

George Chase, formerly superintendent of the Pacific Iron Works, Bridgeport, Conn., is now superintendent of the Lake Torpedo Boat Co., Bridgeport.

A. L. Mitchell, for some time round-house foreman for the Wabash R. R. at Decatur, Ill., is now general foreman of the C. P. & St. L. Ry. shops at Springfield, Ill.

W. A. Hopkins, electrical engineer for the Wabash Ry., is now engaged in installing the electrical machinery for the new drop-pit in the Wabash shops at Springfield, Ill.

The successor of Edmund Pennington as vice-president and general manager of the Soo Line, will be John M. Egan, who for several years has been general manager of the Great Western Railroad.

The official photographer of the E. R. Thomas Motor Co., Buffalo, N. Y., is Miss Mimmette Ives Meade, who probably is the only woman in the United States making a specialty of machine shop photography.

H. W. Heidenger, a graduate of Rose Polytechnic Institute, Terre Haute, Ind., has been made mechanical engineer of the Baltimore & Ohio Southwestern Railroad, with headquarters at Washington, Ind.

A. B. Fleming, purchasing agent of the Fairmont Mining Machine Co., Fairmont, W. Va., has resigned his position, and Clarke Evans, secretary of the company, will attend to the purchasing hereafter.

Henry Dreses, president of the Dreses Machine Tool Co., Cincinnati, Ohio, spent a greater part of February and March on a pleasure trip in Cuba, Florida and other Southern parts.

Charles Sterne, mechanical engineer of the Baltimore & Ohio Southwestern Railroad, formerly located at Washington, Ind., has been transferred to Louisville, Ky., to act as round-house foreman.

J. M. Robinson has resigned his position of assistant superintendent of the Chapman Valve Mfg. Co., Springfield, Mass., and has been made assistant manager of the Henry R. Worthington Co., Harrison, N. J.

J. A. Bennett, for ten years with the Pratt & Whitney Co. and later foreign representative for the Niles-Bement-Pond Co., has been made mechanical engineer of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

L. G. Nilson, chief engineer of the Strang Gas Electric Car Co., 15 Wall St., New York, has been elected president of the Nilson-Miller Co., Hoboken, N. J. Mr. Nilson will continue as consulting engineer for the Strang Gas Electric Car Co.

D. O. Ives, chairman of the official classification committee of the Trunk Lines' Association, New York, and former general traffic manager of the Wabash R. R., has been made secretary of the New England Board of Trade and Transportation.

George F. Fenno, for two years past insurance engineer with the Middle States Inspection Bureau, an organization maintained by thirty-six of the leading fire insurance companies, has joined the staff of the George H. Gibson Co., Tribune Building, New York.

Isidor Rauh, for many years president and general manager of the Cincinnati Electrical Tool Co., Cincinnati, Ohio, has resigned his position and has been succeeded by I. W. Becker. Mr. Becker is well and favorably known throughout the Middle West.

Henry Hair, son of John M. Hair, superintendent of motive power of the Baltimore & Ohio Southwestern Railroad, who succeeded Mr. Charles Sterne, formerly mechanical engineer, has been transferred to Seymour, Ind., to act as round house foreman.

Fred J. Miller, vice-president of the A. S. M. E., became on March 1 connected with the Union Typewriter Company of New York, with the title of Assistant to the President. He will devote himself especially to matters connected with the manufacuring department of the company, which has factories at Ilion, Syracuse and Bridgeport.

J. W. Bray, who formerly represented the Bullard Machine Tool Co., Bridgeport, Conn., in New England territory and for the past year was located in Philadelphia, has returned to the Bridgeport headquarters and will travel in New England territory again. Mr. R. H. Snider has taken charge of the Philadelphia office at 1414 South Penn Square.

A. Eugene Michel has opened an advertising office at 1572 Hudson Terminal Buildings, New York. Mr. Michel is a graduate engineer, and has had eleven years advertising and engineering training. He will confine his advertising work principally to steam specialties and apparatus, power transmission appliances, and machine tools.

Prof. Lester P. Breckenridge, head of the mechanical engineering department of the University of Illinois for several years, has been made professor of mechanical engineering at Yale University and a member of the governing board of the Sheffield Scientific School. Prof. Breckenridge succeeds Prof. C. B. Richards, who resigned after twenty-five years service.

E. V. Thompson, for some time assistant superintendent of motive power of the Chicago & Northwestern Railroad Co. at the Chicago shops, has been made superintendent of motive power of the Chicago, St. Paul, Minneapolis & Omaha R. R., with headquarters at St. Paul, Minn. He is succeeded at the Northwestern shops by Mr. E. W. Pratt, who was master mechanic west of the Missouri River.

Price H. M. Brooks, for many years foreman of the Hill shop and Water shop of the United States Armory, Springfield, Mass., has resigned his position. The position has been abolished, and hereafter the Hill shop and Water shop will be under independent foremen. Donald J. Manning has been made foreman of the Hill shop and C. H. Ladd continues as foreman in charge of the Water shop.

Robert Thurston Kent has resigned as engineering editor of the *Iron Trade Review*, Cleveland, Ohio, to become managing editor of *Industrial Engineering*, Pittsburg, Pa., a new paper devoted to mechanical engineering subjects. Mr. Kent has been with the *Iron Trade Review* since 1905, and prior to that time was associate editor of the *Electrical Review*, New York.

George A. Spooner, for some years inspector of tools at the United States Armory, Springfield, Mass., has been made master armorer, a title that has been revived. The master armorer has charge of all the master gages and tools required for absolute interchangeability of the parts of the guns made in the Springfield, Mass., and Rock Island, Ill., armories. There has been no title of master armorer at Springfield for over fifteen years. The revival of the title makes no change in the duties.

Arthur C. Hoefinghoff has been appointed sales manager of the Heald Machine Co., Worcester, Mass., beginning March 1. Mr. Hoefinghoff comes from New Orleans, La., where he was located for some time as manager of the machine tool department of the Fairbanks Co. He is a brother of the late Harry C. Hoefinghoff, who was at the head of the Bickford Machine and Tool Co., and was associated with his brother in the management of that business. Mr. Hoefinghoff has had extensive experience in the building and selling of machine tools and is well fitted for his new work.

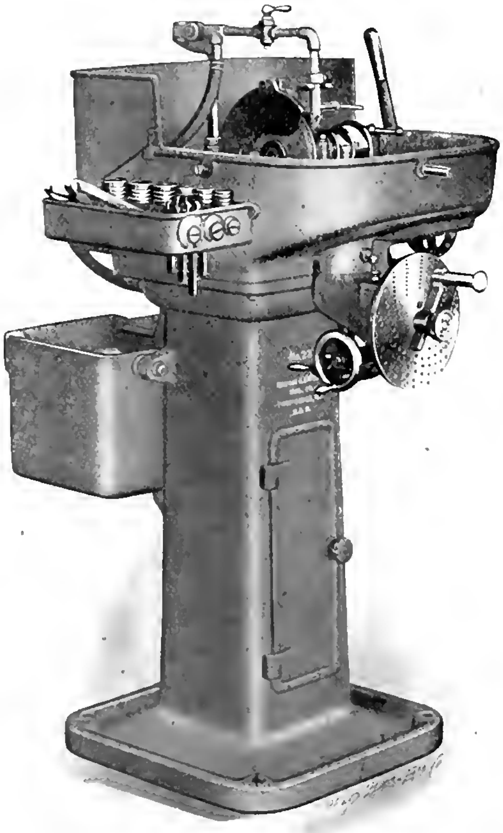
TWO NEW

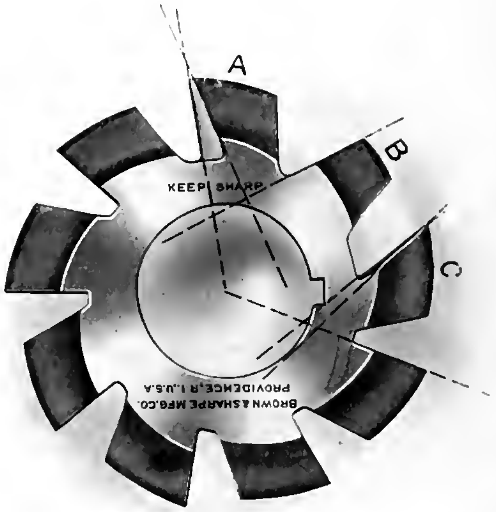
The Gear Cutter Grinding Machine Does Away with the Inaccurate Method of Grinding Gear Cutters by Hand

The form of gear cutter teeth should never be altered or else the accuracy of the cutter is destroyed.

By the aid of an indexing mechanism this machine grinds cutters radially and equidistant, that is without changing their form.

An economical machine to employ where only a few gear cutters are to be ground.





Cut shows how the shape of tooth is lost when ground by hand.

A—Ground on an angle.
B—Ground back of centre.
C—Ground front of centre.

BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.

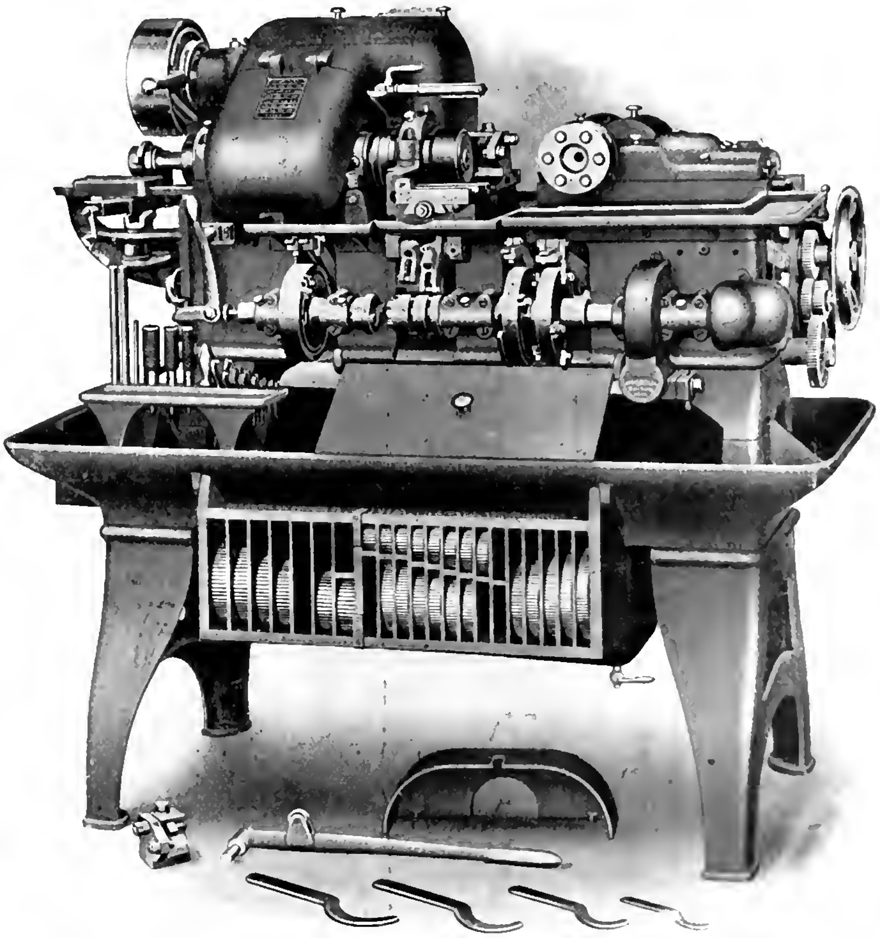
MACHINES

Automatic Screw Machines Of the Constant Speed Drive Type Offer a Distinct Advantage

The complicated overhead works that were formerly necessary are eliminated.

The doing away of the overhead works is an important factor in the development of the automatic screw machine. The care and room necessary to maintain them are dispensed with and all changes of spindle speed, which were formerly made by the awkward shifting of belts are now quickly and conveniently obtained by a system of gearing in the machine, thereby materially increasing its efficiency.

The Constant Speed Drive readily adapts the machine to motor driving.



A special circular describing the machine in detail sent free to any address.

BROWN & SHARPE MFG. CO.
PROVIDENCE, RHODE ISLAND, U. S. A.

Oskar Kylin, formerly designer of special machine tools with the Taylor Iron and Steel Co., High Bridge, N. J., returned on February 26 by the *Adriatic* to New York, after having spent over a year studying the conditions of the machine tool trade and manufacture in various European countries. The main results of his investigations have been published in MACHINERY during the past year in the form of letters and special articles, the latter presenting, with the halftone engravings and concise descriptions, a comprehensive review of the present state of machine tool manufacture in the leading European countries. During his travels, Mr. Kylin went to Germany, Austria, Italy, Switzerland, Belgium, France, England, Denmark and Sweden, visiting the most prominent machine tool manufacturing firms and dealers in these countries.

Einar Morin, formerly in charge of the tool designing department of the Ponds Works of the Niles-Bement Pond Co., Plainfield, N. J., sailed on February 25 by the *La Savoie* for Europe, after a three months' stay in the United States in the interest of his present employers, Stora Kopparbergs Aktiebolag, owners of Domnarfvet's Iron & Steel Works, Borlänge, Sweden. Mr. Morin, who is the author of the series on jigs and fixtures which has been published in MACHINERY during the past year, will spend some time in France and Germany, studying business conditions, and will then return to Sweden, where he will supervise the equipment and take charge of a new manufacturing plant for making machinists' small tools, such as taps, threading dies, cutters, reamers, drills, etc. The series on jigs and fixtures contributed by him to MACHINERY is concluded by the installment in the present issue. We expect, from time to time, to be enabled to publish articles from his pen on interchangeable manufacturing and economical methods of production as developed in his new work.

* * *

OBITUARY.

James Millikin of Decatur, Illinois, president of the Union Iron Works and the Millikin National Bank and founder of the James Millikin University which, with the exception of the State University and the Armour Institute, is the best technical and trade school in the state, died at Orlando, Florida, March 2, aged eighty-two years.

Major Edwin L. G. Zalinski, a retired army officer, an inventor and engineer, died of pneumonia, March 10, in New York, in his sixtieth year. Major Zalinski acquired international fame through his invention of a dynamite gun in which a projectile charged with dynamite was hurled by compressed air. The gun-boat *Vesuvius* was equipped with three of the Zalinski dynamite guns, which threw torpedoes weighing one thousand pounds charged with five hundred pounds of dynamite. The dynamite gun was a practical failure on account of its limited range.

Ervin Saunders, vice-president of D. Saunders' Sons, Yonkers, N. Y., died at the home of his brother in Yonkers, February 17, in his sixty-first year. He was born in Swindon, England, and came to New York with his parents in 1850, and moved to Yonkers in 1854. He entered his father's machine shop at twenty, and after his father's death the firm of D. Saunders' Sons was formed. Mr. Saunders had been in poor health for twenty years and had given more attention to real-estate and his investments than to manufacturing interests. Two brothers, Alexander and Leslie M., survive.

* * *

The enormous number of railway wrecks due to fractured rails has made the need of a higher grade product than the common Bessemer steel rail, very apparent. The open hearth process will in all probability supersede the Bessemer steel process for rail making, but even this steel is not all that could be desired to meet the trying condition of present railway traffic. Heavy engines and high speeds require a rail having physical and chemical characteristics that can be supplied only by some of the alloyed steels. The Bethlehem Steel Co. has, after a long series of experiments, produced a nickel-chrome rail at $51 per ton which, of course, is almost double the present rate for Bessemer steel rails. The standard rail price is $28 per ton for Bessemer steel and $34 for open-hearth steel. It is hardly to be considered that the Americal railways will generally adopt rails that cost $51 except for curves and stretches of track offering particularly difficult conditions.

* * *

COMING EVENTS.

April 27-30.—Annual meeting of the International Master Boiler Makers' Association at Louisville, Ky. H. D. Vought, 95 Liberty St., New York City, secretary.

May 4-7.—Spring meeting at Washington, D. C., of the American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City, secretary.

May 12-14.—Annual meeting of the National Supply and Machinery Dealers' Association, at the Fort Pitt Hotel, Pittsburg, Pa. Secretary-Treasurer A. T. Anderson, 41 Wade Building, Cleveland, Ohio. The association has a membership of 141 manufacturing concerns.

May 18-20.—American Foundrymen's Association convention. Cincinnati, Ohio, Hotel Sinton, headquarters. Richard Moldenke, secretary, Watchung, N. J.

June 1.—Opening of the Alaska-Yukon-Pacific Exposition in Seattle, Washington, which is designed to call the attention of the world to the importance of Seattle as the western gate-way to the United States, and to its rapidly growing commercial importance. The exposition will include many working exhibits, among which are meat packing, watch making, jewelry, silk-making, rope-making, telephoning, printing, etc.

June 1-5.—Annual meeting of the International Railway General Foremen's Association at Chicago, Ill. E. C. Cook, Royal Insurance Building, Chicago, Ill., secretary.

June 7-19.—Cleveland Industrial Exposition, under the auspices of the Cleveland Chamber of Commerce, Cleveland, Ohio. It is estimated that 125,000 different articles are manufactured in Cleveland's 3,500 shops, and it is proposed to display to the world at this exposition the wonderful industrial facilities of the city. The products comprise steel ships, heavy machinery, hardware, twist drills, reamers, milling cutters, wire nails, bolts, nuts, vapor stoves, malleable castings, automobiles, paints and oils, etc. William G. Rose, secretary, Cleveland, Ohio.

June 9-11.—Joint convention of the Southern Hardware Jobbers' Association and the American Hardware Manufacturers' Association at Hotel Shenley, Pittsburg, Pa. F. D. Mitchell, 309 Broadway, New York, secretary and treasurer.

June 16-18.—Annual convention of Railway Master Mechanics' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 16-23.—An exhibition of machinery, tools and supplies for the railway supply trade will be held under the auspices of the Railway Supply Manufacturers' Association in connection with the railway conventions at Atlantic City, N. J. Membership dues in the association are $25 per year and carry one badge only. Additional badges may be obtained by members for $5 per badge. Contracts have been let for the erection of exhibition structures covering 59,000 square feet, exclusive of aisles. The charge to exhibitors will be 40 cents per square foot, to cover the cost of erection, etc. The association has prohibited the distribution of souvenirs. Application for space should be made immediately to Mr. Earl G. F. Smith, secretary, 345 Old Colony Building, Chicago, Ill.

June 21-23.—Annual convention of the Master Car Builders' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

September 25-October 2.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the Tribune Building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

SOCIETIES AND COLLEGES.

THE STATE LEAGUE OF SHEET METAL WORKERS at its recent convention held in Springfield, Illinois, selected Quincy as its next meeting place and chose Robert Byron, the retiring president, to represent Illinois at the national convention in Denver next August. At the concluding session the following officers were elected for the ensuing year: W. E. Mosher, Aurora, president; G. R. Wheelock, Decatur, vice-president; F. W. Efert, Alton, recording secretary; August J. Hernsdorfer, Quincy, secretary-treasurer.

THE EVENING MACHINISTS' ASSOCIATION OF PRATT INSTITUTE, Brooklyn, N. Y., gave its annual dinner at the Machinery Club, New York, March 20th. About one hundred and twenty-five were present, including F. B. Pratt, secretary of Pratt Institute G. D. Pratt, treasurer; A. L. Williston, director of science and technical department, and W. J. Kaup, head of machine department, who is known as the "hoss." William Reinicker is president of the alumni association, and John Royals acted as toastmaster of the dinner. The event was a great success, not only as a dinner, but as a manifestation of the strength of the association and the institute's motto: "Help the other fellow."

THE ENGINEERING SOCIETY OF WISCONSIN was organized at the University of Wisconsin, February 24-26. About 150 city engineers, general managers of power and traction companies, construction engineers, superintendents of power and light plants, mechanical and civil engineers, superintendents of highway construction were present and became charter members. Dean F. E. Turneaure, of the College of Engineering, University of Wisconsin, was elected president. The new organization will hold annual meetings for the purpose of bringing together engineers from all parts of the State interested in the solution of problems arising in connection with municipal plants, large construction work, bridge work, water powers, forestry, light and power, etc.

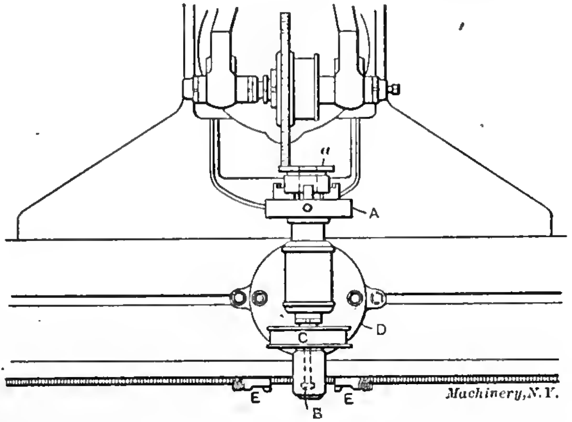
L. C. SMITH COLLEGE OF APPLIED SCIENCES, Syracuse University, has instituted a plan of securing employment for its graduates along the lines of similar plans now in vogue at Cornell and several other technical institutions. An alumni employment committee has been appointed to carry on the work. The committee will keep closely in touch with the graduates and with various engineering interests employing college graduates. A record of the characteristics of the graduates and their work after graduation will enable the committee to recommend men to prospective employers who are likely to fill any reasonable requirement. The advantage of placing graduates through a committee of this character lies in the fact that it has the knowledge and ability to judge a man's capacity even better than the man himself, and fewer failures are likely to result than by employing graduates without the advice of a supervising committee. The work of individuals employed through the committee reflects upon it and tends to make it conservative in all recommendations. It is expected that the result of employment in this way will be very satisfactory to all concerned.

Supplement to MACHINERY, May, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Cylindrical Grinding.—II"

SHOP OPERATION SHEET NO. 97

Paul W. Abbott MACHINERY, May, 1909



Machinery,N.Y.

Grinding a Hardened Steel Bearing—Grinding the Face.

NOTE.—Before using any grinder see that it is well cleaned and oiled. The wheel slide should receive particular attention, as a free movement of this part is essential to accurate work. The grinder illustrated herewith is a Brown & Sharpe universal.

1. Remove the loose pulley which is used for grinding work on dead centers, and screw a three-jawed universal chuck *A* on the spindle. See that the pin *B*, which engages with the pulley *C*, is withdrawn so that the spindle may revolve.

2. Fasten the work in the chuck with the flanged end out, as shown, and set it practically true by using a test indicator which may be attached to a surface gage or base resting on the platen.

3. Select a grinding wheel of about 60 M Norton grading, having a face from ½ to ⅝ inch wide, and place it on the spindle. Arrange for wheel and work speeds of about 5,000 and 35 feet per minute, respectively, the work speed being the peripheral speed of the largest part. Adjust the feed of the table to about ⅛ inch per revolution of the work.

4. Loosen the head-stock and set it, by the graduations on the base *D*, to 90 degrees; also set the platen, which is graduated on the end, to the zero mark.

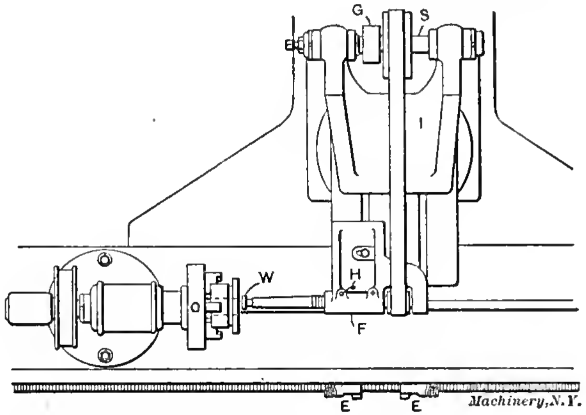
5. Adjust the dogs *E* so that the wheel will grind on the left side of the work as shown in the illustration; then the surface of the work being ground will revolve against or opposite to the rotation of the wheel.

6. Grind on the left-hand side until the surface of the work is trued, and then dress the wheel for finishing. As the surface of the work must be perfectly flat it should be tested, as the graduations on the base *D* are only intended to give an approximate setting. To do this allow the wheel to pass clear across the face *a* and note the density of the sparks. When the sparks show the same at all points the surface is flat.

7. Finish the face by grinding on the left-hand side, being careful to leave sufficient stock for finishing the inner face of the flange.

SHOP OPERATION SHEET NO. 98

Paul W. Abbott MACHINERY, May, 1909



Machinery,N.Y.

Grinding a Hardened Steel Bearing—Grinding the Hole.

1. Turn the head-stock back to the zero position, remove the wheel spindle from its stand *I*, and replace it with the speed spindle *S*.

2. Reverse the position of the stand *I*, as shown, and mount the internal grinding fixture *F* on the wheel slide.

3. Select a wheel *W*, ¾ inch in diameter by ¼ inch wide (assuming that the hole to be ground is 1 inch), with a grain and grade of about 46 *K*.

NOTE.—The driving belt, which runs on the pulley *G*, should be crossed so that the wheel and work will revolve in opposite directions.

4. By changing the overhead belts, adjust the peripheral speeds of the hole in the work and the grinding wheel to about 20 and 4,000 feet per minute, respectively.

5. Set the dogs *E* so that the wheel, at each end of the stroke, will overlap the work about ⅛ inch on each side, and adjust the table travel until the wheel feeds ¼ inch per revolution of the work.

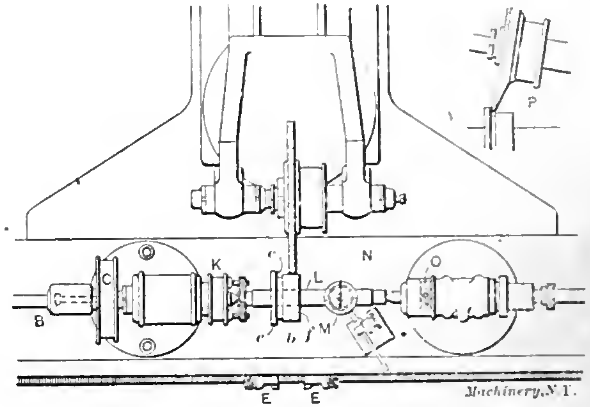
NOTE.—When using the internal grinding attachment, the wheel should not pass clear through the work, as the spring of the spindle will cause the wheel to grind the hole bell-mouthed or large at the ends.

6. Grind sufficient metal from the hole to true it and then dress the emery wheel. Take another light cut and then move the wheel until it is in contact with the opposite side of the hole. As it passes through, note the density of the sparks in order to determine whether the hole is straight or tapering. If the wheel bears heavier as it approaches the back end of the hole, the latter is smaller at that end, but if the density of the sparks becomes less, the hole is smaller in front. When the wheel bears the same on both sides throughout the length of the hole the latter is straight.

7. When the work is properly set, grind nearly to size, taking very light cuts. Cool the work so that the diameter of the hole will be reduced to its natural size; reduce the traverse of the platen to ⅛ inch per revolution of the work, and take the finishing cuts allowing the wheel to pass through the hole several times without feeding it.

SHOP OPERATION SHEET NO. 99

Paul W. Abbott MACHINERY, May, 1909



Machinery,N.Y.

Grinding a Hardened Steel Bearing—Grinding the Body and the Flange.

1. Remove the chuck from the head-stock, and place the loose pulley *K* on the end of the spindle. Insert the cone center and lock the spindle by engaging the pin *B* with a hole in the pulley *C*.

2. Remove the internal grinding attachment and replace the speed spindle used for driving the attachment with the regular wheel and spindle.

3. Select a well-centered arbor *L* of the proper size to fit the hole in the bearing, and place it between the centers. With an indicator *M* test the body of the arbor to see if it runs true. If it is satisfactory, drive the work on lightly.

4. Set the traverse dogs *E* so that the wheel will traverse the body *b*, and grind this part, using a feed for the table of ¼ inch for each revolution of the work, and a peripheral speed for the latter of about 25 feet. Measure the body at each end with a micrometer. If it is not ground perfectly straight swivel the platen *N* slightly, using the fine adjusting screw provided at one end. Continue to rough grind the part *b* and then the flange *c* until these parts are within 0.003 inch of the finish size.

5. True off the periphery of the wheel by traversing a diamond truing tool, held in the foot-stock clamp *O*, across its face. Reduce the table feed to ⅛ inch per revolution of the work, and finish the parts *b* and *c* to size.

NOTE.—After all bearings have been ground as described in the foregoing, they may again be placed on the mandrel and the inner surfaces *e* of the flanges finished in the following manner.

6. Replace the regular wheel with one of a dish shape, swivel the wheel base to an angle of 45 degrees, and dress the periphery of the wheel to that angle; then set the wheel base to an angle of about 10 degrees as shown at *P*.

7. Feed the wheel in and out across the flange by the hand cross feed, taking off about 0.001 inch at each cut until the flange is finished to the required width. Grind the end *f* in the same manner; remove the finished work, and place another bearing on the mandrel.

I.—BORING BARS AND HEADS

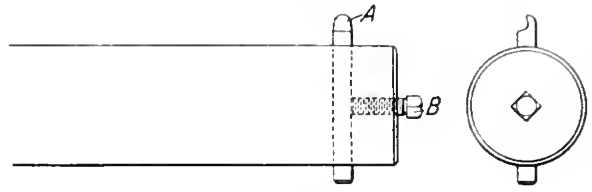


Fig. 1.

Inexpensive type of bar having a square tool A which is a sliding fit in its slot and is held in place by the set-screw B.

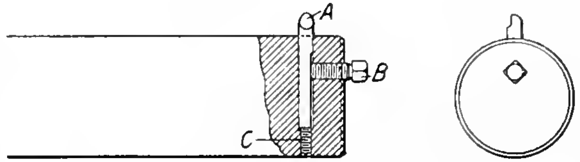


Fig. 2.

Bar equipped with round tool A flattened on one side for the set-screw B which holds it. The tool is adjusted by the screw C.

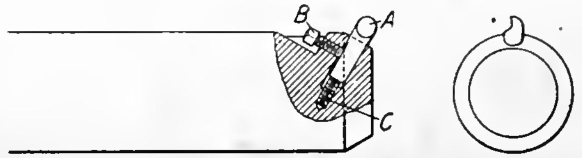


Fig. 3.

Bar with tool A set at an angle for boring blind holes, etc. When the tool is removed, adjustments are made by the screw C against which the tool rests.

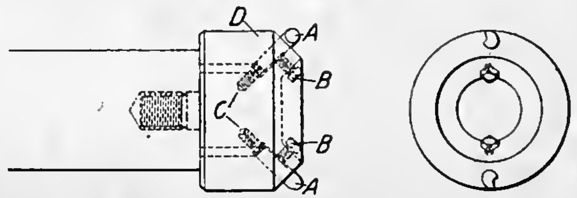


Fig. 4.

Boring head with two cutters A, which may be guided by the surface D. The tools are adjusted by the screws C.

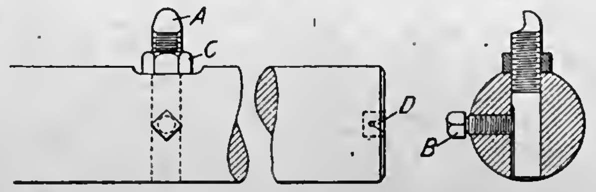


Fig. 5.

Bar with tool threaded at one end and adjusted by the nut C. Set-screw B, bearing against a flattened side, retains the tool in place. The bar is equipped with hardened centers D.

Contributed by Lucien L. Haas

II.—BORING BARS AND HEADS

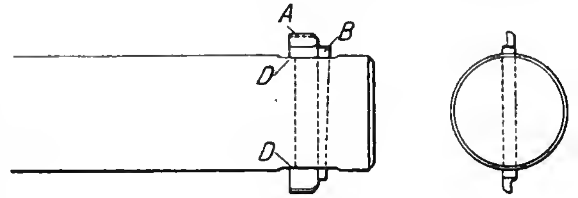


Fig. 6.

Flat cutter for heavy boring, which is held in place by the wedge B and centered by the fitting D, D.

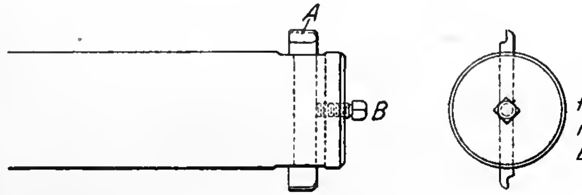


Fig. 7.

Method of fastening a flat cutter when the latter is located at the end of the bar.

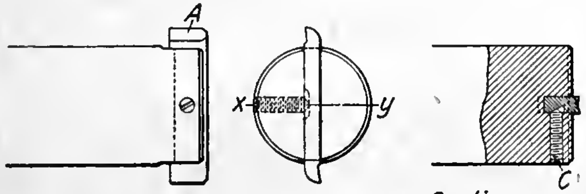


Fig. 8.

Section x-y.

Tool for boring and facing, which fits in the slotted end of the bar and is held in place by the conical-pointed screw C which bears against an angular surface in the cutter.

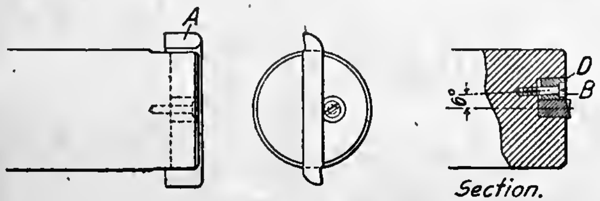


Fig. 9.

Section.

Cutter, similar to Fig. 8, which is held in place by the screw B which forces the flattened side of the hardened bushing D against the cutter.

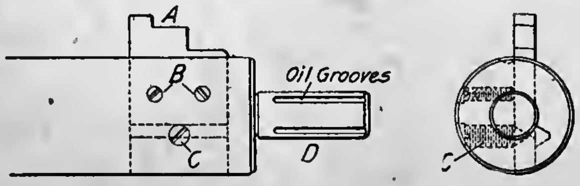


Fig. 10.

Single-step boring tool which is adjusted by the conical-pointed screw C and held in place by the screws B. The bar should be equipped with a pilot D.

Contributed by Lucien L. Haas

III.—BORING BARS AND HEADS

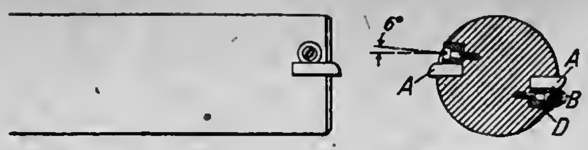


Fig. 11.

Boring bar for light work, having two cutters A which are held in place by flattened bushings D and angular screws B as in Fig. 9.

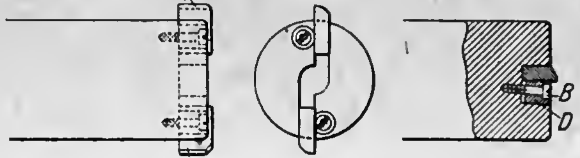


Fig. 12.

Another type of bar for light work, having two cutters A which are held by flattened bushings D and angular screws B inserted in the end of the bar.

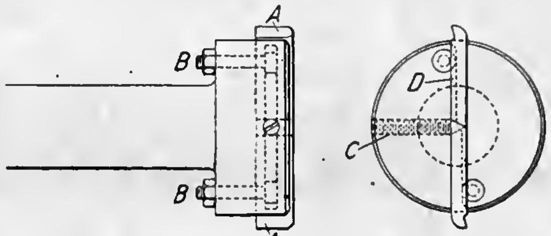


Fig. 13.

Cutters for boring and facing, which are adjusted by the conical-pointed screw C and held in place by bolts B, the heads of which enter the grooves D.

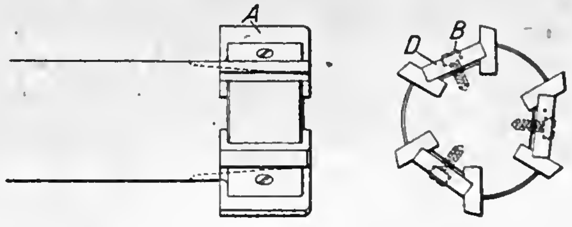


Fig. 14.

Boring head for finishing cuts, having six tools which fit in tapering slots thus permitting adjustment. The cutters are held by the screws B and clamp D.

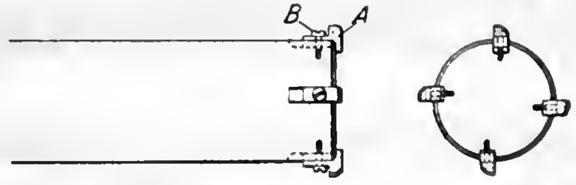


Fig. 15.

Roughing tool for cast iron. The four cutters fit tightly in their slots and are held by the screws B.

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IV.—BORING BARS AND HEADS

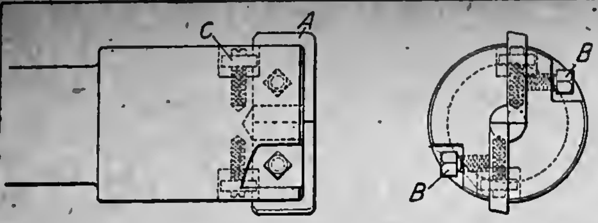

Fig. 16.

Bar for cast iron with two cutters A which are held by screws B and are adjusted by the hardened screws C, the heads of which fit in slots in the cutters.

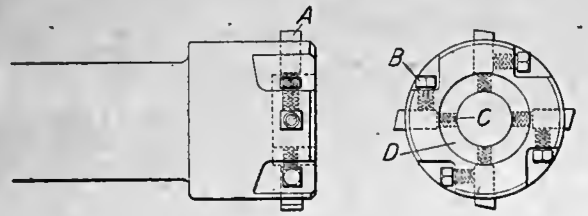

Fig. 17.

Boring head for steel, with high-speed steel cutters which are clamped by the screws B and adjusted by the screws C in the ring D.

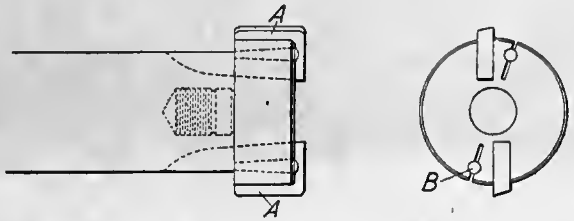

Fig. 18.

Bar for brass and other light work, having two cutters A which are adjusted by changing their position in the tapering slots, and clamped in place by driving in the taper pins B.

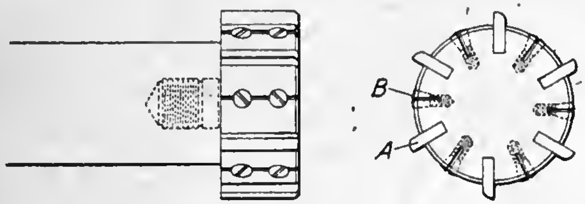

Fig. 19.

Boring head for finishing, having six blades which are clamped by screwing in the taper-headed screws B.

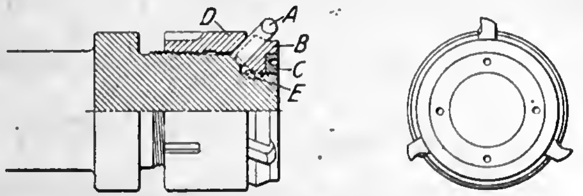

Fig. 20.

Design of head adapted to small work. The cutters A fit in slots in the ring B and are adjusted by screwing the ring C inward after the ring D is loosened.

Contributed by Lucien L. Haas

MACHINERY

May, 1909

LOCOMOTIVE REPAIR SHOP PRACTICE

THE CHICAGO & NORTHWESTERN RAILWAY SHOPS AT CHICAGO

ETHAN VIALL*

IN no railroad repair shop in the Middle West is the practice more up-to-date, the amount of work handled greater, or repairs more quickly made, than at the Chicago shops of the Chicago & Northwestern Railway. Altogether there are eighty-one shops in the great cluster of buildings which enclose the thousands of workmen, the clanking machines, the roaring forges and the Gatling-gun-like pneumatic hammers. The average mechanic is apt to look upon a railroad shop as a place where only rough, dirty work is done in an out-of-date manner, but a walk through this works past the huge milling machines, shapers, and high-speed lathes, to say nothing of the drill-presses and boring mills, all of the latest type, would convince anyone that not all or even a larger part of the work is of a rough or dirty class nor done in an antiquated way even if the pieces operated on are as a rule large ones. The milling practice alone of this shop is enough to make the most unobserving "sit up and take notice." Milling cutters with inserted teeth of high-speed steel, plow over rows of castings set in jigs two or three times as long as the ones usually seen on the same class of work. Not only is high-speed steel used in these machines, but also wherever else possible, and beside the big wheel lathes are piles of chips that are not blue but black. The lathe tools are, in many cases, only tipped with high-speed steel, the body of the tool being a cheaper grade of steel to which a small piece of high-speed steel has been welded. This welding is done on the premises and is the first of the kind that I have seen in a railroad shop.

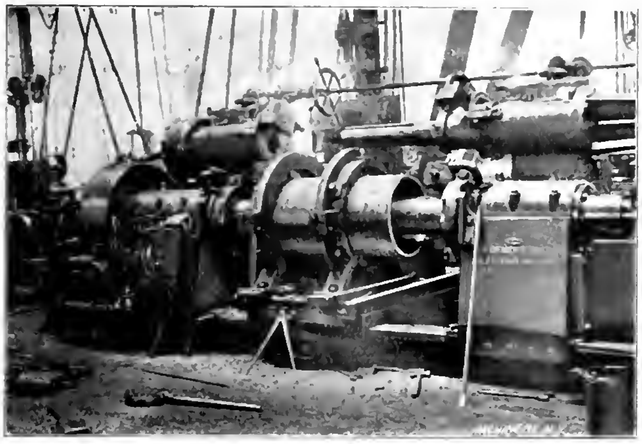
Fig. 1. Boring out a Casting for Piston Rings

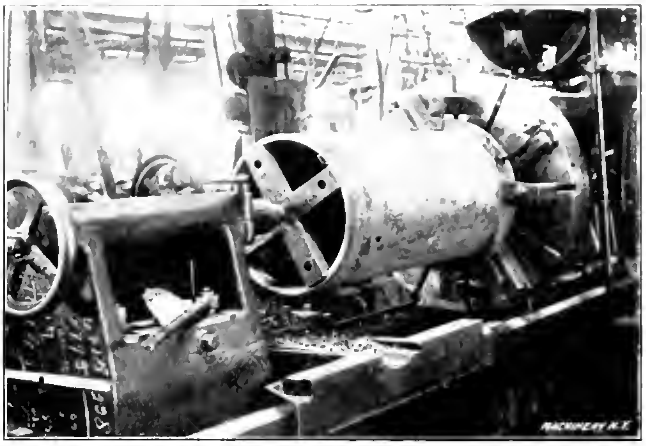

Fig. 2. Turning the Outside of the Piston Ring Casting

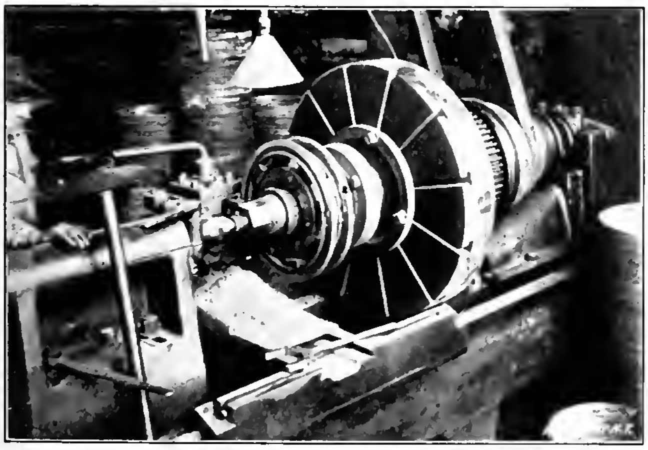
Fig. 3. Finishing Two Piston Rings simultaneously on an Expanding Mandrel

Fig. 4. Drilling Twelve Spring Rings which are held in Place by a Pneumatic Clamping Device

For the handling of materials there are overhead traveling cranes large enough to swing a locomotive, trolley traveling-cranes of the monorail type, swinging cranes, pneumatic hoists, chain hoists and lifting contrivances of every description wherever needed. The power-house is equipped with coal-lifts, automatic stokers, ash-removers and loaders, and everywhere as much manual labor is saved as possible.

While the shop system includes wood-working, painting, car-repairing and numerous other departments that have features of mechanical interest, this article will be confined principally to descriptions of locomotive repair work in its various branches, the machine shop of course coming in for a lion's share of attention. In the beginning I want to express my obligation to Mr. H. D. Kelley, shop demonstrator, who took unusual pains to show me all there was to see and to arrange things for me and assist me in my photographic work. Permission to describe the various methods and processes for the benefit of the readers of MACHINERY, was obtained through Mr. H. T. Bentley, assistant to the Superintendent of Motive Power, Mr. Quayle.

Making Piston Rings

Entering the machine shop from the office one of the first big machines to be noticed is the one shown in Fig. 1, which is at work boring out a piston-ring casting. The way these castings are held while being bored is plainly shown, the jig being very similar to a double steady-rest minus the jaws and in place of which large set-screws are used to center and hold the work. The bored-out castings are taken to the lathe shown in Fig. 2, where they are rough-turned on the

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* Associate Editor of MACHINERY.

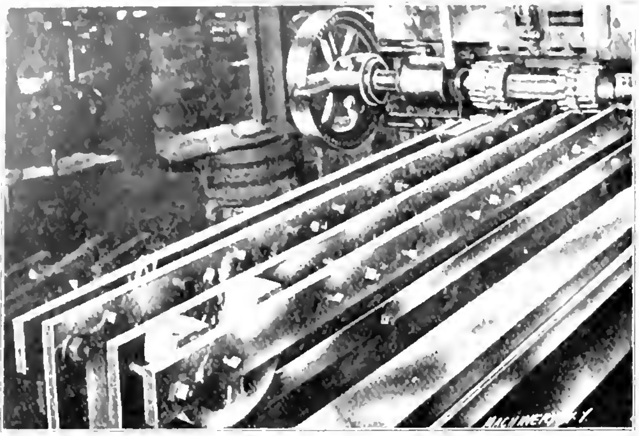

Fig Fixture for Holding Eccentrics and Eccentric Straps while Milling the Ends

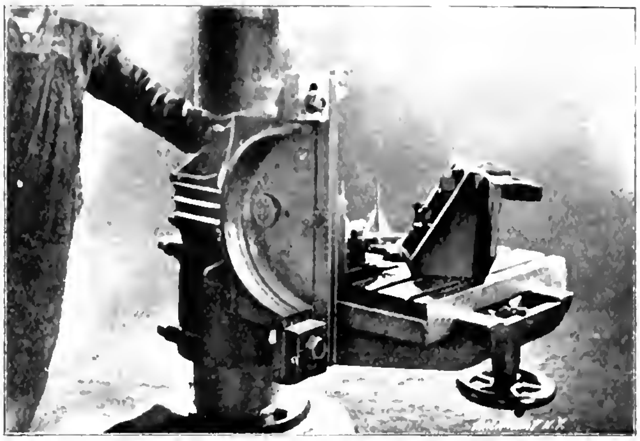

Fig. 6. Indexing Fixture for Holding Eccentric Straps while Drilling Oil and Set-screw Holes

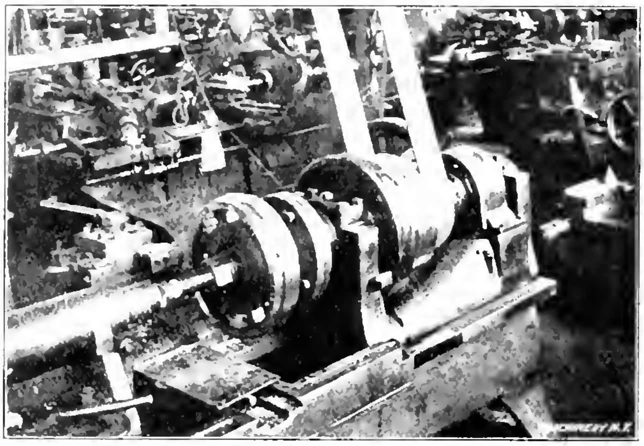

Fig. 7. Turning Eccentric Strap Brasses

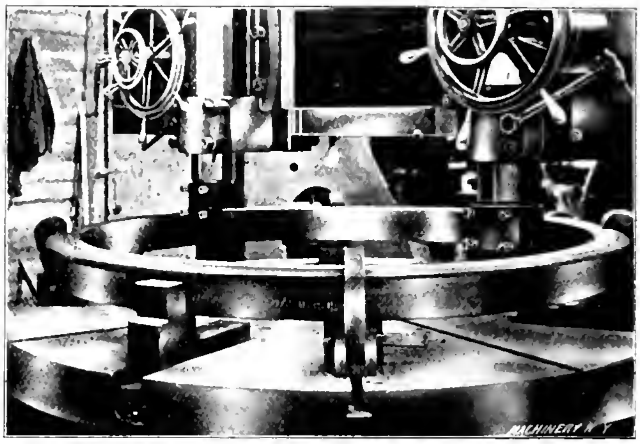

Fig. 8. Driving Wheel Tire held in Place on the Boring Mill by Hook-clamps

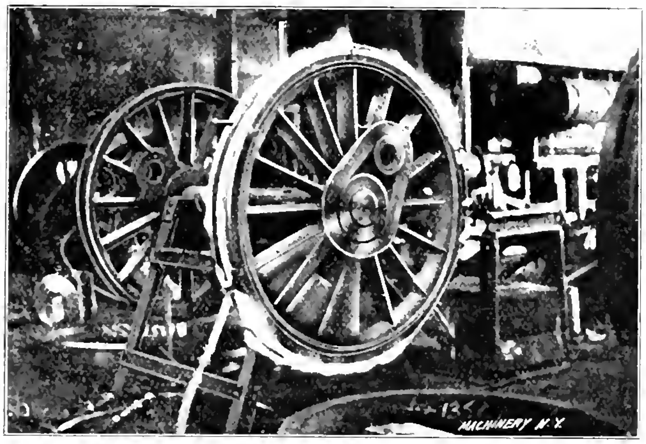

Fig. 9. Gasoline Tire Heater

Fig. 10. Portable Gasoline Tank for the Tire Heater.

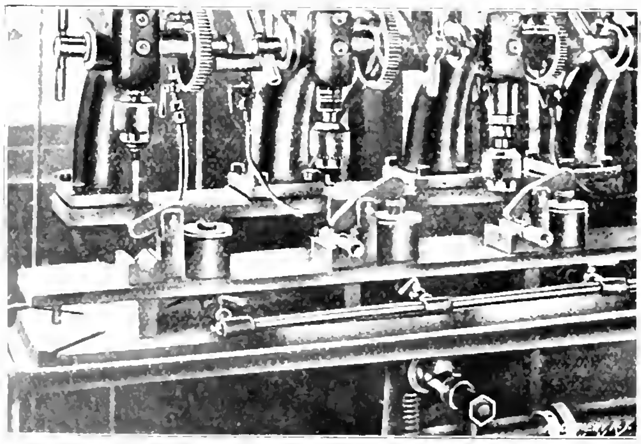

Fig. 11. Multiple Spindle Drill Press with Pneumatic Clamps

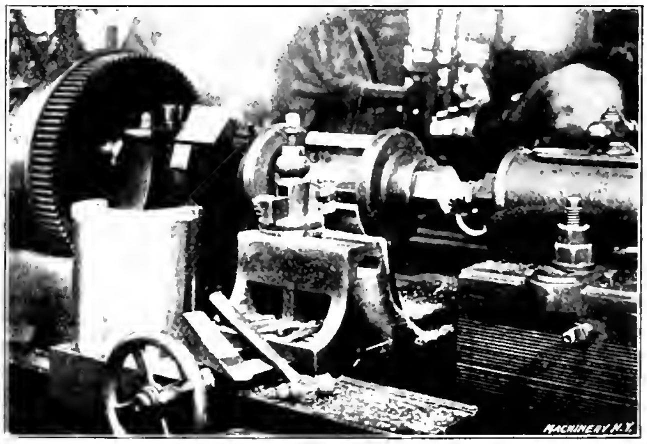

Fig. 12. Mandrel for Holding the Brasses while Turning the Outside

Fig. 13. Planing Twelve Locomotive Driving Boxes simultaneously

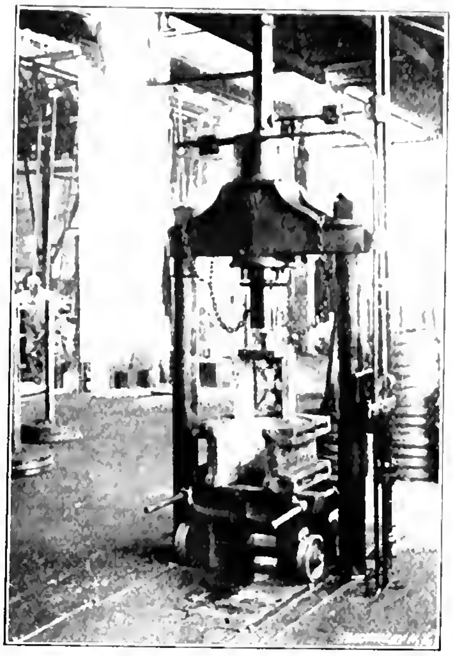

Fig. 14. Hydraulic Press for Forcing the Brasses into Place

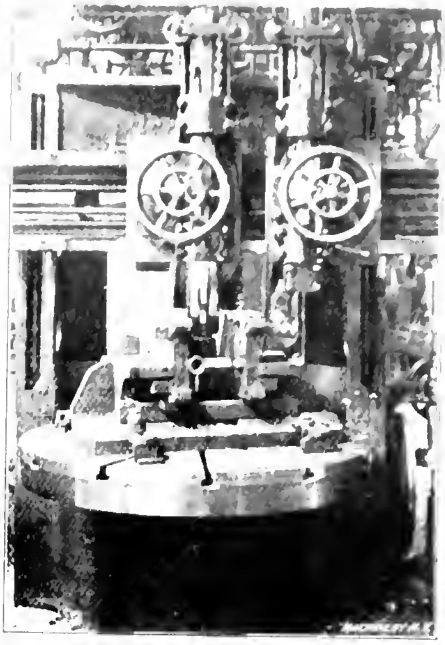

Fig 15 Boring a Box Note the Special Two-Jawed Chuck for Holding it

outside and cut into rings. In the engraving the undercut chuck-jaws and auxiliary clamps, as well as the spider used on the tail-stock center, can be seen at a glance. In Fig. 3 is shown the expanding mandrel made to hold two rings which are finished on both sides and to the right diameter, at one cut. The rings are then split and fitted in the usual way.

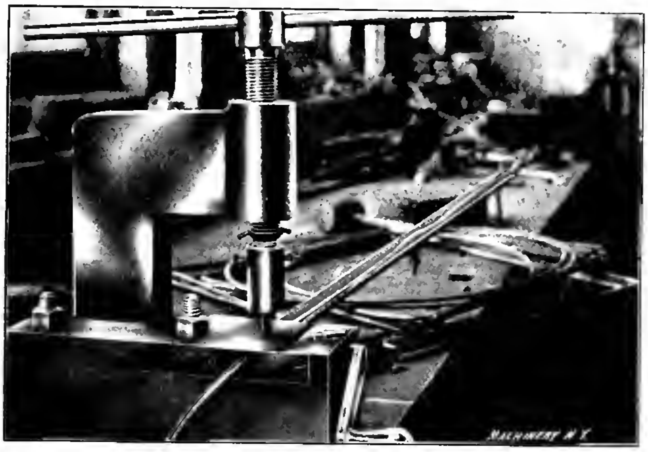

Fig. 16. Press for Cutting Dome and Steam-chest Gasket Wire

Machining Driving Boxes and Brasses

Leaving the piston-ring machines, we are next attracted by the way the driving boxes are machined. The first machine upon which they are placed is the big planer shown in Fig. 13, which is capable of planing twelve driving boxes at once. Both heads are used, and the jig shown is simply a

Fig. 17. Solder Molds and Mandrels used when casting Rocker-arm Bearings

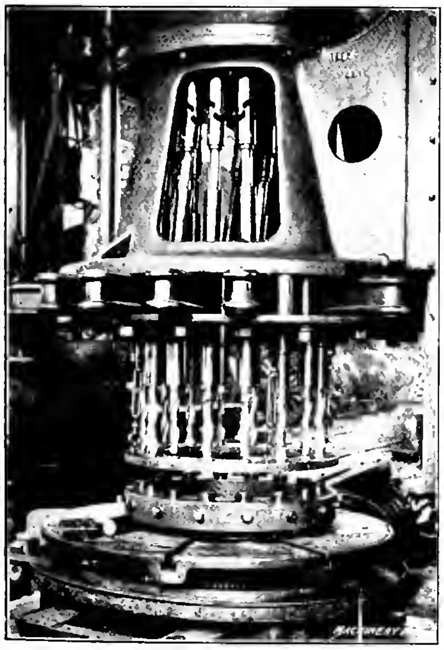

Fig. 18. Drilling Sixteen Bushings simultaneously

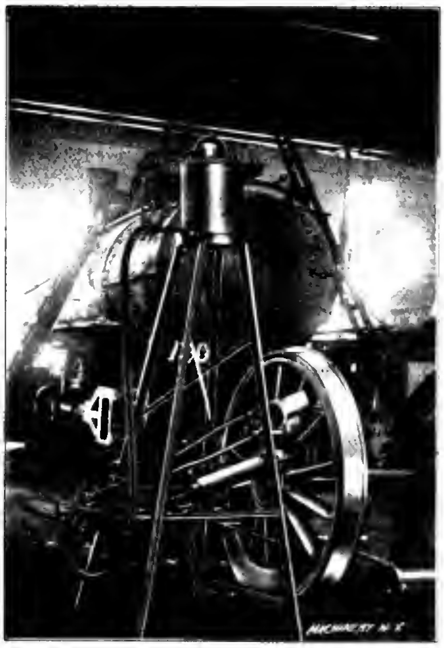

Fig. 19. Crude Oil Burner used for Frame Welding

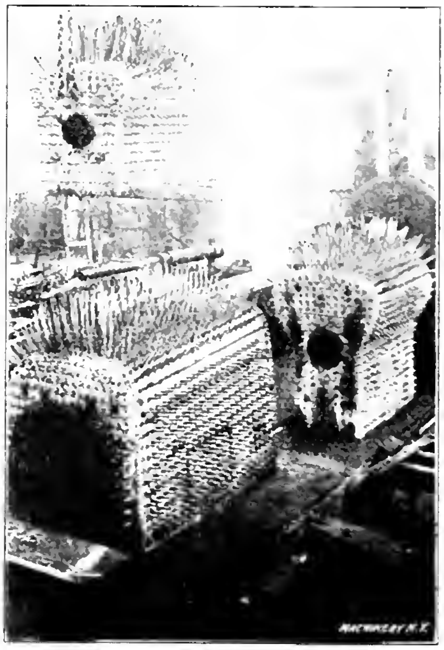

Fig 20. Fire Boxes removed bodily from the Engine

Fig. 21. Hydraulic Spring-assembling Press

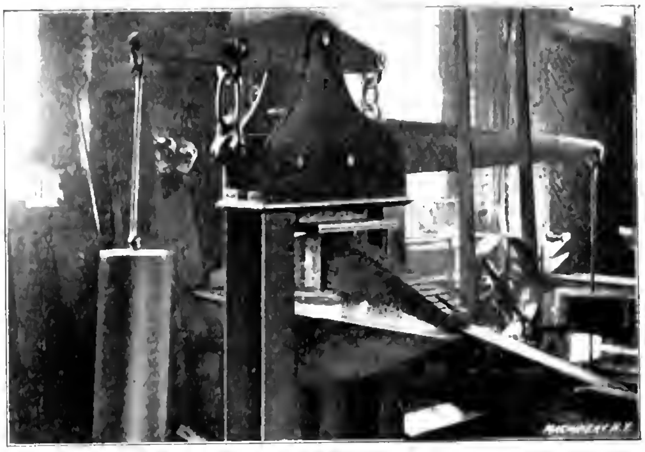

Fig. 22. Tinius Olsen's Spring Testing Machine

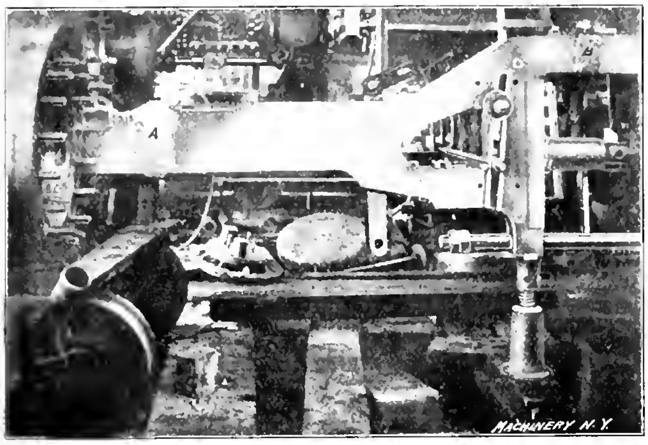

Fig. 23. New Section of Frame Welded to the Old by the Thermit Process

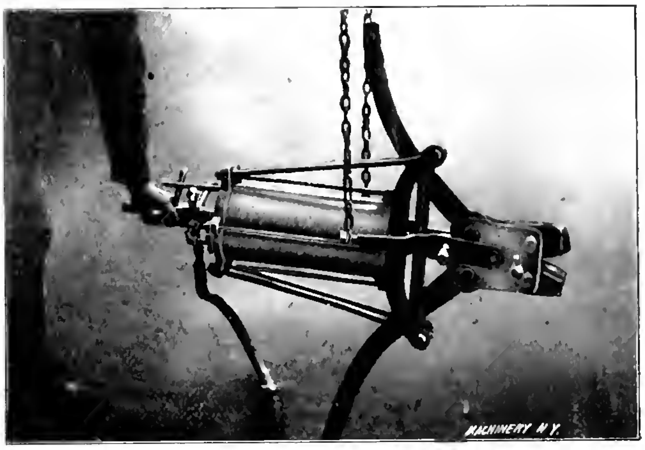

Fig. 24. Pneumatic Staybolt Clipper

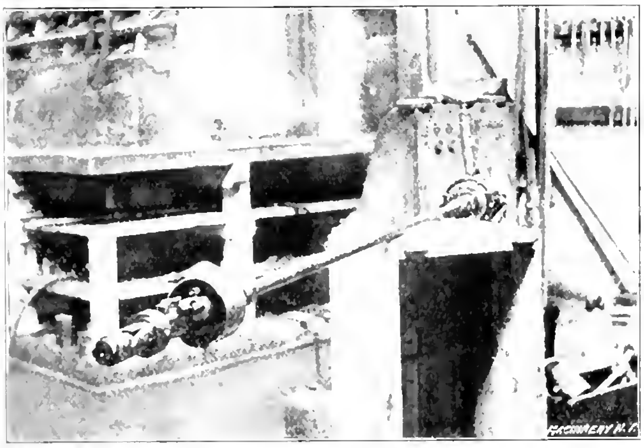

Fig. 25. Pneumatic Flue Cutter which whistles when the Flue is severed

Fig. 26. Pneumatic Flue Trimmer

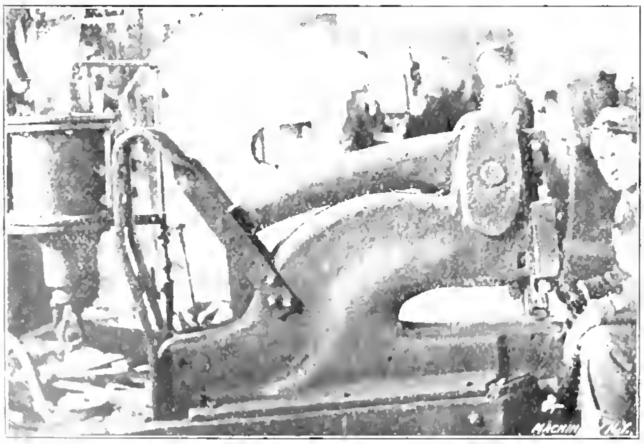

Fig. 27. Old Hand Punch now Operated by Air

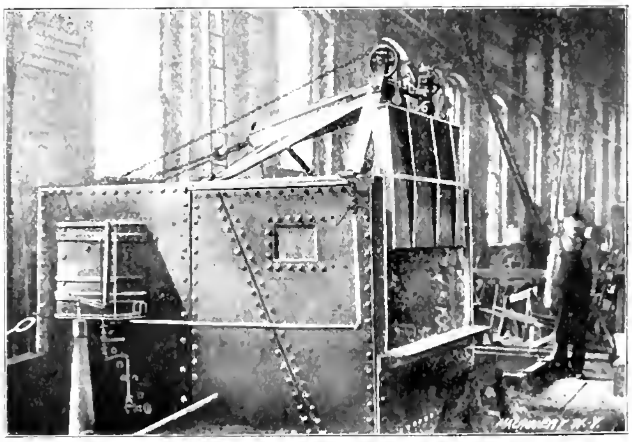

Fig. 28. Case-hardening Furnace with Pneumatic Door Lift

big iron channel (solidly bolted to the table) to which the boxes are clamped by bolts and cross-bars as illustrated. The boxes are then machined for the brasses on the slotter shown in Figs. 41 and 42 on which three are planed simultaneously.

The brasses are pressed into the boxes with a hydraulic press, as shown in Fig. 14. The truck upon which the box is mounted and run under the piston, is a very convenient one as it can be readily lengthened by loosening two locking-collars, and the axles are supported by springs so that under heavy pressure the springs give, allowing the weight to come on the heavy legs and not on the axles and wheels. The way these driving-box brasses are held between two grooved iron flanges mounted on an arbor, while the outside is turned, is shown in Fig. 12, one of the brasses being clamped in place, while a turned one is resting on the lathe carriage.


Fig. 29. Tool Storage Room equipped with Revolving Racks

When the brasses are being bored in the boring mill. Fig. 15, the box is held in a special universal two-jawed chuck which has a stop at the back, against which the partially finished casting is placed. The jaws are then tightened and the box is brought central without any unnecessary loss of time. This chuck is the only one I have seen used for this purpose, as the other shops I have been in simply clamp the work to the platen with bolts and iron straps.

Milling Eccentrics and Eccentric Straps

The ends of the eccentrics and eccentric straps are tongued and grooved on the slab miller shown in Fig. 5. The jig on the machine will hold two different sizes, and sixteen pieces can be placed in it and milled at one setting. Except for its size, the jig is simplicity itself; the work is easily put in or removed, while if any of the bolts or set-screws break they can be quickly replaced. While drilling the oil and set-screw holes, the eccentric straps are held in an indexing jig, Fig. 6. A similar though smaller jig is shown on the platen. When properly set, these jigs are very handy, for just as soon as one hole is drilled the jig is indexed a notch and the next hole drilled, and so on until finished. An expanding mandrel, Fig. 7, which is of the same general pattern as the one used to hold piston rings, is used to hold eccentric strap brasses while finishing the outside.


Fig. 31. Row of Tool Cupboards

Novel Drilling Jig for Link-block Bushings, Drilling Spring Rings, etc.

At the first glance, there is nothing unusual about the appearance of the drill jig shown in Fig. 18, except that it holds sixteen pieces at one time, but a closer inspection shows that the top of the jig holding the drill-guiding bushings, lifts with the drill spindles, allowing the finished work to be taken out by loosening the set-screws. The jig-top is counterbored under each drill-bushing so that as it is lowered it centers itself over the work. The turnbuckles that hold the top and allow it to be adjusted up or down, can be easily seen in the engraving. The link-block bushings which are drilled out in this machine, were formerly made of heavy tubing, but now the solid stock is drilled out and the final cost of the bushings is far below that of those made of tubing. Close to this drill-press is another multiple-spindle machine, shown in Fig. 4, which is fitted with a pneumatic chuck for holding and drilling twelve cylinder spring-rings at once. This clamping device is worked by an air-cylinder in the center, the piston rod of which is cone shaped on the end, as shown. As this rod is lowered it forces four short plungers outward, clamping the rings against stop blocks. The ends of the four plungers that come in contact with the rings, are fitted with pins backed by springs to allow for any unevenness or variation in the size of the object clamped. The four-spindle drill press shown in Fig. 11 is used to drill cotter-pin holes in several kinds of bolts and pins. The interesting feature of this machine is the pneumatic clamps used for holding the work; nothing more simple or effective could be imagined.


Fig. 30. Box Tools, Expanding Reamer and Strainer Punch and Die


Fig. 32. Lathe equipped for Machining Brass Taper Plugs

Boring and Removing Locomotive Tires

For holding locomotive tires on the boring mill while turning out the inside, some means other than the regular chuck or face-plate jaws must be used on account of the tendency of the tires to spring out of round because of the pressure from the jaws. This difficulty is overcome by the arrangement shown in Fig. 8. As shown in the engraving, the chucking jaws are only used to center the tire and not to clamp it, the clamping being done by hooks projecting over the top of the tire from the outside, which are tightened down

onto it by the driving in of a taper key. Four of these clamping-hooks are used and they make a very quick and effective method of locking the tires in place without danger of springing them out of round. This scheme has attracted considerable attention and has been copied to some extent in other railroad shops. Using this device on the 96-inch boring mill, 54 tires were bored out in 9 hours on a test run, the tires being handled by a pneumatic hoist with an eagle-claw clutch.

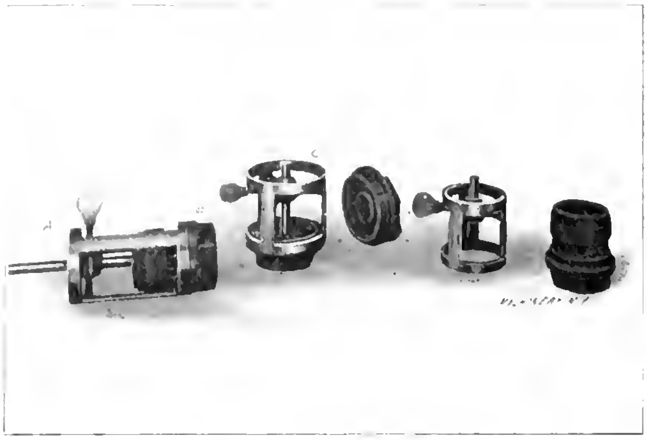

Fig. 33. Gages for Measuring Lift of Air Pump Valves

To remove locomotive tires, the wheels are hoisted onto a horse by the traveling crane and the tires are heated with the gasoline burner shown in Fig. 9, which quickly heats them so that they expand sufficiently to be easily removed from the wheels. The engraving shows one tire already off and the other being heated. The gasoline vapor used in this heater is obtained from the portable tank, Fig. 10, the pressure being supplied by air through a hose connected to the shop pipe line. This tank is very handy and is used to supply several other kinds of burners beside the one shown.

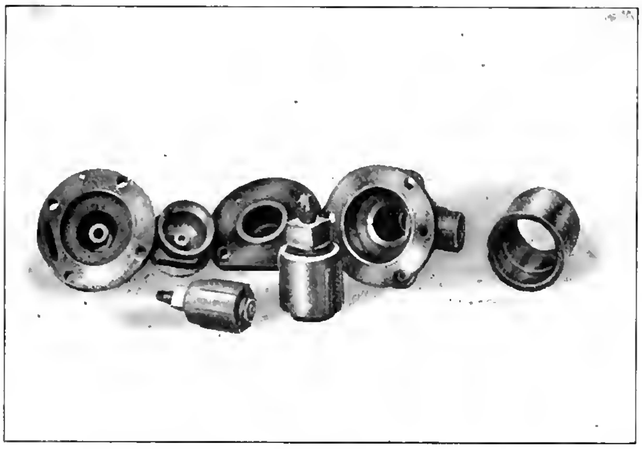

Fig. 34. Types of Reamers used for Air Pump Repairing, and Examples of the Work

Fig. 19 is a crude oil burner, stand and tank, used on some jobs of frame-welding, though the Thermit process is used for most of them. A Thermit repair is shown in Fig. 23, and aside from the method of welding, the job is interesting from the fact that a section of the old frame has been cut out and a new one is being put in. At *A* the end of the section has been welded onto the old frame and is ready to chip, while at *B* the wax core for the next weld is being made. The reason that a new section was put in is that the old frame showed so many defects at this place that it was not thought advisable to risk any repairs on it; so the bad section was cut out and a new one put in as shown. A frame repaired in this way is just as good as an entire new side and far cheaper, as only a few bolts, rivets, and braces have to be removed in comparison with the number connected to the whole side. In the opinion of the foreman in charge the cost of the work on this particular job would not exceed fifty dollars; whether or not this was more than a mere guess, I'll let those familiar with the work decide.

Interesting Tools and Methods in the Boiler Shop

There are very few shops capable of removing fireboxes with radial stay-bolts bodily, as shown in Fig. 20, but this is an everyday occurrence here, and is one of the sights of the shops for visitors. Mr. J. W. Kelley, the foreman of the boiler repair department, is justly proud of his work.

A patented pneumatic stay-bolt clipper, Fig. 24, is used for removing bolt heads on most of the boiler work in this department, and another patented pneumatic device, Fig. 25, is used for cutting out old flues. This tool differs from some similar ones in having a roller cutter (like the one on the familiar hand pipe-cutter) instead of a single blade, and also in having a shrill alarm-whistle which sounds the instant the flue is cut off, thus preventing waste of time whether from carelessness or intention. The shriek of the whistle is ear-splitting and can be heard for half a block above the usual din of the boiler shop.

All old flues are rattled or tumbled in a huge tumbler full of water, and from appearances this seems to be a more effective way than the dry method practiced in some shops, though the results are good either way. The number of flues that are welded here will range from five to nine thousand a month, and one of the best machines for trimming flues to length that I have seen, is shown in Fig. 26. This machine is the usual form of rotary cutting machine to which has been added an air-cylinder for raising and lowering the cutter. In all of those that I have seen elsewhere this is done by means of a hand-wheel, but for ease and speed the air device is much superior to the hand method. The use of an air attachment on the flue cutter brings me around to the old hand-power punch, which has been made over by the addition shown in Fig. 27. In this way a tool that was practically useless for doing a large amount of work, has been made into a productive machine.

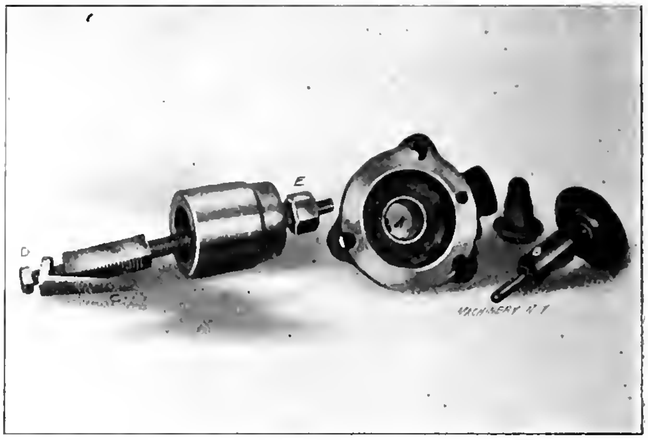

Fig. 35. Triple Valve and Tool for Facing Seat

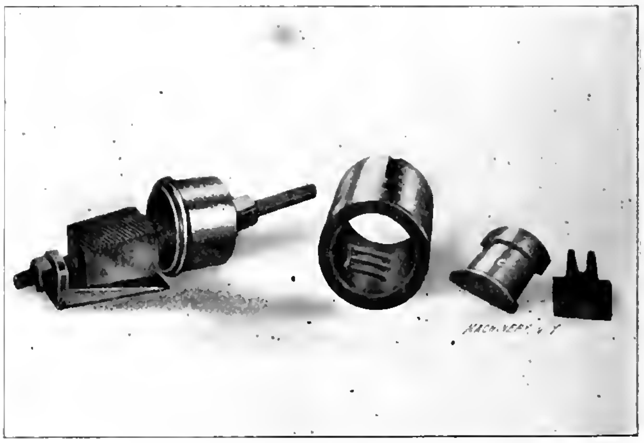

Fig. 36. Main Valve Bushing with Tool and Guide for Facing Valve Seat

Assembling Locomotive Springs

In the blacksmith shop, which is in charge of Mr. John McNally, the new springs used for repair work on all classes of locomotives, are cut, rolled, tempered, assembled, and tested, or new leaves are put in to replace broken ones in old

springs. Fig. 21 shows the special hydraulic press used to clamp the leaves together while a temporary ring is slipped on to hold them while putting on the regular band. After the temporary ring is in place, the spring is removed from the press and set on end in a socket, as shown in Fig. 45. The hot band is then dropped over and driven to place by means of a hand-set and sledge-hammer. As soon as the band is in place, the spring is put in the 100-ton hydraulic press, Fig. 46, which compresses the band around the spring in a box-like die and holds it firmly until it cools and sets. After cooling, the spring is next tested in the big Tinius Olsen testing machine, Fig. 22. The spring shown in the engravings is known as a trailer spring for class D engines, and is tested to 21,560 pounds, while the maximum load it is expected to carry is rated at 17,250 pounds.

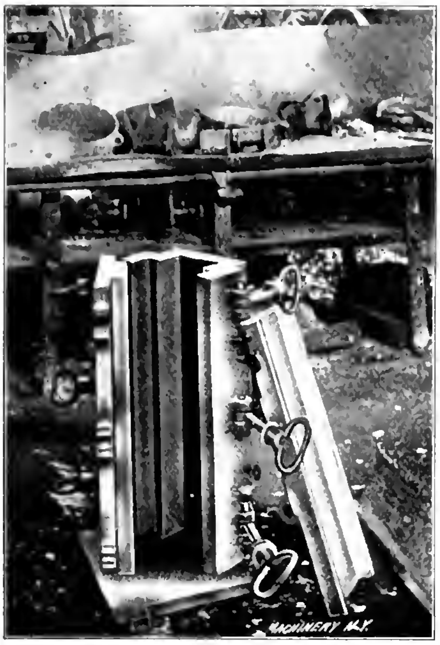

Fig. 37. Mold for Babbitting Two-bar Guide Cross-head Gibs

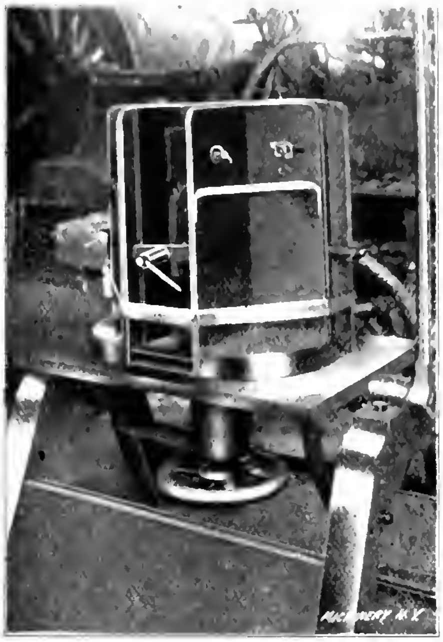

Fig. 38. Mold ready for Babbitting a Four-bar Guide Cross-head

Fig. 39. Cross-head Babbitted in the Mold shown in Fig. 38

The case-hardening furnace used in the blacksmith shop has a pneumatic door-lifter, that saves lots of time and trouble, which is shown in Fig. 28. The arrangement is very simple and could be used to good advantage on almost any large furnace of this type where connection with the air line can be easily had.

Fig. 40. Heating the Cross-head Prior to Pouring the Babbitt

Fig. 41. Machining a Cylinder on a Slotter—First Position

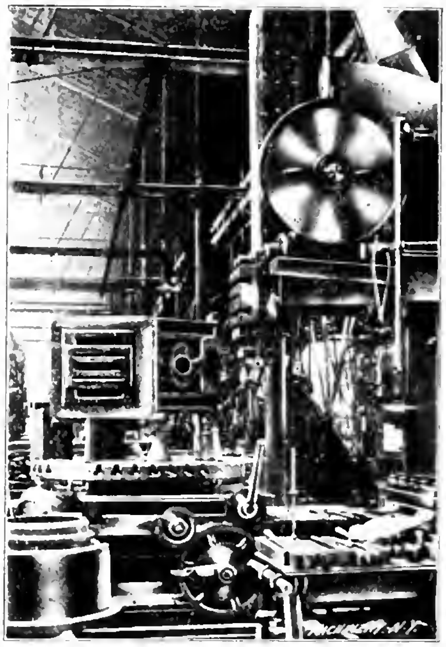

Fig. 42. Machining a Cylinder on a Slotter—Second Position

Tool Storage, Brass Finishing Department, and the Brass Foundry

The tool-storage room of the main shop is well equipped in every way, the revolving racks, Fig. 29, being especially neat and convenient. Close to the toolroom, which is in charge of Barney Henrickson, is the brass-finishing department in charge of William Water. The box-tools in use in this department are the equal of those used in the finest brass working shops in the country. Two of the wing-type box-tools are shown in Fig. 30, and a special expanding reaming tool is shown at the right, while leaning against the wall is a strainer punch and die of splendid workmanship. The tool cupboards, a few of which are shown open in Fig. 31, are filled with box-tools, forming tools, special taps, dies and the like, which are all made in a way that would reflect credit on any toolroom.

Fig. 32 shows a lathe set up for machining brass taper plugs. The box-tool used is shown swung around, while the self-opening die is just ready to begin to cut the thread on the taper plug held in the two-jawed chuck.

The brass foundry, in charge of Mr. T. Ryan, has two kinds of brass melting furnaces. One is a regular crucible furnace which is used for the finer grade of brass castings, while the other kind is of the box-type, crude-oil-fired furnace shown in Fig. 49. These furnaces are so made that they can be easily tilted by means of a hand-wheel, and in this way all melted brass is easily run out or kept in, as desired. A very refractory black slag forms on top of the brass melted in this way and has to be carefully skimmed off to prevent it mixing in and spoiling the castings.

Fig 43 Babbitting Car Brasses

Fig. 44 Furnace for Melting Babbitt from Old Brasses

A machine that is said to save at least twenty-five dollars a day for the brass foundry is shown in Fig. 48. It is a washer used to wash out all the dirt and save the brass chips and lumps that would otherwise be lost. A pile of several hundred pounds of brass, representing three days washing, showed what a gold mine was being successfully worked.

Air Pump Tools and Gages

There are many ways of obtaining the proper length of plug for the right valve lift in an air-pump, but I have seen nothing better than the gages shown in Fig. 33. The gage *A* is used when fitting the longer plug or cage *B* for the lower air valves (see also Fig. 50) while the shorter gage *C* is for the upper cap *D*. Each gage consists of a brass barrel through the middle of which slides a short rod, which is locked at any point by a thumb-screw. This rod is as much longer than the brass barrel, as the lift of the valve is to be. When fitting the upper plug *D*, the barrel of the gage *C* is set over the plug opening in the pump and the rod is pushed down until it comes into contact with the top of the valve. The thumb-screw is then tightened and the plug is so dressed that when it is inserted in the opposite end of the brass barrel, as shown at *C*, the boss against which the valve strikes, just touches the end of the iron rod. When fitting the lower

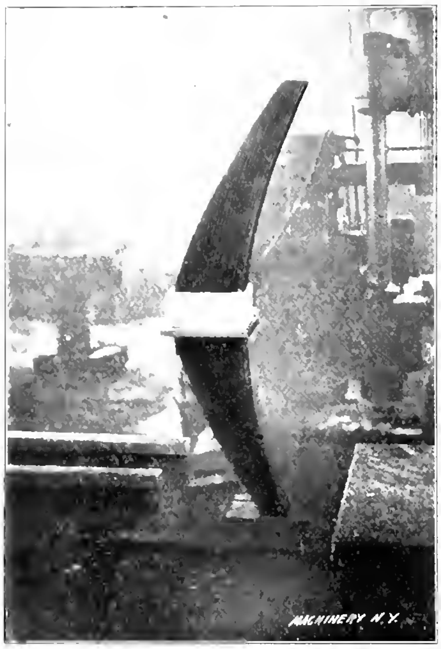

Fig 45. Position of the Spring as the Heated Band is Put in Place

Fig. 46. Hydraulic Press which compresses the Band on the Spring while it cools

Fig. 47. Grinding an Air Pump Head with Air Motor

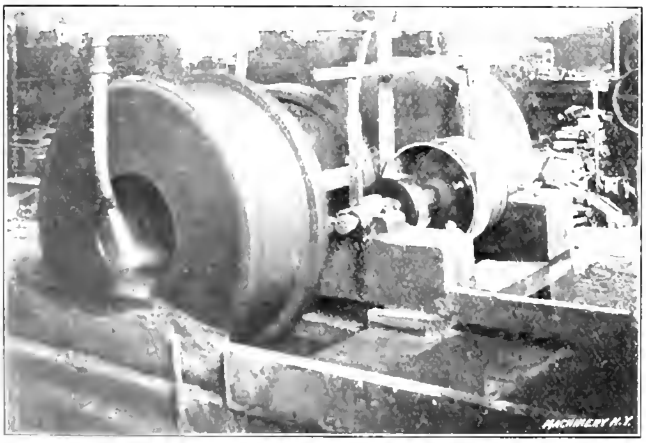

Fig. 48 Washing Machine for Separating Fine Particles of Brass from Foundry and Shop Dirt and Cinders

Fig. 49 Box Type of Brass Melting Furnace, which is fired by Crude Oil

plug the gage *A* is placed over the valve opening as before, and the rod is set against the boss *b* (Fig. 50), against which the lower valve strikes. The plug and valve are then dressed until the latter just touches the opposite end of the gage rod when tested as shown to the left in Fig. 33. Gages for the various valves are kept on hand and there is no excuse for a mistake in getting the right valve lift.

For facing off worn cylinders of triple or brake valves, pump governors, main valve bushings, and cups for air pump heads, the class of expanding reamer shown in Fig. 34 is used. The reamer blades are forced outward by means of the small screw in the middle of the wrench-hold. The tool used for facing off the worn seat of the triple valve at *A*, Fig. 35, to which the part *B*·fits, is something on the plan of a broach. It is set to cut the right amount by means of the wedge *C* and cap-screw *D* and it is drawn through the cut by screwing the nut *E* down on the spindle, which is kept from turning by a box-wrench on the squared end. A similar tool used for facing the seat of the main valve bushing for the 9½-inch air-pump, is shown in Fig. 36. This tool differs from the one just described, in that it has a back *C* to slide on while it is cutting. This cutter hasn't the tendency to turn that the one illustrated in Fig. 35 has, on account of the flat cutting surface, so no wrench is needed to keep the drawing spindle from rotating when the nut is being turned.

Fig. 47 shows how the top-head of a 9½-inch air-pump is ground to a perfect fit, with an air motor to turn it, while emery is used as a grinding medium.

Babbitting Jigs

The jig used while babbitting the crosshead slippers for alligator guides, is shown in Fig. 37, while Fig. 38 shows the jig used when babbitting crossheads for four-bar guides, with a crosshead in place, the side-plates on and all ready for pouring. Fig. 39 shows the crosshead finished and the jig with the side-plates removed. The way the crossheads are heated before they are placed in the jig is shown in Fig. 40.

Car-brasses are babbitted by placing them face down on the special half-mandrels shown in Fig. 43, and the babbitt is poured in through the holes in the brasses. Thousands of these brasses, just as they came from the cars, are shown in the pile in the background. These old brasses are thrown into the furnace, Fig. 44, and heated just enough to melt the babbitt, which runs from a spout into the big kettle shown at the right of the furnace. If the brasses are not too much worn they are re-babbitted, but if they are badly worn they are melted up and re-cast.

Miscellaneous Features of Interest

In Figs. 41 and 42 is shown an unusual way of machining engine cylinders on the slotter. Many advantages are claimed for this method, however, such as quickness and ease in handling and setting, and steadiness under a cut.

All sheet rubber or sheet copper gaskets used for any purpose in these shops are cut in special punch-press dies. The initial cost of the punches and dies is, of course, large, but the aggregate time saved for a year's repair work is enormous. Some cover and steam-chest gaskets are made of heavy copper wire, which is cut to the right length, after which the ends are square-lapped and brazed. The cutting and square-lapping is done at one stroke on the hand-press shown in Fig. 16. An adjustable stop on the bench, in line with the cutting-die, and graduations on the bench for the different sizes of gaskets used, makes it but the work of a moment to cut any size gasket wanted.

As solder is used in immense quantities in the various departments, it is mixed and cast into sticks in the works, the molds being shown in Fig. 17. The nearest molds have been emptied while the white appearance of the rest is caused by the steam of the water used to cool the solder. Close to the window is a set of mandrels for use in casting rocker-arm bearings. These mandrels vary in size by thirty-seconds of an inch, so that a mandrel can be selected from the set that will, by allowing for shrinkage, enable the molder to cast a bearing to fit any rocker-arm that can be used.

Beside their splendid shop practice, these shops have one of the best apprenticeship systems that I have found anywhere, which will be described in detail in another article.

BORING-BARS AND HEADS[*]

LUCIEN L. HAAS[†]

The design of a boring-bar or head is usually somewhat of a problem to most designers, as so much is often required of these tools. There are many important things to be considered in connection with this work, and in the following description of twenty different designs, which are illustrated in the Data Sheet accompanying this issue, I shall endeavor to cover at least the greater part of the questions involved under this head.

Fig. 1 illustrates a temporary boring-bar, which is an old design that is used universally. The end of the bar has a square slot through it into which the square tool *A* is a sliding fit. The tool is clamped in place by the set-screw *B* (which should be of the standard size), and is adjusted by tapping it lightly with a hammer. The bar shown in Fig. 2 is very similar to that of Fig. 1 with the exception that the tool is round instead of square. Set-screw *C* also provides means for a finer adjustment of the cutter than could be obtained for the one shown in Fig. 1. The set-screw *B* which bears against a flattened side on the cutter, clamps the latter in place. If this flattened surface is not provided on the tool it is liable to turn when taking a cut and serious damage may be the result. The bar illustrated in Fig. 3 is so designed that the cutting edge of the tool *A* is slightly in advance of the end of the bar. This tool is held by the screw *B* and adjusted by the screw *C*. Of course, it is necessary to remove the tool when making adjustments. This bar is adapted to boring blind holes, or for working close to shoulders, etc. The cutting tool should be set at an angle of about 60 degrees with the axis of the bar. Fig. 4 is a design of boring-head with two cutting tools. This head, after it has been hardened, is ground on the exterior *D* so that it can be used to guide the tools. It is fastened to the bar by the threaded shank shown. The cutting tools, which are set at an angle of 45 degrees, are made of round stock, and are held in place by set-screws *B*. When the tools are to be adjusted, they are removed and the adjustments are made by the screws *C*. Fig. 5 illustrates a bar with a cutter which is adjusted by means of a nut *C*. The tool is only threaded at one end and is a sliding fit in the bar. When properly adjusted it is held by the set-screw *B* which bears against a flattened surface. That part of the bar which is in contact with the nut *C* is also flattened. While all boring-bars will work with good results for a short time with soft centers, it is always advisable when accurate work is to be done to insert hardened centers *D* in the ends of the bar. These are easily made, and often much time has been wasted and much work lost simply because this point has been overlooked.

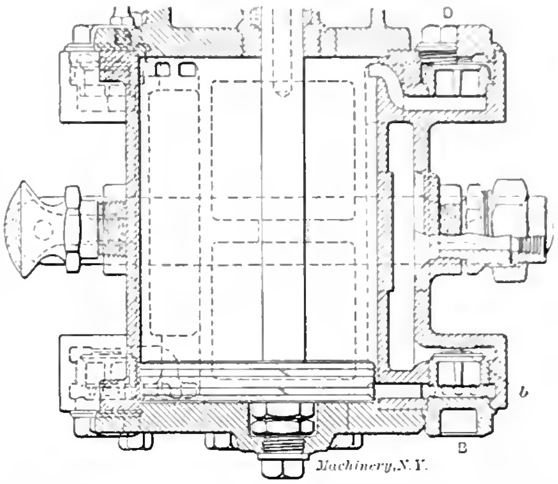

Fig. 50. Section of Air Cylinder of 9 1-2 inch Westinghouse Pump—The Valves are given the Correct Lift by the use of the Gages shown in Fig 33

The types shown in Figs. 6 and 7 are very much alike with the exception that the cutting tools are held differently. With the design of Fig. 6 the cutter can be placed in the

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[*] With Data Sheet Supplement.

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center of the boring-bar as well as at the end; but with the method of fastening shown in Fig. 7, the tool must be located at the end. In one case, as will be seen by referring to the illustrations, the cutter is held in place by a wedge, while a set-screw is used in the other. The tools in both cases should be made to hook over flats on the bars, thus centering them. The cutting edges are backed off similar to the teeth of a milling cutter. Both these designs are very good for heavy boring or cutting. Two designs which are also very similar are shown in Figs. 8 and 9. As will be seen, the ends of the bars are slotted, and the tools fit into these slots centered by fittings on either side, as in Figs. 6 and 7. Bars of this type are designed to face as well as bore, and they are admirably adapted to roughing out heavy work. The cutter in Fig. 8 is held in place by the conical-pointed screw which bears against a slot milled to an angle of 30 degrees in the cutter. As *C* is screwed inward the cutter is forced against the bottom of its slot. The cutting tool in Fig. 9 is held by means of a hardened bushing *D*—the flattened side of which is forced against the cutter by the screw *B*—which, as shown, is placed at an angle of 6 degrees with the side of the cutter. This method of fastening the tools is more expensive than that shown in Fig. 8, and does not give any better results. Fig. 10 shows a single-step tool with means of adjustment, which I have used in automatic turret machines for boring out steel, with excellent results. It has been found advisable, through experience, to equip a bar carrying such a tool with a pilot as shown in the illustration. The bar can be made of ordinary machine steel, but the pilot should be carbonized and ground to fit whatever sized bushing is used in the head of the machine. The cutting tool is beveled on the bottom at an angle of 30 degrees, and is adjusted by means of a hardened headless screw *C*, which has a corresponding taper. The tool is held in place by the two screws *B*.

The bars shown in Figs. 11 and 12 were designed for light boring, in such metals as aluminum, etc., and give the very best results for this class of work. Slots are cut on either side of the bar into which the cutters *A* are fitted. Hardened bushings *D* and screws *B* hold the cutters as in Fig. 9. The design illustrated in Fig. 13 works very successfully where there is facing as well as boring required, when it is absolutely necessary to have the cutters adjustable, and, as often happens, when it is also necessary that the cutters be held in place by some simple means accessible at the back instead of at the face or side of the head. The bar is slotted across the end to receive the two tools which are also slotted, as shown at *D*, sufficiently to allow one side of the round heads of the clamping bolts *B* to enter. This arrangement makes it possible to clamp the cutters by simply tightening the nuts on the bolts *B*. The tools are adjusted by the conical-pointed screw *C*, the end of which bears against the inner ends of the cutters, which are also tapered. The design shown in Fig. 14 is excellent when a boring-head for finishing cuts is wanted. It acts similarly to a reamer, and the tools *A* are very easily adjusted as they fit in tapering slots, and adjustments are obtained by varying their position. The clamps *D* and the screws *B* hold them in place. The bar shown in Fig. 15 is one that has been used for years as a roughing tool for cast iron cylinders.. The small cutting tools *A* which are held in place by the screws *B*, fit tightly in the slots provided for them. This design is defective, however, in that when adjustment is required it is necessary to insert new cutting tools.

Fig. 16 illustrates a design which is preferable to the one shown in Fig. 15, as the tools are provided with adjustment and, in addition, are rigidly held so that they will withstand a great strain. The bar is especially adapted to the boring of cast iron cylinders and gives excellent results when made up in sets for roughing and finishing. The bar has a slot across the end in which the boring cutters *A* fit. These cutters are notched, as shown, to allow the partial entrance of the heads on screws *C* which give the necessary adjustment. When the cutters are set they are held in place by the hardened set-screws *B*. The inserted-tool boring head shown in Fig. 17, is one of the strongest made. It is intended for boring steel, and will stand up under the most severe tests. The head should be made of steel and the cutting tools, should be made of the very best high-speed square steel and a sliding fit in their slots. The end of the head should be bored out first for the ring *D* and then slotted for the cutters and tapped for the set-screws *B*. Ring *D*, which contains the adjusting screws *C*, may then be driven in place. Fig. 18 illustrates a boring-bar or head with two inserted blades, which is an excellent tool for finishing brass or aluminum and may also be used for steel as well. The head is attached to the bar by means of a threaded shank. The cutting tools are tapered on the bottom and fit in slots having a corresponding taper, thus providing means of adjustment. They are clamped in place by driving in the taper pins *B*. Fig. 19 shows another design of boring-bar head, for finishing, which is attached to the bar in the same manner as the one shown in Fig. 18. The blades are also held in practically the same manner, but instead of using taper pins which often work loose, specially designed hardened screws *B* with heads tapered to about 8 degrees included angle, are used to clamp the cutters. Fig. 20 illustrates an excellent design for small cylindrical boring. The bar is threaded to fit the hardened collar *D* and the lock-nut *C*. The ring *B* should be a sliding fit on the bar and is kept from turning by the key *E*. This ring is slotted to suit the cutting tools, which should be made of square stock and which are adjusted by screwing back the collar *D* and tightening the lock-nut *C*. Three cutting tools are shown, but this number can be varied according to the size of the head.

* * *

GREAT POSSIBLE INCREASE OF BOILER CAPACITY

A preliminary report on the work of the Technologic Branch, United States Geological Survey, relating to experiments on steam boilers, has recently been issued. These experiments have been undertaken to ascertain the possibilities of increasing the capacity of boiler plants. It is stated in the report that the experiments so far made indicate that it is possible to double or triple the capacity of the plant without making any radical changes in furnace and boilers. This increase would require that a correspondingly increased amount of air be put through the grates; to do this, it would be necessary to apply increased pressure to the air, in order to force it through the grates. An equipment of fans designed to supply three or four times as much air under several times the pressure would be required. The results, however, appear as yet to be only tentative. The forcing of air under high pressure through the grates would require considerable power, and the proper ratio between this increased power, and the increased efficiency, must be established. It should not be attempted to force more air through existing grates by running fans a great deal faster, because the power required for this increases in too rapid a ratio. New fans would have to be installed of sufficiently larger size to supply the larger quantities of air at higher pressure. It is likely that new designs of grates, stokers, furnaces and boilers would be required in order to obtain the highest efficiency; but while the designs be improved, it is understood that no radical changes would be necessary. The United States Geological Survey will, in the near future, issue a bulletin on "The Significance of Drafts in Steam Boiler Practice" and another bulletin entitled "Drafts." They will deal in detail with the question of the influence of increased draft on the capacity of steam boilers.

* * *

An army officer whose duties require him to frequently visit three large cities which are so situated that a straight line drawn from one to the other forms a perfect triangle is soon to be court-martialed for adding a fourth side to the triangle.—*New York Times.*

This description of an equilateral triangle as a "perfect triangle" is on par with a "round circle." The addition of a fourth side would stagger Euclid himself. A caustic contemporary remarks: "That unique triangle ought to be put in a museum and kept there for the everlasting delectation of mathematical amateurs."

VERTICAL SAW-TOOTH ROOF CONSTRUCTION

In the accompanying illustrations is shown a type of vertical-sash saw-tooth for roof lighting, developed by F. W. Dean, mill engineer and architect, Boston, Mass. It, of course, is commonly known that in order to exclude direct sunlight from a skylight which faces toward the north the angle of inclination of the sash varies with the latitude. In general practice the face is inclined at an angle of between 60 and 80 degrees with the horizontal. The angle of 60 degrees which has been adopted by some as a standard in the average latitude of the principal manufacturing industries in the United States admits some direct rays when the sun is in the zenith. For the mean latitude of the United States it may be shown that the angle of the face should approximate 73 or 74 degrees.

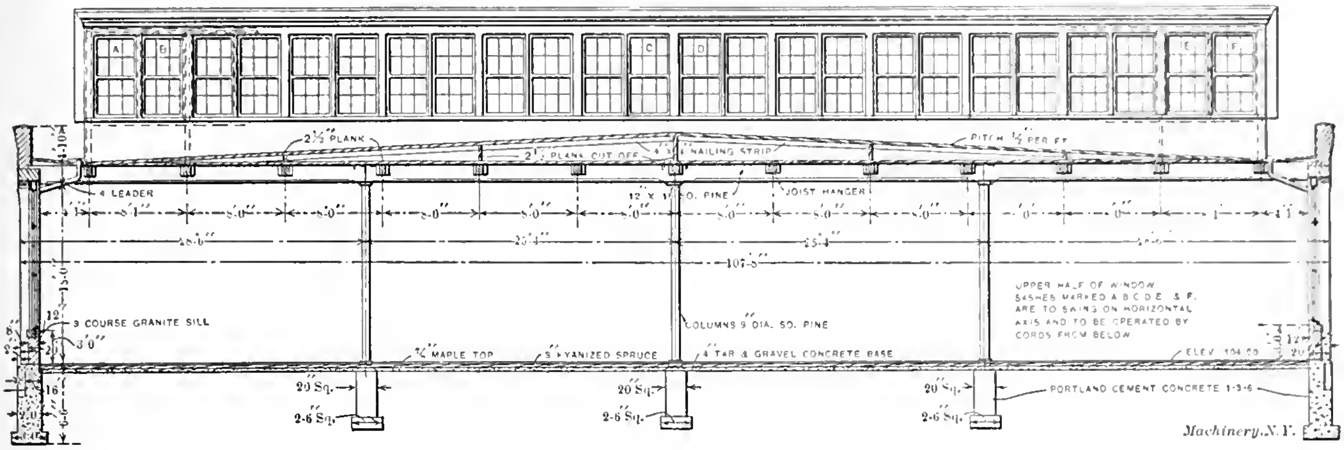

Fig. 1. Section through Building having Vertical Saw-tooth Roof

Study of the angles concerned shows that it makes but little difference in the lighting whether the face be vertical or not, but it is manifest that in features of construction and maintenance the vertical face avoids certain somewhat objectionable features of the inclined surface. Not only is the roof of the skylight more easily and simply supported in this design, but ordinary window sash may be used in place of the somewhat elaborate form of rigid metal sash with special provisions against leakage which is required when the glass is inclined.

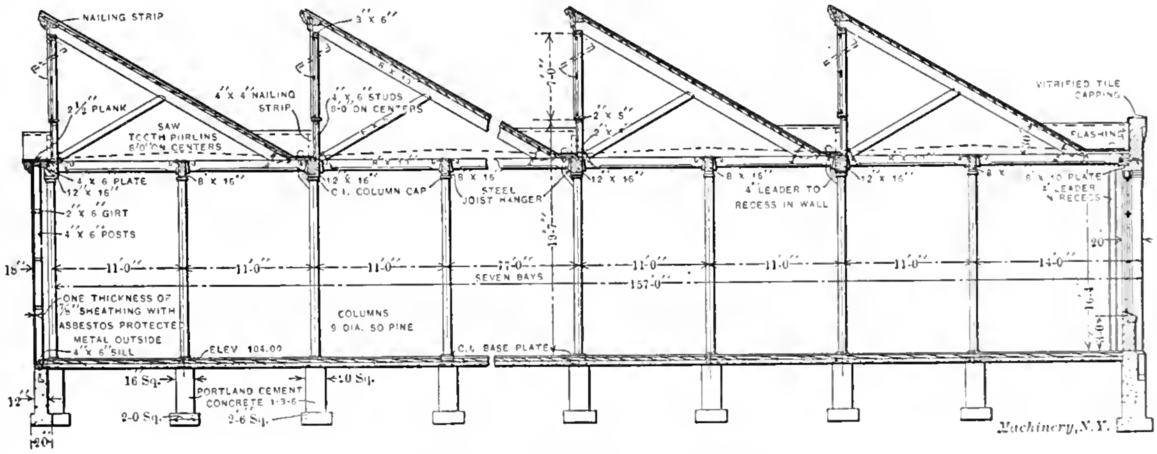

Fig. 2. Section showing Saw-tooth Roof Construction

In Mr. Dean's design regular window sash are used. The saving thus effected is practically balanced by the increased expense due to the longer rafters which are required, but it is not necessary to provide independent ventilators, for the upper sash are hung on a horizontal central axis and arranged to be operated by cord from below. By this arrangement the ventilation can be regulated to suit the exact requirements, either by opening some of the windows, or opening all a portion of the way. Condensation on the glass is positively caught by the zinc trays at the stools. The skylight roof, which is inclined at an angle of 30 degrees to the horizontal, consists of 2½-inch plank carried on 8 by 10-inch rafters, spaced 8 feet on centers and braced by 6 and 6-inch struts. The roof is covered with plastic slate, which is extended up the front of the skylights to act as flashing. The skylight windows are about 3½ feet wide by 6½ feet high.

This style of roof was used on the machine shop recently designed by Mr. Dean for the Canadian Rand Co., Ltd., of Sherbrooke, P. Q. It has also been employed to advantage in textile and similar mills.

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TRAINING OF GERMAN ENGINEERS

An interesting reference to German methods in the practical training of engineers is given by Mr. Franz zur Nedden in the *Engineering Magazine* for April, 1909. The practical training of a German engineer is briefly as follows: The boys usually leave the high-school at an age of eighteen years. All German technical colleges require that candidates for admission must have passed through a year of practical work in a machine shop or factory. During this year the students are called volunteers and not apprentices, the name indicating that their aims are different from those of the latter class. This year of practical work is followed by four years of study in the technical college. Each year there is a three months' vacation, during which additional practical training is acquired. There are no shops for special training in the colleges, although from year to year the mechanical laboratories are becoming more important in the whole plan of instruction. It is evident that the training of a one-year "volunteer" is not always a very profitable undertaking to the firm where a student obtains his practical experience, and therefore a number of prominent German machine firms required a payment by the student of from $75 to $125 a year for giving special training to prospective engineers. Some firms, among which may be mentioned the Ludwig Loewe & Co., have instituted a high-grade educational course for their regular apprentices which was mentioned in the September, 1908, issue of MACHINERY, and their volunteers attend this course also.

FORMULAS FOR CRANE BEAMS OR GIRDERS

C. R. WHITTIER*

In a former article (March, 1909) it has been shown that for I-beams of the minimum sections, which are commonly used, with a fiber stress not exceeding 16,000 pounds per square inch, and properly braced sideways at distances not exceeding twenty times the width of the flange, the depth of a beam, h, is closely determined by the formula $h = \sqrt{1.2\,l\,W} + 1$, where l is the span in feet and W the center load in tons. And approximately for center loads for the standard plate girders tabulated in the Carnegie hand-book, with a fiber stress not exceeding 15,000 pounds per square inch, $h = \sqrt{l\,W}$. But for the ordinary crane beam, and similar uses which do not admit of side supports, the above formulas require modification.

They become with center loads: For beams, $h = \sqrt{1.2\,l\,W} + 1 + 0.004\,l^2$; for girders, $h = \sqrt{l\,W} + 0.004\,l^2$.

Of course these are based on the supposition that the beams are sufficiently long not to fail by crippling of the web—a case which almost never occurs in practice.

These formulas give a ready means for determining the size required for a given load and span without the use of tables and the usual trial-and-error methods; they are especially useful in the field, and for preliminary work. Up to the point where the length of the beam does not exceed seventy times the flange width, they will be found sufficiently accurate. Above this point the error slowly increases, but always on the safe side.

As with the original formulas, the correction given is not purely empirical, but is deduced from accepted laws. The result is surprisingly simple when the long road required to reach it is considered. The method may be of interest.

The manner of determining the proper coefficient for reducing the usual load to prevent undue strains in the compression flange when the beam is considered as a column, is well known; and different authorities give slightly varying figures. The Carnegie table is as follows:

When the length of a beam does not exceed 20 times the flange width, the coefficient for safe load = 1.
When the ratio does not exceed 30, coefficient = 0.9.
When the ratio does not exceed 40, coefficient = 0.8.
When the ratio does not exceed 50, coefficient = 0.7.
When the ratio does not exceed 60, coefficient = 0.6.
When the ratio does not exceed 70, coefficient = 0.5.

Changing the length to feet, and keeping the width in inches, this is equivalent to the following:

When the ratio, l in feet, w in inches = 1.7, coefficient = 1.
When the ratio, l in feet, w in inches = 2.5, coefficient = 0.9.
When the ratio, l in feet, w in inches = 3.3, coefficient = 0.8.
When the ratio, l in feet, w in inches = 4.2, coefficient = 0.7.
When the ratio, l in feet, w in inches = 5.0, coefficient = 0.6.
When the ratio, l in feet, w in inches = 5.8, coefficient = 0.5.

We now wish to substitute for w its equivalent value in terms of h. By plotting, and deducing an approximate formula for the curve, we find that $w = 1.4\sqrt{h}$ very nearly, this being a simple parabolic curve which closely averages the plotted points.

Substituting in the above, we have, for the first case,

$$\frac{l}{1.4\sqrt{h}} = 1.7. \quad \text{Reducing } \frac{l}{\sqrt{h}} = 2.4, \text{ and}$$

$$\frac{l^2}{h} = 5.7.$$

Applying this method to the other ratios, as well, we have:

When ratio $l^2/h = 5.7$, coefficient of load = 1.
When ratio $l^2/h = 12.2$, coefficient of load = 0.9.
When ratio $l^2/h = 21.2$, coefficient of load = 0.8.
When ratio $l^2/h = 34.7$, coefficient of load = 0.7.
When ratio $l^2/h = 49.0$, coefficient of load = 0.6.
When ratio $l^2/h = 67.0$, coefficient of load = 0.5.

Plotting the above, it will be found that the straight line formula, coefficient = 1 — 0.008 ratio, gives practically the same coefficients. Therefore, coefficient for safe load, $C = 1 - \frac{0.008\,l^2}{h}$.

$$C = \frac{h - 0.008\,l^2}{h}$$

Now let W_1 represent the load in our original formula for plate girders, *i. e.*, $h = \sqrt{l\,W_1}$

Applying our coefficient for correction we have approximately, $W_1 = \frac{W}{C}$, and $h = \sqrt{\frac{l\,W}{C}}$. Squaring, and clearing of fractions, $h^2\,C = lW$. Substituting the value of C determined above:

$$\frac{h^2\,(h - 0.008\,l^2)}{h} = lW, \text{ and } h^2 - 0.008\,l^2h = lW.$$

Completing the square, and solving for h:

$$h - 0.004\,l^2 = \sqrt{l\,W + (0.004\,l^2)^2}\ .$$

The quantity $(0.004l^2)^2$ is so small in comparison with lW as to be negligible, and we have finally, $h = \sqrt{lW} + 0.004\,l^2$, as first given.

By a similar process for I-beams, we have approximately:

$$h = \sqrt{1.2\,l\,W} + 1 + 0.004\,l^2$$

It is easy to point out discrepancies in the extreme cases of this method of averaging by simple curves, but the final tests show that the errors of the approximations are relatively small. The resulting formula is so simple that it can be solved mentally, and is close enough for all but construction work. A few comparative examples with extreme lengths are appended, to show their accuracy; shorter lengths give even more accurate determinations.

For this purpose, a size of beam and span are assumed, the safe loads taken from the tables and corrected for center load, and the usual correction applied for no lateral support, giving the net load for this condition. Then for comparison with this usual method, assuming this same net load and span to be given, the process is reversed, and the size of beam determined by the formula.

From the tables, reduced to center load:
24-inch I-beam, 36 feet span, 12.9 tons load.
$w = 7$ inches,
$36 \times 12 \div 7 = 62$,
$C = 0.6$,
$12.9 \times 0.6 = 7.7$ tons net safe load.
By formula:
$h = \sqrt{1.2 \times 36 \times 7.7} + 1 + (0.004 \times 36^2) = 18.3 + 1 + 5.2 = 24.5$ inches, required height of beam.

Similar extreme examples for smaller beams give the following results:

Beam =	18 inches	12 inches	6 inches	4 inches
$W =$	6.5 tons	3.3 tons	1.0 ton	0.4 ton
$l =$	36 feet	20 feet	30 feet	20 feet
$w =$	6 inches	5 inches	3 inches	2.66 inches
$\frac{12\,l}{w} =$	72	72	80	90
$C =$	0.5	0.5	0.4	0.3
$WC =$	3.3 tons	1.6 ton	0.4 ton	0.12 ton

Calculated by the formula the required heights of the beams, in inches, are the sums of the following:

12	7.6	3.1	1.5
1	1	1	1
5.2	3.6	1.6	1.6
18.2	12.2	5.7	4.1

In practical solutions, all decimals of feet and tons may be disregarded, using the nearest whole number, and the results obtained mentally will give the same beam. A few decimals were retained in the examples for the purpose of showing how closely the formula applies.

* * *

A 2,000-kilowatt steam turbine installed in Rugby, England, has been placed on a rubber foundation and it is expected in this way to avoid objectionable vibration. The turbine is bolted to a concrete base 2 feet thick, which in turn, rests on several circular rubber stools, standing on a regular concrete foundation. Each rubber stool is a cylinder about four inches in diameter and three inches high when compressed by the weight of the turbine set. The idea of mounting turbines in this way is not new, but it is stated by *Engineering* that it has never before been tried with so large a turbine unit.

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DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—5

GIRDERS

R. B. BROWN

The primary consideration when designing an overhead crane lies in selecting the correct type of main girders, since not only the general efficiency of the crane is affected by this question, but, as the girders usually represent the bulk of the machines, the subsequent success in competition largely depends upon the selection of an economical type. Coincident with the question of type is that of the factor of safety, or the working stress. Practically all crane girders are now built of steel sections made by the open hearth acid process, and usually specified to possess a tensile strength of from 28 to 32 tons per square inch.

A great variation of opinion exists on the question of working stress; while many cranes are made having girders stressed to only four tons per square inch and even less, others, will be found having above seven tons stress. Taking into consideration the fact that a general factor of safety of five seems to be usual and most desirable in crane work, it is necessary to limit the stress to one-fifth of the maximum breaking strength of the steel, which gives approximately 5½ tons per square inch.

There are four types of girders commonly used, *viz.*, box-plate girders, single web-plate girders, braced girders, and rolled beam girders. Each will be considered independently.

The simplest form of girder for spans up to about 40 feet is the rolled steel joist, and for light loads it is undoubtedly the cheapest type. The effective range of span and load for beam girders will be seen from Table IX which has been compiled to show the type of girder generally considered suitable for a given span and load.

For cranes up to 15 tons with spans too great for joists but not more than 65 feet, the best form of girder is the single web type. Up to 40 feet span, providing the traveling speed is not very high, these girders can be made to carry themselves and a light platform, if the flanges are moderately wide, but above 40 feet span these girders will be found weak laterally, and a subsidiary braced platform girder of light construction should be added, the same being braced horizontally to the main girder, as shown in Fig. 17. Although this type has been found somewhat costly, there is no doubt it is stiffer laterally than a box girder, and the single web girder always possesses the advantage of permitting inspection and painting, thereby avoiding deterioration from corrosion, such as occasionally takes place in box girders. For cranes above 15 tons and for spans up to 65 feet, however, the box girder is considered the best and cheapest type that can be used. The sections and proportions required by such loads generally ensure the girder being stiff enough to carry the platforms and cross-shaft without causing any lateral distortion.

For cranes up to and including 4 tons, above 40 feet span and for all cranes from above 65 or 70 feet span, braced girders are the most economical. They are cheaper to make, and the reduced weight of the crane effects a saving in the power required for traveling, and may possibly reduce the scantlings of the runway girders. The most important question concerning braced girders lies in the adoption of the correct system of bracing, of which there are three designs in use, *viz.*, the Warren, the Linville and the latticed, as shown in Figs. 18, 19 and 20, respectively.

In point of cost, weight, and general convenience, the Warren type is the most suitable for the ordinary form of traveler. It has fewer joints and members, and gives satisfactory results in all respects. When the rolling load is large in proportion to the structural load, as is invariably

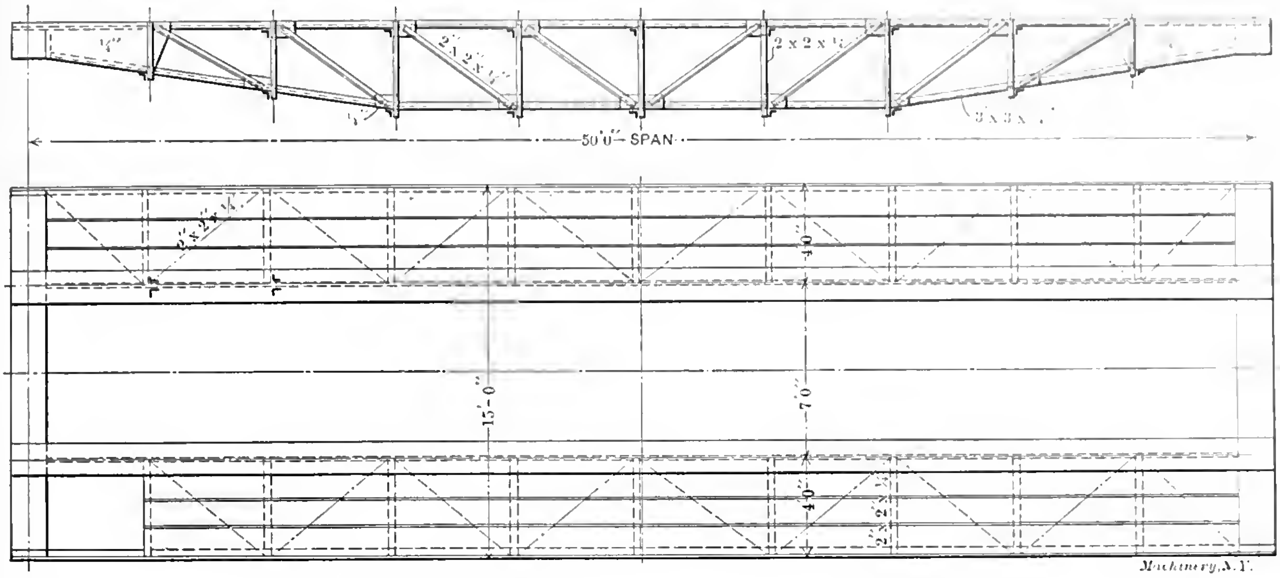

Fig. 17. Web-plate Girder with Braced Platform Girder, added to insure Sufficient Strength for Wide Spans

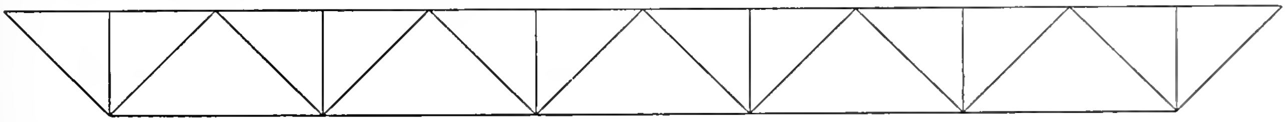

Fig.18

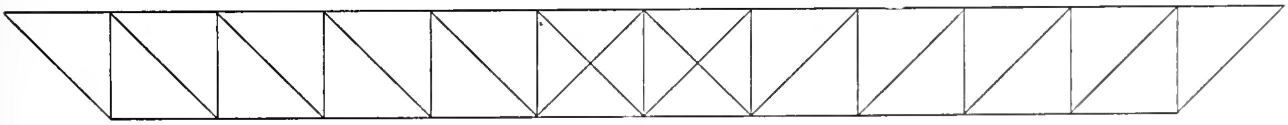

Fig.19

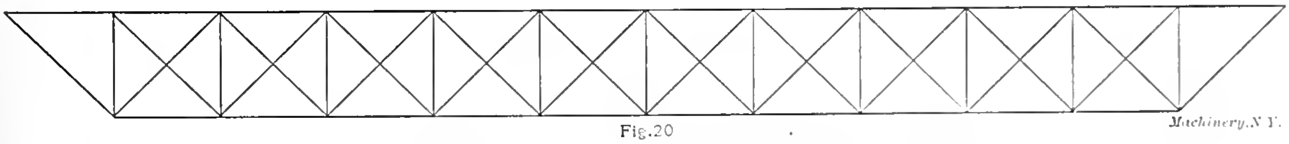

Fig.20

Figs. 18 to 20. Warren, Linville and Latticed Girders

the case with cranes, the Linville type requires so much counterbracing in the center, that it practically results in a latticed girder pure and simple, which, although frequently adopted, is heavier and more costly than the Warren type.

In order to treat the subject completely, it is proposed to consider the details of each type of girder, *i. e.*, solid, web, and latticed, independently, and although some parts may be a repetition, the arrangement will be more convenient to the designer.

Single Web, Box and Beam Girders

The preliminary calculation concerning the strength of girders of the above type is principally that of finding the bending moment in the ordinary way. This quantity should include the forces due to the rolling load of the weight and crab combined, the structural load due to the weight of the girder itself and the platform and cross shaft; and, if the driving motor is in the center, allowance must be made for this also.

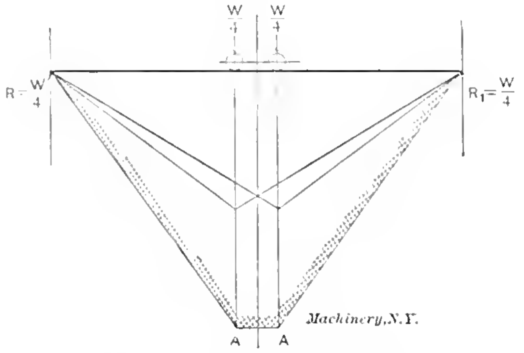

Fig. 21. Bending Moment Diagram, showing how the Effective Span of Girder is shortened by the Center Distance of the Crab Wheels

The practice of making some allowance for impact forces is neglected by the majority of crane builders, while, on the other hand, when work of this nature is undertaken by bridge builders, one finds as much as 50 per cent being added to the actual rolling loads to cover supposed impact forces.

TABLE IX. TYPE OF GIRDERS USED FOR DIFFERENT LOADS AND SPANS

R S B = beam section.
S W P = single web girder with lateral bracing girders.
B G = ordinary box girders.
L G = lattice girders, preferably Warren type.

Load in Tons.	Span in Feet.					
	30	40	50	60	70	80
5	R S B	R S B	S W P	S W P	L G	L G
10	R S B	S W P	S W P	S W P	L G	L G
15	R S B	S W P	S W P	S W P	L G	L G
20	R S B	S W P	S W P	S W P	L G	L G
25	B G	B G	B G	B G	L G	L G
30	B G	B G	B G	B G	L G	L G
40	B G	B G	B G	B G	L G	L G
50	B G	B G	B G	B G	L G	L G
60	B G	B G	B G	B G	L G	L G
75	B G	B G	B G	B G	L G	L G
100	B G	B G	B G	B G	L G	L G

That some allowance should be made appears quite consistent, particularly in high speed cranes, but there seems to be no definite rule for this. Generally speaking, the working stresses of crane girders, say 5 to 6 tons per square inch, provide a margin for small additional impact forces. No allowance will be made in the following calculations for impact stress, but such allowance could easily be added if considered necessary in any particular case.

If the crab is symmetrically built, the rolling load may be considered to be divided equally over the four wheels. By making this allowance it will be seen, as far as the rolling load is concerned, that the effective span of the girder is shortened by a distance equal to the center distance of the crab wheels. This can better be seen by reference to the bending moment diagram in Fig. 21, where it will be seen that the maximum bending moment from the rolling load occurs at *A A*, and is equal to the reaction at either support multiplied by the distance from that support to the center of the crab wheel. This quantity is also the bending moment at the center. To find the bending moment due to the structural load, it is usual to treat the latter as an evenly distributed load, where $M_b = \frac{WL}{8}$; similarly a traveling motor in the center of the span must be considered as a concentrated load, where $M_b = \frac{WL}{4}$.

A bending moment diagram might be drawn combining the whole of the above forces, but the same result can be found more quickly directly by figures, as shown in the following example.

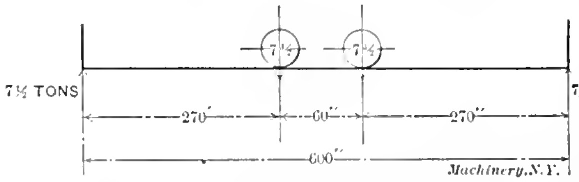

Fig. 22. Example for Calculating Bending Moment in Crane Girder

Find the total bending moment of a 25-ton crane, 50-foot span, weight of crab 5 tons, centers of wheels 5 feet. Approximate weight of one girder and platform, etc., 5 tons. Traveling motor in the center: weight ¾ ton. (See Fig. 22.)

$$\text{Bending moment, rolling load} = 270 \times 7\tfrac{1}{2} = 2025 \text{ inch-tons}$$

$$\text{Bending moment, structural load} = \frac{5 \times 600}{8} = 375 \text{ inch-tons}$$

$$\text{Bending moment, traveling motor} = \frac{3 \times 600}{4 \times 4} = 112.5 \text{ inch-tons}$$

$$\text{Total,} \quad = 2512.5 \text{ inch-tons}$$

When the maximum bending moment has been found, the depth of the girder must be considered. Modern practice generally makes this quantity the nearest even dimension equal to 1/15 or 1/16 of the span. In the case of heavy cranes, however, it is more economical to increase the depth of the girders than to make the flanges abnormally heavy, so that in the case of 100-ton overhead cranes of moderate span, the best proportion is about 1/12 of the span. An exception to the above rules occurs in the case of all short span cranes, where the depth becomes a matter of convenience.

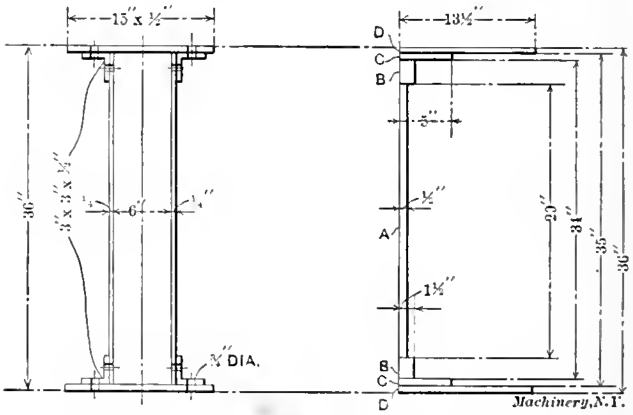

Fig. 23. Proposed Section of Girder, drawn to convenience its Calculation

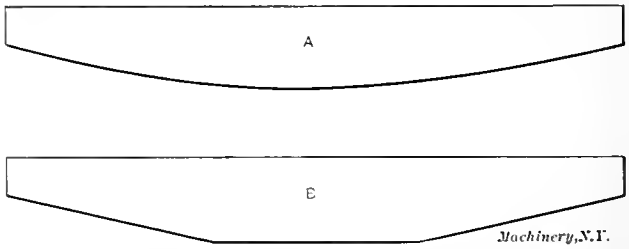

Fig. 24. Types of Fish-bellied Girders in Use

In determining the section of the girder it has, until quite recently, been common practice to totally ignore the value of the webs to resist bending, the flange area alone being

taken into consideration. This practice is open to some question; it seems that if the webs are stiffened in the usual way, they are of such value as to allow the whole section of the girder being taken into account, but in any case, the webs do not add much to the modulus. In order to calculate the strength, the moment of resistance or modulus of the section must be found; and this must be equal the bending moment divided by the working stress F in the girder:

$$\frac{M_b}{F} = Z$$

When finding a required modulus, the section has to be assumed, preferably by comparison, after the depth has been fixed. Allowance should be made for the rivet holes in the flanges to be ⅛ larger than the size of rivet. It is generally found convenient to draw the proposed section as shown in Fig. 23.

Before the modulus itself can be found, the moment of inertia of the section must be calculated. This quantity, for rectangular symmetrical sections taken about the neutral axis, is equal to 1/12 $b h^3$, when b = breadth and h = height of rectangle.

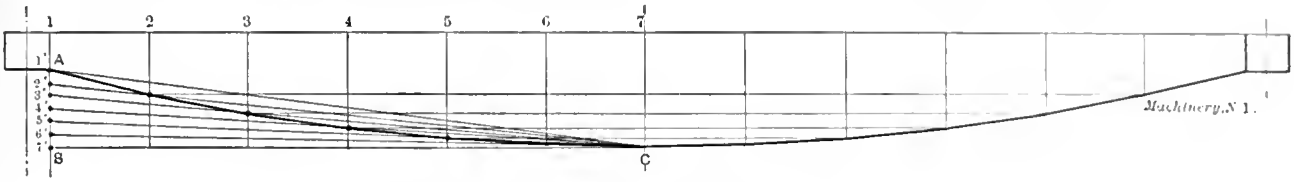

Fig. 25. Laying out a Girder of the A Type, Fig. 24

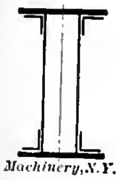

TABLE X. GENERAL DIMENSIONS OF BOX GIRDERS FOR ELECTRIC OVERHEAD CRANES, AND MODULUS OF GIRDER SECTION

Depth.	Flange, Inches.	Angles, Inches.	Webs, Inches.	Modulus.
2'-3"	12 x ⅜	3 x 3 x ⅜	¼	230
2-3	12 x ½	3 x 3 x ½	¼	292
2-6	12 x ⅜	3 x 3 x ⅜	¼	273
2-6	12 x ½	3 x 3 x ½	¼	308
2-9	12 x ⅜	3 x 3 x ⅜	¼	314
2-9	12 x ½	3 x 3 x ½	¼	380
3-0	15 x ⅜	3 x 3 x ⅜	¼	378
3-0	15 x ½	3½ x 3½ x ½	5/16	530
3-6	15 x ⅜	3½ x 3½ x ⅜	¼	500
3-6	15 x ½	3½ x 3½ x ½	5/16	653
4-0	18 x ½	3½ x 3½ x ⅜	5/16	797
4-0	18 x ⅝	3½ x 3½ x ½	5/16	940
4-6	18 x ½	3½ x 3½ x ½	5/16	998
4-6	18 x ⅝	4 x 4 x ½	5/16	1118
5-0	21 x ¾	4½ x 4½ x ¾	⅜	1809
5-0	21 x 1	4½ x 4½ x ¾	⅜	2057

Referring to Fig. 23, it will be understood that, owing to its irregular shape, each rectangle A, B, C, and D must be treated independently.

The total moment of inertia of the section can, therefore, be stated as follows:

$$I = \frac{(36^3-35^3)\times 13\frac{1}{2} + (35^3-34^3)\times 5 + (34^3-29^3)\times 1\frac{1}{2} + 29^3\times\frac{1}{2}}{12}$$

= 8,600 approximately.

It is well known that the modulus of moment of resistance of a symmetrical section is equal to the moment of inertia divided by the distance from the neutral axis to the extreme outer edge of the section; consequently the modulus Z of the section $= \frac{8600}{18} = 478$.

Tables X and XI give approximate values of various box and single web sections suitable for crane work.

Although box girders have been made with 3/16-inch web plates, it cannot be considered good practice to use plates less than ¼ inch thick, owing to the small margin allowed for deterioration from rust. For box girders on cranes up to and including 20 tons, ¼-inch webs have been repeatedly used and show no signs of buckling with the ordinary arrangement of stiffeners. The same applies to 5/16-inch webs for 30- to 50-ton cranes, above this size ⅜-inch plates are recommended.

In the case of single web girders, ¼-inch plates have been used for cranes up to 7 tons, increasing to 5/16 inch up to 20 tons, and ⅜ inch or more, above, as required. When the stiffeners are placed outside, T sections are generally used, but for cranes up to 10 tons, 2½- to 3-inch angles are amply strong enough, and also convenient for fastening the brackets. The various formulas for pitch of stiffeners used in bridge practice do not seem to agree with the results found in crane girders, since they usually give the centers of stiffeners unnecessarily close. The average practice is to place the stiffeners about 5 feet apart, but it is better to reduce this dimension to 4 feet 6 inches for girders up to 2 feet 6 inches deep. The practice of placing channels or Z-bars inside, instead of using outside T-stiffeners, generally necessitates some hand riveting; otherwise this is a neat and strong type.

As shown in Fig. 24, there are two forms of fish bellied girders in use. The lower boom in both cases is polygonal, that in A having a side or flat for each division made by the stiffeners, while that in B has three straight cuts only, and is, therefore, cheaper; the general opinion is that both look equally well when erected. To find the varying depths in girder A, it is best to draw a parabola in the usual way, as shown in Fig. 25. The divisions 1 to 7 represent the centers of the stiffeners, and the distance AB must be divided into the same number of equal divisions on each side of the center line of the girder. Drop verticals from 2, 3, and 4, etc., and join $C2'$, $C3'$, $C4'$, etc. The point of intersection between these two lines gives the depth of the girder at that point. Although the above method gives a well-shaped girder, it is not theoretically correct, since the parabola should be set off from the top flange. When this is done, however, the ends of the girder have to be parallel for a certain distance and this causes extra trouble in planing the webs, without any economy in material. In the case of type B, the correct parabola should be laid out, and the flats laid off to suit.

For girders up to 40 feet span which are going to be shipped in one piece, it is possible and preferable to have

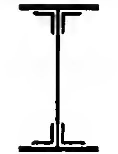

TABLE XI. GENERAL DIMENSIONS OF SINGLE WEB GIRDERS FOR ELECTRIC OVERHEAD CRANES, AND MODULUS OF GIRDER SECTION

Depth	Flange, Inches.	Angles, Inches.	Webs, Inches.	Modulus
2'-3"	12 x ⅜	3 x 3 x ⅜	¼	202
2-3	12 x ½	3 x 3 x ½	5/16	271
2-6	12 x ⅜	3 x 3 x ⅜	¼	238
2-6	12 x ½	3 x 3 x ½	5/16	282
2-9	12 x ⅜	3 x 3 x ⅜	¼	272
2-9	12 x ½	3 x 3 x ½	5/16	315
3-0	15 x ⅜	3 x 3 x ⅜	5/16	340
3-0	15 x ½	3½ x 3½ x ½	5/16	467
3-6	15 x ⅜	3½ x 3½ x ⅜	5/16	448
3-6	15 x ½	3½ x 3½ x ½	⅜	583
4-0	18 x ½	3½ x 3½ x ⅜	⅜	705
4-0	18 x ⅝	3½ x 3½ x ½	⅜	849
4-6	18 x ½	3½ x 3½ x ½	⅜	881
4-6	18 x ⅝	4 x 4 x ½	⅜	1002
5-0	21 x ¾	4½ x 4½ x ¾	7/16	1631
5-0	21 x 1	4½ x 4½ x ¾	½	1917

the flange plates and angles in one length, and thereby avoid the joints. When, however, joints are necessary in the flanges, it is the practice of some makers to allow 25 per cent extra section for the rivets, and the flange joint plates and angles should be of the same section as the flanges themselves, at least.

For cranes traveling at a moderately high speed, that is, anything over 200 feet per minute, the lateral stresses due to suddenly stopping the load require consideration. If, for example, the 25-ton crane previously referred to travels at 300 feet per minute (5 feet per second) under full load, the momentum of the load and crab at full speed will be $\frac{W v^2}{2 g}$

$$\text{or } \frac{30 \times 5^2}{64.4} = 11.6 \text{ foot-tons.}$$

It is difficult to assume what would be the least distance that the crane would travel before coming to rest after the current had been shut off and the brake had been applied, but a minimum of five feet has been found satisfactory, and under this condition the average horizontal force on the two girders would be $\frac{11.6}{5} = 2.3$ tons, or 1.15 ton per girder. This would be the concentrated effort, but there is also the distributed effort due to the girder itself, which will be found by the above formulas to be about 0.95 ton per girder.

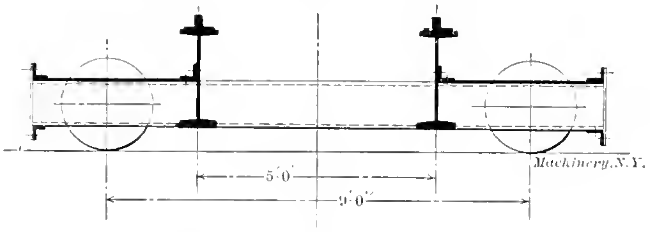

Fig. 26. Method of Stiffening Steel Joist Girders

In order to avoid possible distortion from the concentrated load, one must assume that it is carried by the upper part of the girder only, that is, the flange plate, angles and about 18 inches of the webs. The bending moment from the concentrated load, in the above example, allowing for the spacing of the crab wheels, is $0.57 \times 270 = 154$ inch-tons.

The modulus of the upper flange taken horizontally is 45.7, therefore, the stress is $\frac{154}{45.7} = 3.4$ tons per square inch.

The distributed load is carried by the full depth of the girder, and, allowing for the horizontal modulus of the whole of the section, gives a stress equal to about 0.7 ton per square inch, bringing the total lateral stress up to $3.4 + 0.7 = 4.1$ tons per square inch.

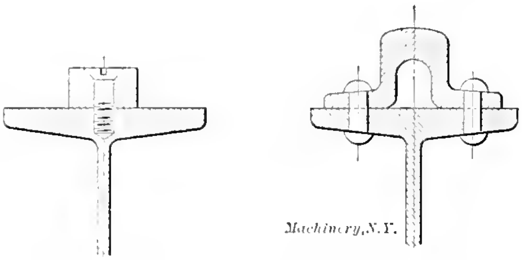

Fig. 27. Methods of Attaching the Rail to the Beam Girder

The total lateral stress should not exceed four tons per square inch under the above conditions, since the ratio between flange width and span, which is usually about 1 to 40, is large, and the girder is, therefore, more easily deflected.

By referring to Table IX it will be seen that rolled steel beams can be used for cranes of varying capacity, up to 40 feet span. The most economical and only really practicable method of using steel beams for moderate-speed and high-speed cranes is to attach a steel chequer-plate platform to both girders in such a manner as to provide the necessary lateral stiffness. Fig. 26 shows a typical form of this arrangement.

There are two common methods of fixing the rails on the beams, either by riveting on a bridge section rail, or screwing on a flat bar, as shown in Fig. 27. Both methods are equally satisfactory.

[In the fourth installment of this series, published in the April issue, two errors occurred in the numerical calculations. At the top of page 578 the calculation of the weight required for mechanical brakes should have been, theoretically, 127 pounds, instead of 12.5 pounds, and the weight with the extra allowance about 150 pounds, instead of 15 pounds, for the conditions given. The numerical example for a brake of the friction disk type also contains an initial error which makes the subsequent results erroneous. The formula given, however, is correct. Those who file these articles should, therefore, make note of this in the places referred to, so that confusion may be avoided when the matter is referred to in the future.—Editor.]

* * *

ANTI-FRICTION ALLOYS FOR BEARINGS*

The load at which rubbing begins is generally greater, the harder the metals in contact; the coefficient of friction on the other hand is generally smaller, the harder the metal. In order to reduce friction as well as to avoid cutting, hard substances should be used for bearing surfaces—hence the use of phosphor bronze.

The use of hard substances, however, corrects only the effects of defective lubrication, and assumes that the surfaces in contact are regular, so that the load is uniformly distributed and not concentrated in certain points. If the metal is hard and unyielding, the pressure on these points becomes considerable and leads to heating and cutting. Hence the bearing metal must have a certain plasticity so as to mold itself around the shaft and increase the surface of contact. But the bearing itself is constantly wearing away irregularly, and the plasticity of the metal must be such as to constantly restore its contact with the shaft.

We are led, therefore, to seek in alloys for bearings subjected to friction, two apparently contradictory characteristics, namely, hardness and plasticity. We may combine them, however, in using metals composed of hard grains embedded in a plastic matrix, and this is the main principle aimed at in anti-friction alloys.

The constitution of bronzes is the reverse of that of white alloys. Instead of hard grains in a plastic eutectic, we have soft grains in a hard eutectic for the same degree of plasticity. The behavior of bronze and white metals is not identical, and the bronze has a greater tendency to cut than the white alloys.

If the weight borne by the bearing of a uniformly-rotating shaft be gradually increased, when a certain load is reached the oil is driven from the space between the shaft and the bearing, and the metal becomes heated. In the case of white metal the wear is then considerable, and if the load continues to increase, the alloy may be partially fused. In the case of bronze, the portions rich in copper adhere to the shaft, forming a rough surface and increasing the friction.

Bronzes are then inferior to white metals because they are less plastic and do not mold themselves as well around the axle; their greater strength does not permit a heavier load, for then the lubrication is interfered with, and they tend to become heated. Bronzes, on account of their constitution, have a greater tendency to cut than white alloys, and thus produce a deterioration of the axle.

An anti-friction alloy should have hard grains in a plastic matrix; then the load is carried by the hard grains which have a low coefficient of friction, and the cutting can only take place with difficulty. The plasticity of the cement makes it possible for the bearing to adjust itself around the shaft, thus avoiding local pressures, which are the chief cause of accidents. Such properties may be obtained in binary alloys with such metals as antimony, tin, and copper, which form chemical compounds. The requisite properties are better obtained in ternary alloys, which give a good plastic matrix (eutectic). To test an anti-friction alloy, compression and the microscope are invaluable aids.

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* Extract from paper by Mr. A. H. Hiorns, read before the Birmingham Association of Mechanical Engineers, December 17, 1908.

SPECIAL AUTOMOBILE FACTORY TOOLS AND DEVICES[*]

ETHAN VIALL[†]

The things that impress a visitor most as he goes through the great automobile factory of the Geo. N. Pierce Co., Buffalo, N. Y., are the splendid buildings, the magnificent lighting and the immense floor spaces. An idea of the size of the plant may be obtained from the following dimensions of the various buildings that make up the group. The office building is 250 by 67 feet and consists of two stories and a basement, the first floor being used for offices, the second as a dining hall, smoking and club room, while the basement contains closets, individual lockers, bicycle racks and long rows of white enameled wash bowls. Next is the manufacturing building, 401 by 205 feet; the assembly building, 410 by 122 feet; the brazing building, 377 by 55 feet; the power house, 194 by 55 feet; the garage, 139 by 55 feet; and the motor testing building, 91 by 43 feet. All of these, except the office building, are of the one-story saw-tooth roof type. Then there is the three-story body building, where the automobile bodies are set up and finished, the north wing of which is 327 by 60 feet; south wing, 401 by 60 feet, and the east wing, 50 by 40 feet. The floor space represents over 360,000 square feet, and the plant is as nearly fireproof as it is possible to make it, being almost entirely concrete with no more wood anywhere than is absolutely necessary.


Fig. 1. Milling the Ends of the Bearings of Aluminum Crank Casings for Pierce Automobiles

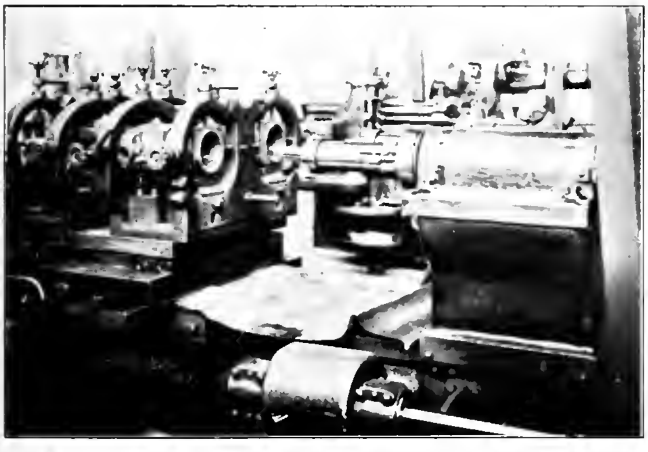
Fig. 3. Lathe Fixture for Holding Four Cylinders while They are being Rough Bored

There are in the factory many very interesting features, viewed from an engineering standpoint, but as this article is to deal principally with special tools and devices, other features not coming under this classification will merely have passing mention.

In the construction of the Pierce Great Arrow car, aluminum is very extensively used; bodies, crank-cases and many other parts being made of this metal. The method of milling the ends of the crank-bearings in the aluminum crank-cases is shown in Fig. 1. A finished crank-case is shown leaning against the machine, while another is clamped to the angle-plate ready to be milled. The lubricant used is a soap-water mixture. Fig. 2 shows the machine that bores out the crank and cam-shaft bearings in one operation, using three boring-bars. In connection with the finishing of these crank-cases, the arrangement shown in Fig. 6 is very useful. It consists of an air-drill to which has been fitted a bracket and taper mill as illustrated, and it is used for trimming off the bosses in order to save chipping and filing. The machine produces a smooth finish quickly and it is easily operated.

Machining the Cylinders

The fixture used to hold the cast-iron cylinders while rough boring, is shown in Fig. 3. After "seasoning," the cylinders are ground on the machine shown in Fig. 4. In this machine the cylinder remains stationary and the emery wheel is rotated around the bore as it grinds. The loose emery and metallic dust is removed through the hose which is coupled to the cylinder, and which is connected with the piping of a powerful suction fan system. A jig for holding cylinders while drilling, reaming or tapping the various holes, is shown in Fig. 7, and a complete set of valve-hole finishing tools is shown in Fig. 5.

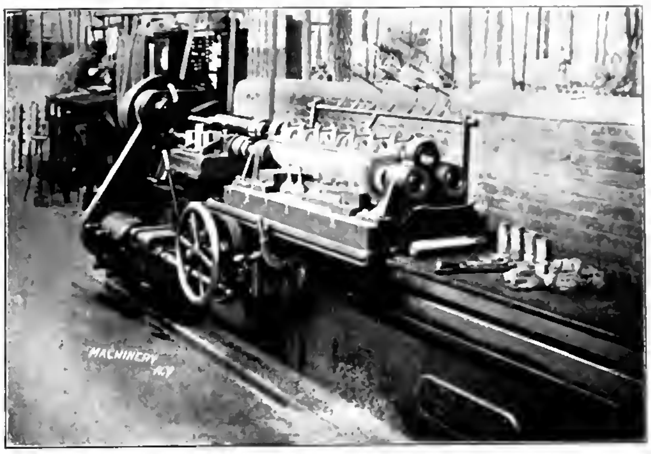

Fig. 2. Machine for Boring the Crank and Cam-shaft Bearings at the Same Time


Fig. 4. Grinding the Cylinders—The Hose to the Right is for Carrying away the Dust

Roughing Out Piston Rings

The piston-rings used in this shop are roughed out in a different way from any the writer has seen elsewhere, though they are finished on the grinder in the usual manner. A view of the specially fitted machine used, is shown in Fig. 8. This view was taken from above, back of the turret and looking toward the chuck. The inside of the ring casting is bored by means of a boring-bar in the turret, guided by a bushing in the spindle, which is the general practice. The outside is also turned eccentric at the same time by means of a sliding tool-carriage and an eccentric cam-ring *A*, acting on the guide *B* which causes the carriage and turning tool to feed in and out as the spindle rotates with the work. The small cam *C*, placed on the outside of the cam-ring *A*, is used to operate a special mechanism for notching the rings at their thinnest point in order to facilitate the splitting operation,

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[*] For previous articles on this subject, see Drop Forge Work in an Automobile Shop, September, 1908; Organization and Equipment of an Automobile Factory, March, 1909; Special Tools and Devices for Automobile Factories, April, 1909, and Autogenous Welding as a Means of Repairing Cylinders, April, 1909.

[†] Associate Editor of MACHINERY.

which is done on a milling machine. As the cam-ring turns, cam C comes into contact with the part D which is pushed outward pulling with it the part E, which causes a little tool at F to notch or mark the casting at its thinnest point, as if it had been struck with the edge of a sharp chisel. Before this notching device was put on the machine, the rings were notched in the tool shown in Fig. 9, which has an indicator needle at the bottom to indicate the thickest part of the ring, thus locating the thinnest place at the top where it is to be split by a saw. The ring is clamped by means of an eccentric lever which pushes up the block *K*. Of course the testing of each separate ring to find the thinnest part took a great deal more time than is required when the rings are automatically marked at the proper place before being cut off from the original casting by the gang tool.

Machining Small Cams, and Balls for Ball-and-Socket Joints, Construction and Use of Special Fixtures, etc.

Small cams used for valve lifting are turned by being keyed in place on a mandrel having a master-cam which operates a sliding carriage holding the cutting tool, as shown in Fig. 10. The carriage guide is held up to the master-cam by a weighted chain running over a pulley as shown.

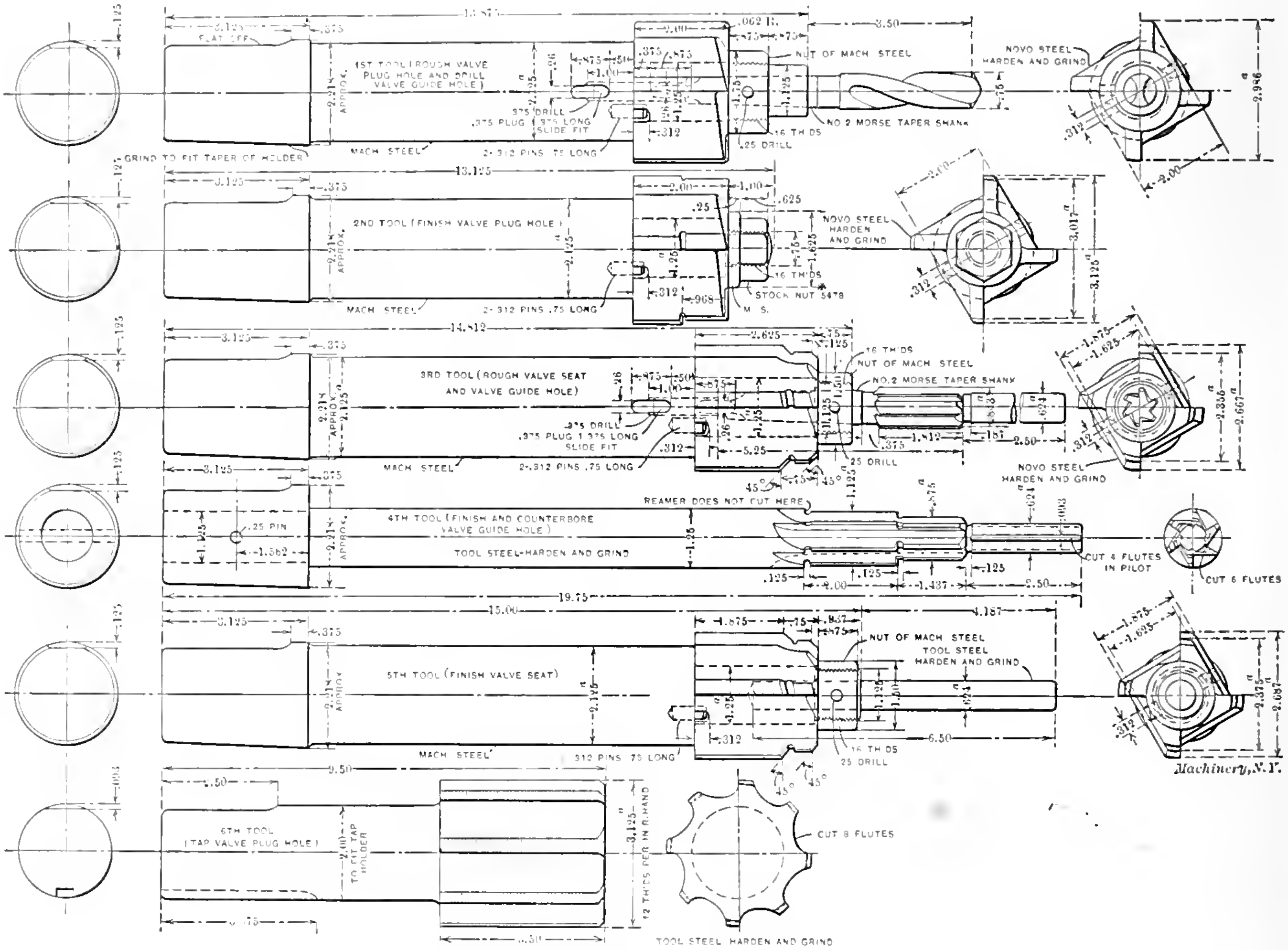


Fig. 5. Complete Set of Tools for Finishing Valve Holes.

The balls on the ends of levers used in ball-and-socket joints and for other purposes, are turned in a lathe by using the device shown in Fig. 12. The height or radius of the cutting tool and, consequently, the size of the ball turned, is regulated by the screw *A*. The tool is swung around in an arc by turning the handle *B* which is fastened to a worm meshing with an enclosed worm-gear.

The pin holes for the front-axle steering-knuckles are drilled and reamed in the jig, Fig. 13, while the differential gear cases on the rear axle, are held as shown in Fig. 11, when the holes for the clamping bolts are drilled.

Many of the cap-screws used are too large, so to avoid trouble in the assembling room, the threads are resized in the device shown in Fig. 14. This is a hand-machine, the spindle of which has a chuck at the lower end, and into this is placed a socket-wrench fitting the heads of the cap-screws to be re-cut. Clamped to an angle-plate below the spindle, is a die and holder as illustrated. A boy can accurately size a large number of screws in a day at a very small expense. For slotted-head screws, a screw-driver is used in the chuck in place of a socket wrench. Undersize nuts are also retapped in this machine by putting a tap in the chuck and using a special socket to hold the nuts.

Bevel gears are hardened and the rough hole is then trued up and ground to size on the machine shown in Fig. 15, the chuck being shown in detail in the line engraving Fig. 28. As will be seen from this illustration, the gear is centered in the chuck by a sliding cup which is pushed forward by a long bolt (not shown) which passes through the hollow spindle of the machine. As this bolt is screwed in, it moves the sliding cup (with the bevel gear in it) forward until the large end of the gear comes in contact with the removable front plate; then only a slight turn is needed to lock it firmly and centrally in place. An end view of another chuck used for holding a number of different sizes of spur-gears while grinding the hole, is shown in Fig. 16.

A special milling fixture used for backing off the teeth of three-toothed claw-clutches, is shown in Fig. 17, and in detail in Fig. 29. In using this device, the milling cutter and clutch blank are placed in the proper relation to each other, and the pin *A* is placed against the stop-pin *B*. The hand lever *C* is then slowly pushed forward in the direction indicated by the arrow. This movement is transmitted, through clutch *D*, to the screw *E* the lead of which determines the angularity of the face *F* of the clutch tooth. When the pin *G* strikes the stop-pin *B*, one cut is completed. The lever *C* and the screw *E* (against which the clutch *D* is pressed by the springs shown) is then turned back, the screw moving 120 degrees or until pin *A* strikes *B*, and the lever and the work moving 240 degrees or until clutch *D* turns in relation to screw *E* 120 degrees after the movement of the latter has been arrested by the pins *A* and *B*. Clutch *D* is

then again forced into engagement with the screw by the springs shown, and in this way the work is indexed for the next cut.

Except for the working of the lever for each cut, the device is automatic in action, as the teeth are cut exactly alike and an equal distance apart, and as the hand lever is drawn back to index, the clutch blank is also drawn away from the cutter and placed in position for the next tooth.


Fig. 6. Air Drill with Taper Mill used for Trimming the Crank-case Bosses

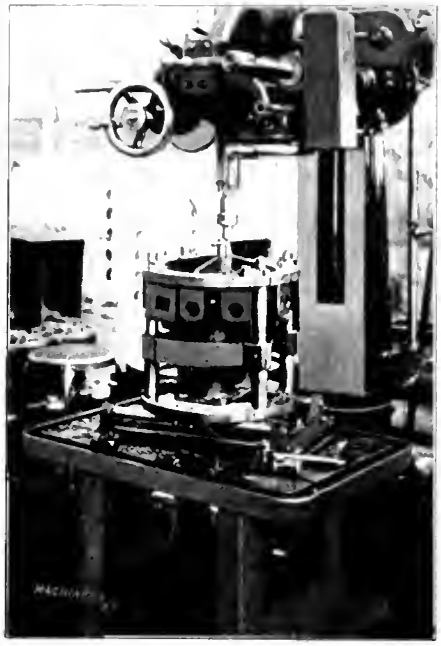


Fig. 7. Jig for Holding Cylinders while Drilling, Reaming or Tapping the Various Holes

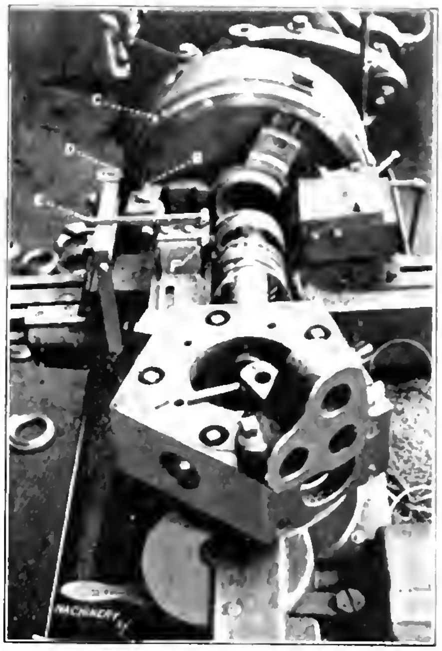


Fig. 8. Machine for Boring the Inside and Outside of Eccentric Rings simultaneously

A fixture used while slotting the quadrants for the change gear lever, is shown in Fig. 18 with a finished quadrant in place. As the bushed pin holes in the side of the device show, the quadrant can be placed in four different positions, corresponding to the several slot ends, without removing it from the fixture.

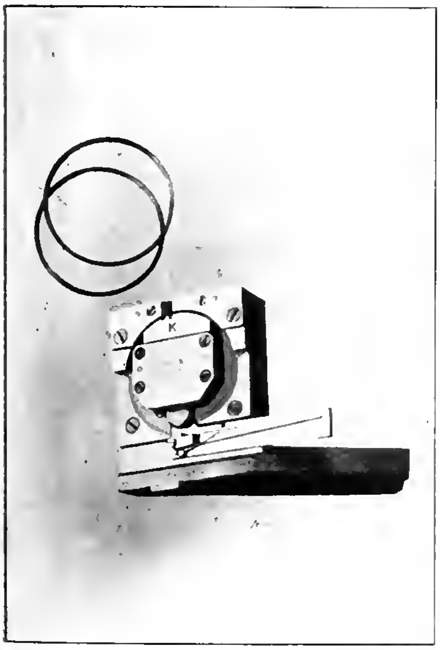


Fig. 9. Tool formerly used for Locating the Thinnest Part of the Rings prior to Splitting

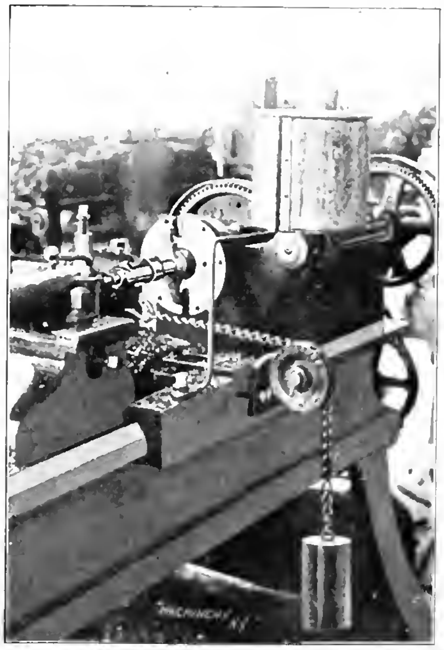


Fig. 10. Machine arranged for Turning Valve Cams

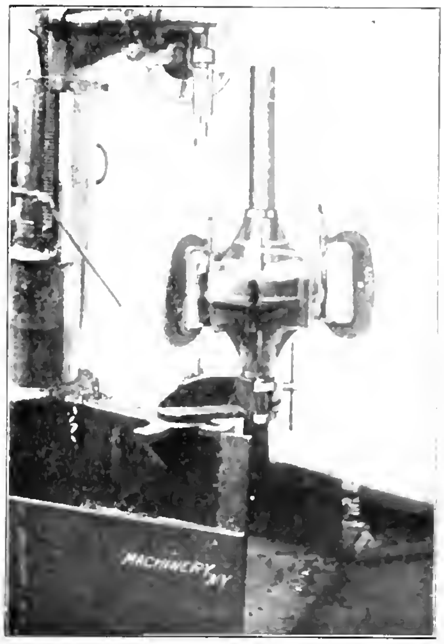


Fig 11. Drilling Bolt Holes in the Differential Gear Case

In Fig. 19 are shown two expanding arbors, and in Fig. 20, three forms of drilling jigs with different locking devices on each.

Brass bushings used in some of the bearings are lined with babbitt in the type of jigs shown at *A* Fig. 21. The bushings are first heated on a flat iron plate *B* and then tinned on the inside with acid and common wire solder. This tinning is done so that the babbitt will adhere firmly to the brass, as it would otherwise have a tendency to peel off. After being tinned the bushings are clamped as shown at *A* and placed as at *D*. The space between the bushing and the half-mandrel is then filled with babbitt from the kettle *C*. An immense amount of brazing of all kinds is done in this factory, and the form of brazing-torch and stand used is shown in Fig. 22.

The Inspecting Department

The department where the machined parts are inspected is in charge of Mr. W. C. Wenk, and it is one of the most important in the factory, for upon it depends, to a great extent, the reputation of the output. Many of the inspecting tools and gages used here have been designed especially for the work by Mr. A. F. Wisner, the chief-draftsman, who has also, in conjunction with Chief Engineer Ferguson, designed a large part of the special tools which have been already shown. The inspection methods of Mr. Wenk and his men are very thorough and no chances are taken on poor workmanship or castings that "might do." All work is taken to the inspecting room after each complete operation, and O. K.'d or rejected before it has a chance to go onto another machine. In this way, a piece that has been spoiled is scrapped before any more useless work has been put on it. As soon as a piece of work has been found that does not come up to the standard requirements, a "Scrap Material" tag like the one shown in Fig. 30, but fully filled out, is attached to it. Three

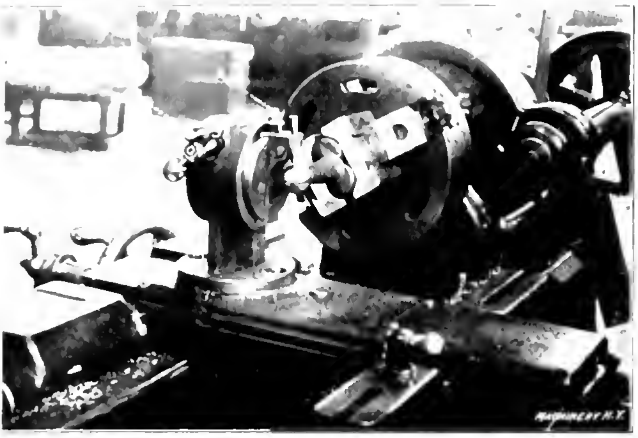


Fig. 12. Attachment for Turning Spherical Ends of Different Diameters for Ball-and-socket Joints

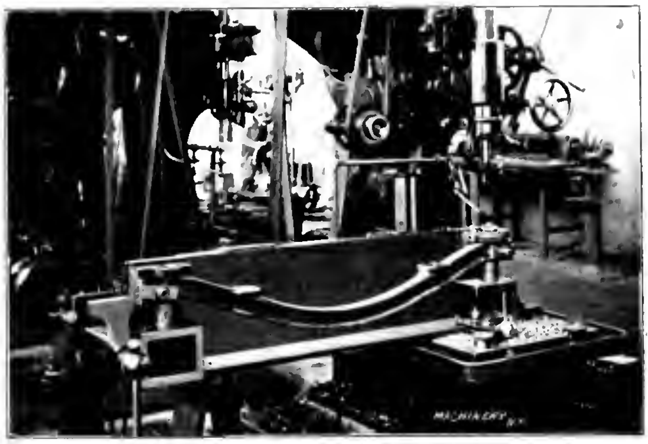


Fig. 13. Drilling and Reaming Pin Holes in the Front Axle for the Steering Knuckles

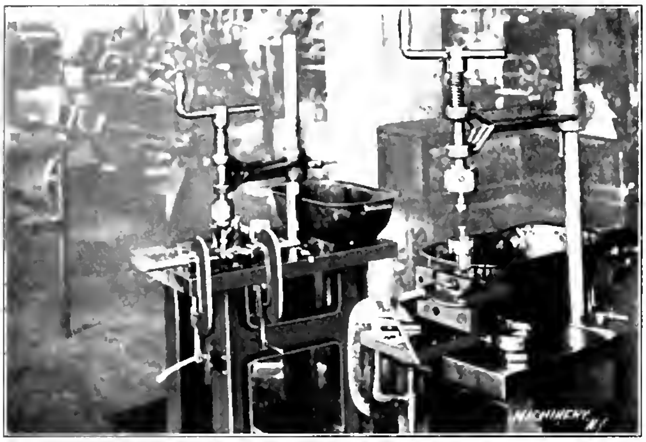


Fig. 14. Small Hand-operated Machines for Re-cutting Cap-screws or Re-tapping Nuts

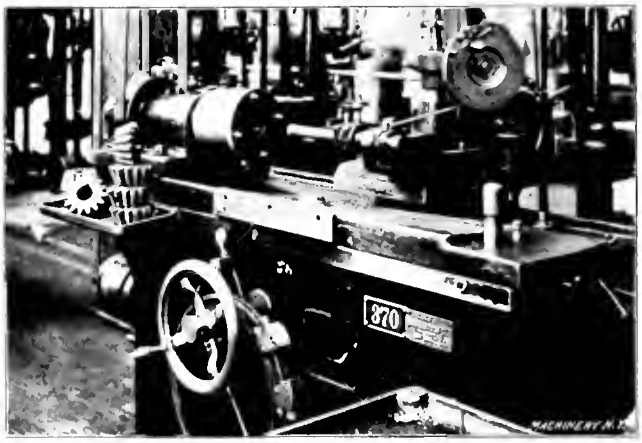


Fig. 15. Grinding the Hole in a Hardened Bevel Gear—See Detail of the Chuck in Fig. 28

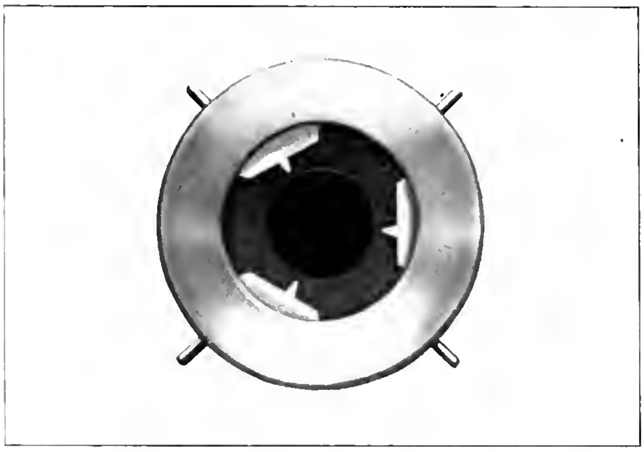


Fig. 16. End View of Chuck for Holding Spur Gears when Grinding the Holes

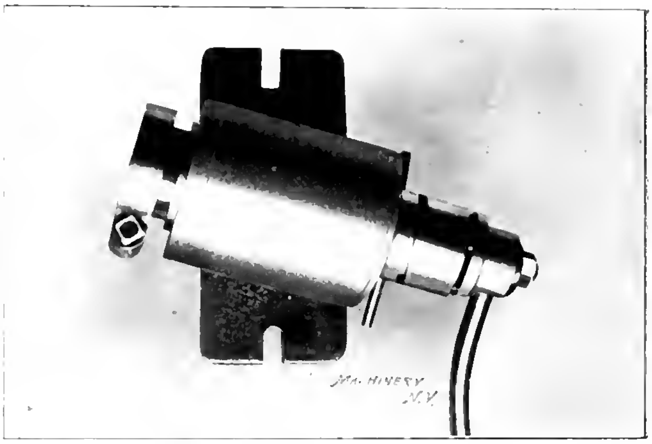
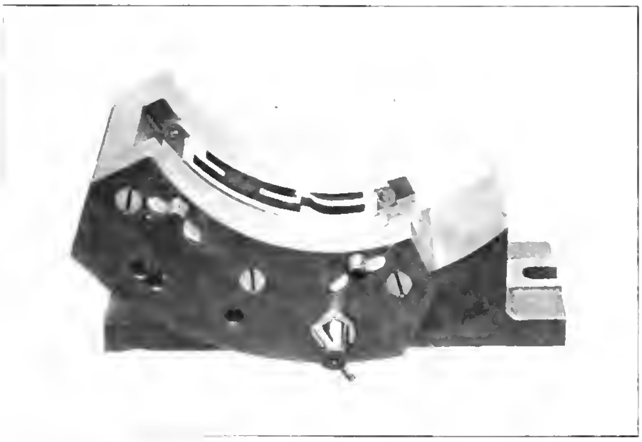


Fig. 17. Fixture for Holding Three-tooth Claw-clutches when Milling the Teeth



Slotting Fixture for the Quadrant of the Change Gear Lever

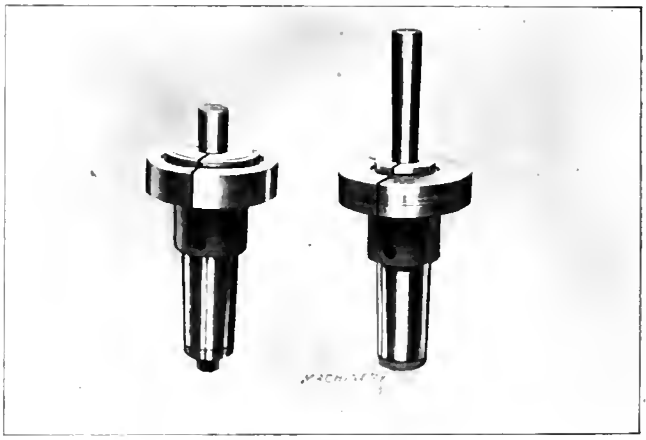


Fig. 19. Two Expanding Arbors

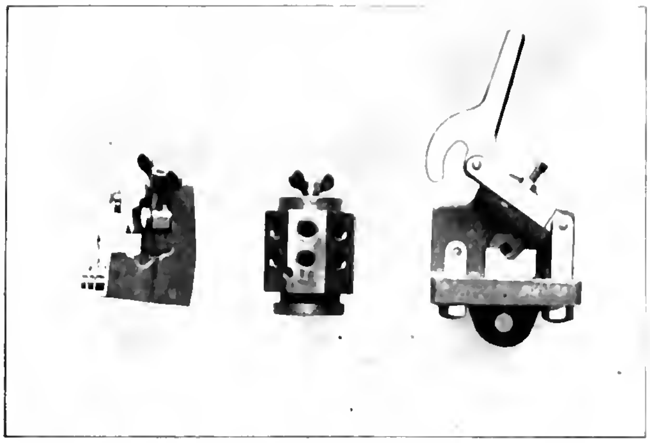


Fig. 20. Three Types of Drill Jigs, each of which is equipped with Different Locking Devices

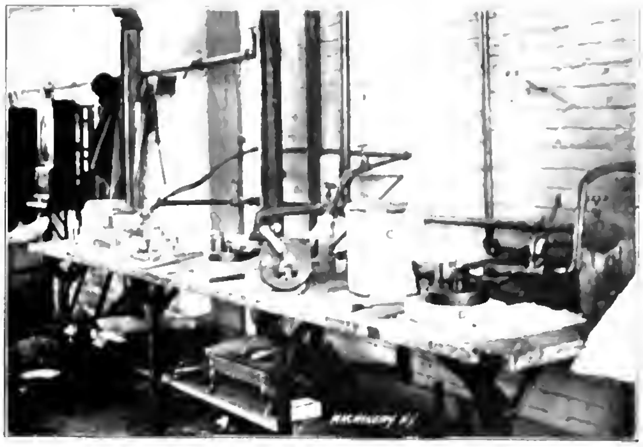


Fig. 21 Bench where Brass Bushings used in some of the Bearings are lined with Babbitt

Fig. 22. A Simple and Inexpensive Form of Burner and the Stand which are used for Brazing

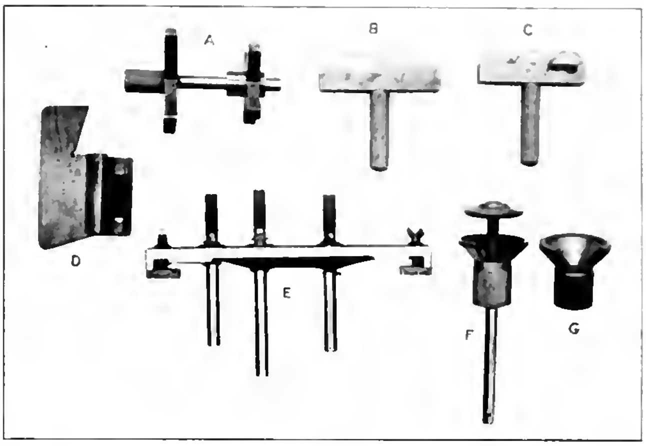


Fig. 23. Some of the Gages used in the Inspecting Department for Testing the Accuracy of Keyseats, Valves, Bevel Gears, etc.

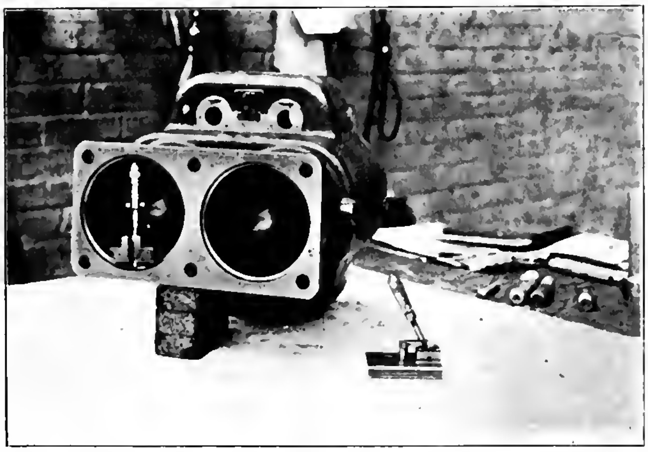


Fig. 24. Micrometer Gage for Testing the Size, Roundness and Parallelism of the Cylinder Bores

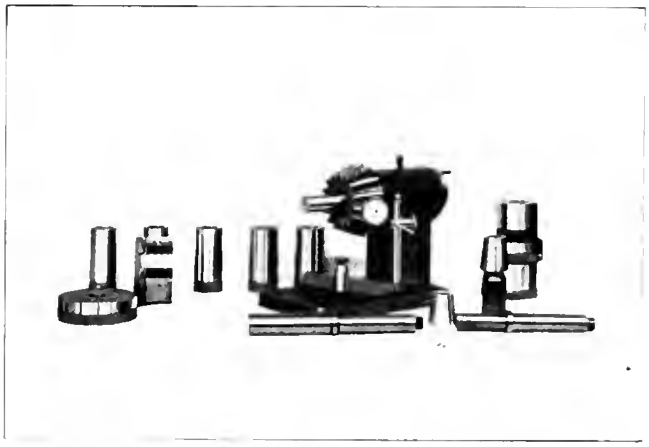


Fig. 25. Starrett Indicator and Stand used for Testing the Accuracy of Gears of Various Kinds and Sizes

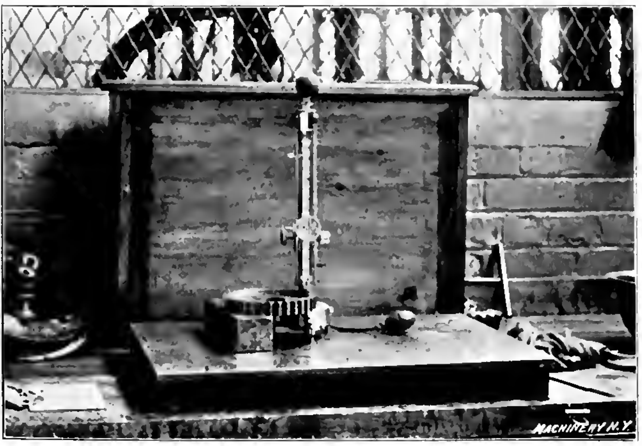


Fig. 26. Testing the Hardness of a Gear with a Scleroscope

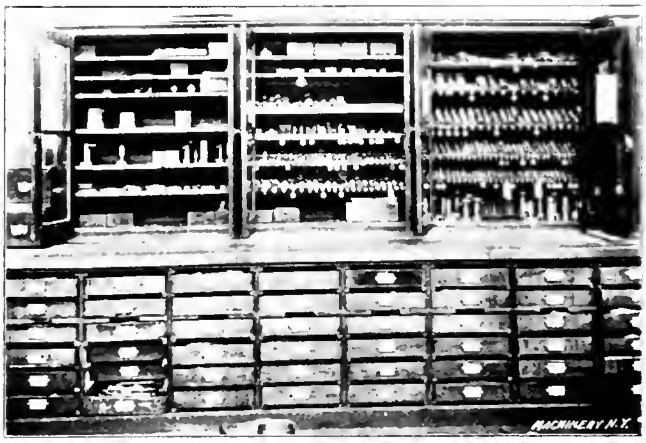


Fig. 27. One of the Gage Cases in the Inspecting Room

duplicate report slips like those shown in Fig. 31 are then made out and one copy filed in the inspecting room, one sent to the general foreman and the other to the cost department. In this way a complete record is kept of all work and the man at fault easily traced. The work of handling the small parts is greatly facilitated by placing them in large, oblong, pressed-steel pans, and wheeling them from place to place on low four-wheeled trucks.

Fig. 23 shows some of the gages used; A is a double "star" gage for testing the size and alignment of the opposite ends of a hub; *B* and *C* are Woodruff key-seat gages for testing the size, depth and alignment of two and three key-seats, respectively; *G* is a valve bevel, size and stem gage which is used as shown at *F*; *E* is a gage for testing the size, distance, depth, straightness and alignment of three holes; and *D* is for testing a bevel gear and its shaft position. Fig. 24 shows an inside micrometer caliper fitted to a special base, which is used for testing the bore of cylinders for size, roundness and parallelism. As the one on the bench shows, the micrometer head can be laid flat or placed upright when it is held in place by spring clips. The special base makes it easy to detect small hollows or other faults that might otherwise escape notice. Fig. 25 shows a stand and a Starrett indicator, used to test gears of various kinds and sizes. The plug or spindle on which the gear is placed, acts as a gage for the hole, while the indicator shows how much the outside of the teeth are out. Gages and bushings for other sizes of gears are also shown in this illustration. Fig. 26 shows the sclerescope used to test the hardness of all gears and other hardened parts. A view of one of the gage cupboards is shown in Fig. 27.

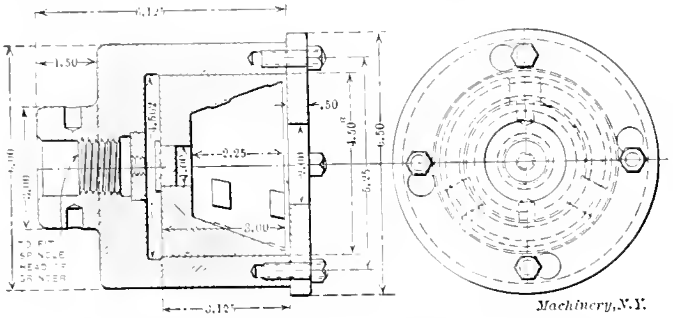


Fig 28. Detail of the Chuck used for Holding Bevel Gears when Grinding them, as illustrated in Fig. 15

Testing the Motors

The motor testing department is in a building by itself some distance from the main group. Here all engines are required to run a large fan, as shown in Fig. 32, at a certain speed for seventy hours, before being allowed to go into an automobile. This method of testing is probably the most satisfactory way of getting at the real power of a motor. The differential and transmission gears are also tested by the fan method, as shown in Fig. 33, the mechanism being driven by an electric motor of measured rating; any friction beyond an allowed amount is at once detected.

Fig. 34 shows the neat way that small parts are stored in metal boxes in the stock room. Everything is plainly labeled and easily found.

A partial view of the big dining room where luncheon is served to the men, is shown in Fig. 35. In this room eight hundred workmen can be seated at once. The lunch is served family style; that is, everything is placed on the table in large dishes or platters and the men help themselves to all they want, at a straight charge of fifteen cents each. The necessary waiters are provided by having the men in the inspection department quit work at 11:30, eat their dinner, and then serve the rest. A glance at the engraving will show that the dining room compares favorably with many of the higher-class restaurants in its fittings, and as to the quantity and quality of the food, the writer can say from personal experience that it is first class in every way.

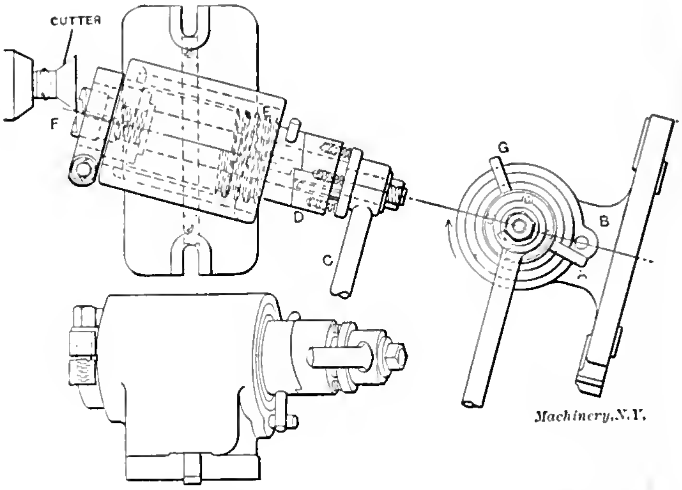
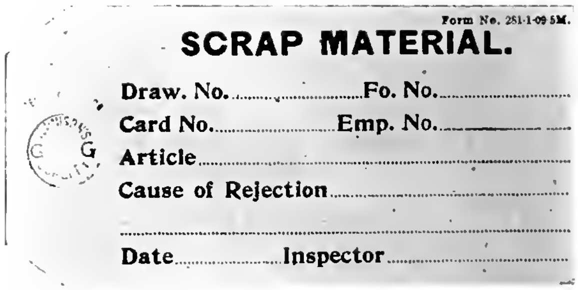


Fig. 29. Plan and Elevations of the Clutch Milling Fixture shown in Fig. 17

* * *

The Comptroller-General of Patents of Great Britain has ordered a patent owned by the British Westinghouse Electric & Mfg. Co., relating to electric-arc lamps, to be revoked on the ground of inadequate working of the patent in the United Kingdom. It appears that the company manufactured about 1,300 lamps in England, but that a license had been granted a German concern to import the patented article in Great Britain, for which privilege the German company paid the British Westinghouse Co. a considerable royalty. As the number of lamps imported under this agreement was several times greater than the number manufactured in the United Kingdom, it was considered by the authorities that the patented article was not manufactured to an adequate extent, and the patent has been revoked and the patentee ordered to pay the applicant for the revocation $375 for costs. Thus, it seems, that manufacturers of patented articles outside of Great Britain run a risk of having their patents revoked if they do not manufacture practically the whole supply for the British demand in that country.



Form No. 281-1-09 5M.

SCRAP MATERIAL.

Draw. No.................**Fo. No.**................

Card No.................**Emp. No.**................

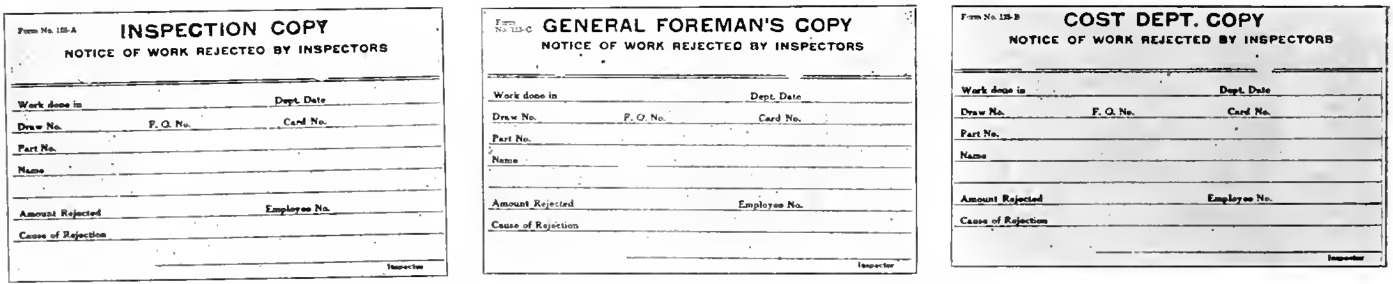
Article................

Cause of Rejection................

....

Date................**Inspector**................

Fig. 30. "Scrap Material" Tag which is attached to Defective Work



Form No. 123-A

INSPECTION COPY

NOTICE OF WORK REJECTED BY INSPECTORS

Work done in ____ Dept. Date ____

Draw No. ____ F. O. No. ____ Card No. ____

Part No. ____

Name ____

Amount Rejected ____ Employee No. ____

Cause of Rejection ____

____ Inspector

Form No. 123-C

GENERAL FOREMAN'S COPY

NOTICE OF WORK REJECTED BY INSPECTORS

Work done in ____ Dept. Date ____

Draw No. ____ F. O. No. ____ Card No. ____

Part No. ____

Name ____

Amount Rejected ____ Employee No. ____

Cause of Rejection ____

____ Inspector

Form No. 123-B

COST DEPT. COPY

NOTICE OF WORK REJECTED BY INSPECTORS

Work done in ____ Dept. Date ____

Draw No. ____ F. O. No. ____ Card No. ____

Part No. ____

Name ____

Amount Rejected ____ Employee No. ____

Cause of Rejection ____

____ Inspector

Fig. 31. Duplicate Report Slips which are filled out when it is Necessary to reject Defective Work

PROPER DESIGNING OF MILLING AND DRILLING FIXTURES AND JIGS*

R. B. LITTLE†

In the designing of milling and drilling fixtures and jigs, I find from experience that there is always a chance of the designer overlooking some important point that is vital to the proper working of the jig or fixture. After observing these points for a long time and noting each one carefully, I have compiled them into a set of sheets carefully arranged, and we find them one of our greatest helps in this work. Each member of our drafting department is given a set of the sheets and is required to answer in his own mind each question given as he proceeds with the design of the fixture.

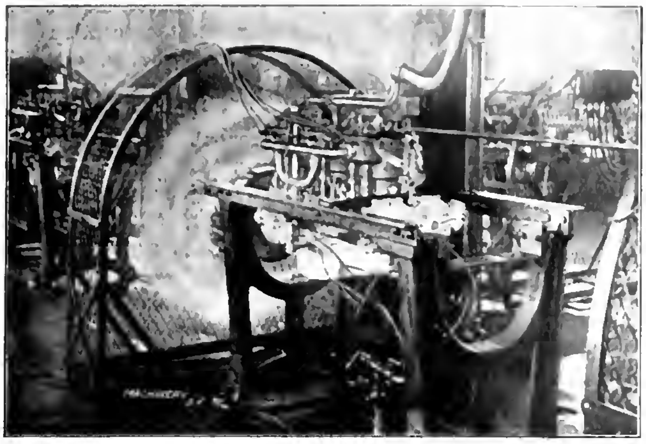


Fig. 32. Motor-testing Department—Each Engine is directly connected to a Fan which it drives for a period of 70 hours

Accompanying the catechism on the design of jigs and fixtures is one for checking drawings which we believe is especially good. It is believed that every point is touched on in proper order. These helps will be found particularly valuable to the chief of the tool-designing department. It will relieve him of much of the checking of drawings and the small details of work, allowing him to put forth more and better efforts in a more profitable direction.

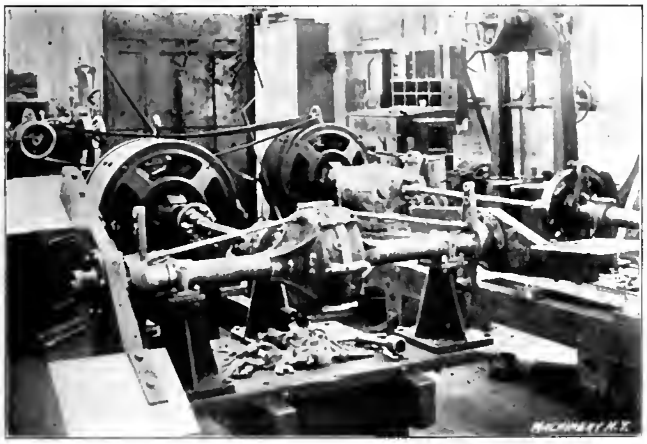


Fig. 33. Testing the Differential and Transmission Gears

Things to be Considered before Designing

1.—Does the part you are working on need a special fixture?

2.—What degree of accuracy is required in the work? Is it necessary that the drilled or milled pieces be intechangeable?

3.—Are there enough pieces to be machined, and will the accuracy of the work or the time gained warrant making the fixture?

4.—If it takes longer to mill or drill the part with a fixture than without it, will the accuracy of the work when done with the fixture compensate for the loss of time?

5.—Will any time be saved if the fixture is designed so as to do a number of pieces at each setting?

6.—Can the fixture be designed so that the operator can be replacing parts already done while others are being done?

7.—In drill jigs, if the holes to be drilled differ greatly in size, will it pay to make two jigs rather than put two largely different sized holes in the one? Have you range of speed or capacity varying enough to drill the two largely different sized holes on any one drill press?

After Designing Milling or Drilling Fixtures

1.—Considering the job, is the fixture too expensive to build?

2.—Will the fixture be a money-saver? Can you do more pieces and do them better with the fixture than without it?

3.—Will the expense of building the fixture be greater or less than that of the employes' extra time required to do the work without the fixture, and do it as well?

4.—What arrangement for holding the part in place in the fixture? Is it the simplest and quickest to operate, both in putting in the part and removing it, of anything you can design without sacrificing effectiveness?


Fig. 34. View of the Stock-room, showing the Neat Arrangement of the Metal Boxes which hold Small Parts

5.—What arrangement for taking care of milling and drilling chips? Can the chips be easily and quickly cleaned away?

6.—Has the fixture any bad places to collect grease and dirt? Any non-get-at-able places that will require cleaning?

7.—Has the fixture any weak points that may be strengthened? Are any of the parts a great deal stronger or heavier than necessary?

8.—Is the fixture too heavy and awkward to handle?

9.—Is there anything to hinder getting oil or compound on the work?

10.—If a pattern is to be made, are there fillets in all sharp corners where it is possible to put them? What arrangement for draft? Can the pattern be made so that it will come out of the sand? Are there any sharp corners to hold the sand in the pattern, or to break away in pouring?


Fig. 35. The Dining Room at the Works, which will accommodate 800 Workmen

11.—Is there anything about the make-up or operating of the fixture to endanger life or limb of the employe?

12.—Is the base of the fixture broad enough so that it has no tendency to tip over while the work is being done? Does the pressure of the work fall within the base?

13.—If the fixture will require oiling at any point, have you provided an oil hole?

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* For additional information on this subject, see Jigs and Fixtures (first installment), April, 1908, and articles there referred to.

† Address: Oscar Lear Auto Co., Springfield, Ohio.

Drill Jigs

1.—How is the part located in the jig with regard to drill bushings? Is it located from the rough or from some previous operation?

2.—Does the jig need fastening down to the drill press bed? If so, what arrangement for same?

3.—If the jig is a small one and not to be fastened down, is there a handy place to hold it from turning with the drill?

4.—What takes the thrust of the drill?

5.—Does the point of drilling at any place fall outside the base of the jig?

6.—If the jig registers from hole to hole, what method of registering is used? Is it quick and simple to operate and is it positive and accurate?

7.—If any of the holes are to be tapped or reamed outside the jig, have you allowed for this in the sizes of the bushings?

8.—Are the bushings as close to the work as you can get them, and are they long enough to guide the drill through the hole?

9.—If the bushings are necessarily long are they relieved at top end to prevent chips from clogging around the drill?

10.—Is there a chance for the drill to run out without drilling a hole in the bed of the drill press?

Milling Fixtures

1.—Can the part be held more securely or the work done more accurately with a special milling fixture?

2.—Will the fixture save any time in doing the work?

3.—What takes the thrust of the cutter? Is it strong enough to take the thrust of the heaviest cut liable to be made?

4.—What arrangement for clamping the fixture to the platen of the milling machine?

5.—What arrangement for locating the part in the fixture in proper relation to the milling cutter? Located from the rough or from some previous operation?

6.—Is there a tongue on the bottom of the fixture for lining it up in the T-slot, and is it the proper width to fit the size of machine to be used on the job?

7.—If the fixture is a long one, is it strong enough to prevent buckling after the mill has passed over?

8.—Are there any projections which will bank the milling chips up in the way of the cutters?

9.—If the fixture has a dividing head or registering arrangement, what method is used? Is it accurate and positive?

10.—If the work is close to the arbor, have you allowed room for the arbor collars to pass over or by it?

11.—If you intend using a facing cutter, is the part supported at the proper places opposite the cutter so as to avoid the tendency of the work to spring away from the cutter?

12.—If formed or outline cutters are to be used, can they be ground without changing their forms?

To Check Your Own Drawing

1.—Have you given all dimensions necessary for the pattern-maker, the forge man, and the tool-maker?

2.—Drawing number on each sheet?

3.—Pattern symbol for each part that requires a pattern?

4.—The material and number required of each detailed part?

5.—The shop number of the fixture to be built or the order number under which it is built?

6.—The name of the fixture?

7.—The symbol of the part to be machined?

8.—The date?

9.—The proper note for every hole, whether drilled, tapped, reamed, bored, cored, or counterbored?

10.—Dimensions for the location of every hole and its depth and size?

11.—On all studs, pins, arbors, etc., the kind of fit required; whether sliding, running, wringing, loose, tight, tapping, drive or press?

12.—Over-all height, length, width, etc., of all parts? Will all sets of dimensions add up and produce the over-all dimensions given?

13.—The diameter and length or thickness of all round parts?

14.—All required finish marks?

15.—The kind and number of threads for all special taps or threaded pieces

16.—Will all the parts fit together as you intend them to, if the tool-maker follows your figures?

17.—Are all your threads shown long enough so that all nuts will come down to place?

18.—Notes for all parts you wish hardened, ground, etc.?

19.—Does your layout show plainly how to assemble the fixture you are building?

20.—Have you given finished faces for the tool-maker to lay out his work from, and have you given the location of all important holes, slots, bosses, tongues, grooves, etc., from these finished faces?

21.—Have you given all the views necessary for each part to make its every detail plain and readable to the maker?

22.—Have you given all necessary notes such as knurl, flat, rough-finish, finish all over, and your authority for all gages quoted, whether B. & S., Stubbs, U. S. Std., etc.?

23.—In laying out circles of holes, have you given the chord from hole to hole?

24.—Notes for all coil springs including size, and whether compressed or extended?

25.—Have you figured your tapers accurately?

26.—Can you do anything to your drawing to improve its appearance?

27.—Is there any way you can show your idea more plainly to the shop man? Can you make your drawing more readable?

28.—Will the fixture you have designed work as well when made as it appears to work on paper.

* * *

THE VALUE OF AN EFFICIENT ACCOUNTING SYSTEM

In an address, "Changing Industrial Conditions," delivered by James Logan, mayor of Worcester, Mass., at the Commencement of the Worcester Polytechnic Institute, June 11th, 1908, strong emphasis was put on the need for efficient accounting systems in manufacturing enterprises. He said that an accounting system is as real an invention and that it marks an advance in industry as great as many mechanical inventions. It was his opinion that cost analysis in some lines of industry has done as much to reduce the cost of production during the past five years as have the mechanical inventions made during the same period. Yet there are manufacturers who spend money lavishly, whose scrap heap for old machinery represents not one, but several fortunes, who are conducting their accounting by as crude methods as those which were in vogue when the stage coach represented rapid transit. These manufacturers have thrown into the scrap heap millions of dollars' worth of machinery which was not worn out and which still had in it years of efficiency, but because they were without definite knowledge of what it cost to operate the old machines, they had been persuaded to throw them into the scrap heap, taking estimated costs of the operation of new machines—estimates which are always stated in minimum figures, and which are almost never correct. As an example in point, Mr. Logan further said:

"I have in mind a series of envelope machines, which with the patents cost approximately $40,000, which could make and print envelopes at one operation for practically nothing if you simply figured the wages of the girl who sat before the machine. But no allowance was made for the fact that, in actual operation of these complicated machines, high-priced mechanics had to stand over them all the time with a monkey-wrench and screw-driver to keep them running. When this cost as well as repairs and interest on the extra investment were considered, the older machine, which made less waste, required less supervision, and stood a smaller interest charge, distanced in the race the new, improved, automatic, fast-running machine, and it has gone to the junk heap and the machines running before this machine was invented and installed in the same factory are still doing good work and at a lower cost (when all the costs were figured in) than the new machine ever did. The point I want to make is this: if there had been a knowledge of the actual costs of operation of the old machines, a comparison of those costs would have developed the fact that the new machine was not a good investment and its purchase would never have been considered."

ANVILS AND FORGES[*]

JAMES CRAN[†]

The anvil and the forge are the two most important appliances of the blacksmith shop. Anvils are made in various shapes to suit different classes of work, but for all around work, and particularly for machine blacksmithing, no anvil gives better service than the standard pattern of solid wrought iron provided with steel face. This class of anvil is practically the only appliance used by the blacksmith that has been standardized. In general, it may be said that the anvil appears to have been developed along intelligent lines, and standard anvils are generally satisfactory with the exception that the square hole for the tool shanks is seldom straight or of exactly the same size in any two anvils of the same make and weight. This difficulty might be overcome by broaching the hole before the face is hardened. With this improvement, tools made to fit one anvil could be used elsewhere without danger of breaking the shank.

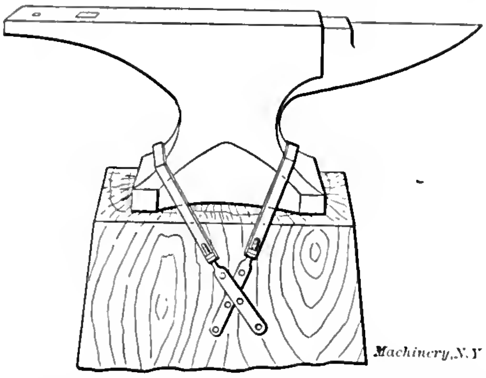

Fig. 1. Objectionable Manner of Holding an Anvil in Position

The quality of an anvil can generally be judged by its "ring," a good anvil giving out a sharp, clear sound when struck with a hammer; if soft or not free from flaws, the sound will be dull. A good anvil mounted on a block in such a manner that it gives out its full volume of sound is easier to work upon than one where the ring is deadened. There is a great deal of difference of opinion as to how anvils should be mounted, the general idea apparently being that it should be strapped fast to the block on which it is placed. If this were necessary, it is likely that the makers of anvils would have provided them with lugs or slots suitable for fastening them to the support.

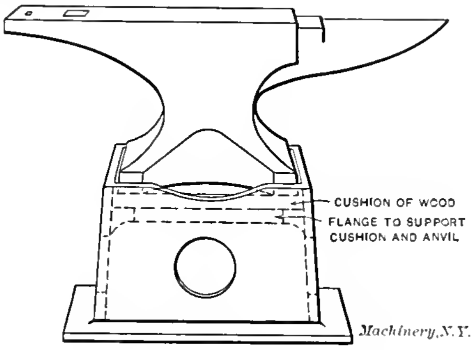

Fig. 2. Correct Form of Anvil Block, and Proper Method of Mounting Anvil.

When a wooden block is used under the anvil, it is necessary to use a few spikes to keep the anvil in place, but these should be placed around the base in such a way that they do not bear directly upon it or pinch the corners. A common but poor way of holding an anvil in position is shown in Fig. 1. This method checks the vibration which tends to keep the face free from scales, and it renders a high-grade wrought iron anvil little better than if it were made from cast iron.

A mistake often made is the selecting of anvils too light for the work to be done. This may be done from a mistaken idea of economy, but light anvils do not give as good service or last as long as heavier ones. The 300-pound anvil is suitable for nearly any kind of machine blacksmithing, and if of this weight or heavier it will not move around when used, or need to be strapped to its block.

Wooden blocks must be sunk to a certain depth in the floor in order to keep them in place, and their height may have to be adjusted from time to time to suit a short or tall blacksmith. Cast iron mounting blocks are therefore preferable. An anvil mounted upon a block by a proper method is shown in Fig. 2. The block is made of cast iron, hollow in the center, with a flange $1\frac{1}{2}$ inch wide by $1\frac{1}{4}$ inch thick, having a heavy fillet on the lower side where it joins the body of the block. On the inside, $2\frac{1}{2}$ inches from the top, a piece of wood about $1\frac{1}{2}$ inch thick and of the same size as the top of the block inside, is placed. This forms a cushion for the anvil to rest on. The top edges of the block in the back and front are made lower in the center than at the ends, permitting the scale and dirt from the work to find its way to the floor instead of getting under the anvil. A flange 3 inches wide all around the outside forms the base of the block and gives it a solid bearing on the floor. The location of an anvil mounted on this type of block can be changed at any time, and its height can be adjusted without much trouble. The wooden cushion gives a block of this kind all the advantages and none of the disadvantages of a wooden block.

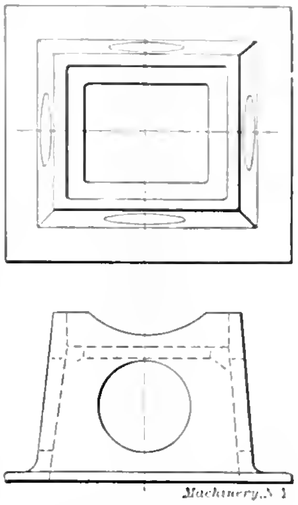

Fig. 3. Cast Iron Anvil Block

In Fig. 3 the cast iron anvil block is shown in detail. It should be so adjusted when an anvil is placed upon it that the face of the anvil will be inclined at an angle of about 3 degrees towards the front. This not only makes the work easier for the blacksmith, but gives the scales a tendency to leave the face of the anvil on the side furthest from him.

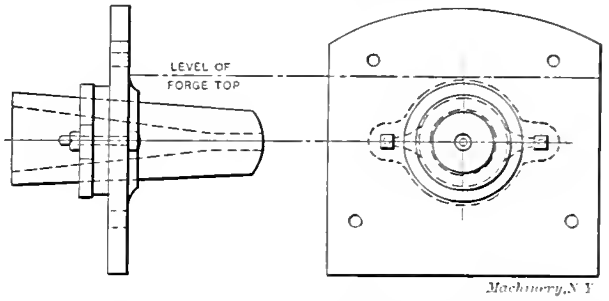

Fig. 4. Solid Tuyere for Side Blast for Light Work

Large pieces of hot metal should never be left on an anvil longer than absolutely necessary, and in no case should hot work be left on the face of the anvil when the blacksmith leaves his work. If this is done, it will affect the temper and soften the face.

The Forge

The forge has been developed along somewhat less successful lines than the anvil. Different makers have turned out various types, if not a little better, at least a little different from their competitor's. There is scarcely a forge on the market which does not have the opening or openings of the tuyere at the lowest point of the fire pan, which is the place where clinkers and slag collect, and the opening of the tuyere gets filled up if not constantly cleaned out. To overcome this evil, some forges have a shaker, which in turn has brought about the enlarging of the opening of the tuyere to accommodate the shaker. This not only has a tendency to spread the fire, making it almost impossible to take short heats, but clinkers and slag are worked through the tuyere into the air chamber or wind box until the blast is obstructed. The aim of the practical blacksmith is to have the forge and fire in such

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[*] For previous articles on blacksmithing and blacksmith shop practice see: "System for the Blacksmith Shop," August, 1908; "Tools for the Blacksmith Shop," September, 1908; "The Steam Hammer and its Use," October, 1908; "Tools for Increased Production in the Blacksmith Shop," November, 1908; "Welding," December, 1908; "Notes on the Economical Working of the Blacksmith Shop," March, 1909; and "The Forging of Hooks and Chain," April, 1909.

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condition that he can concentrate the heat at some given point of his work when required. The lack of a suitable forge for this purpose on the market accounts for so many forges of the home-made variety being used. The home-made forge is usually very crude looking, but it serves its purpose. The material used for the top of the forge may be either stone, brick or a piece of the shell of an old steam boiler or tank, or even a wooden frame forge with sand up to the level of the tuyere. The writer has seen a very serviceable forge made from one-half of a large barrel. This was used for heating work up to five inches in diameter. This, of course, does not mean that wooden forges are recommended.

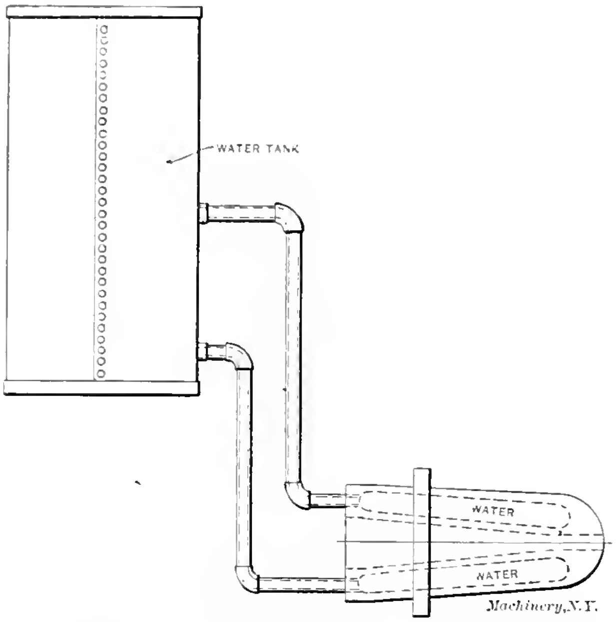


Fig. 5. Water-cooled Side Blast Tuyere for Medium and Heavy Work

The most important features on a forge are the method of conducting the blast from the blower to the fire and a simple and effective means of getting rid of the smoke. In conducting the blast to the fire it must pass through the tuyere. There are two distinct types of tuyere, one with side, and one with bottom blast, either of which will give good service if properly constructed. The side tuyere, although little used in this country, is extensively used throughout Europe, and is preferable to the bottom tuyere for some classes of work, particularly when heating to an even temperature on all sides when the shape of the work does not permit it to be turned in the fire. The work is then placed in the fire on the level of the opening of the tuyere and the fire is so arranged that the blast circulates freely over and under the work. A solid side tuyere with breast-plate is shown in Fig. 4. The shape is circular and slightly tapered, with a collar at about one-third of the entire length from the large end. The inside is hollow and tapers as shown. When placed in position in the breast-plate, the tuyere is forced as far through as the collar will permit, and is held in position by a yoke placed behind the collar. Two bolts connect the yoke with the breast-plate, which in turn is attached to the left-hand side of the forge by bolts. This tuyere is used for light forging.

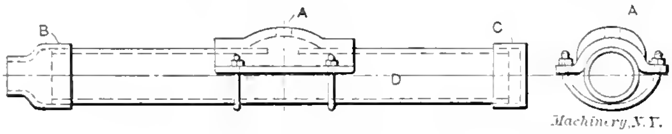


Fig. 6. Air Chamber and Tuyere for Bottom Blast

For medium and heavy work a tuyere as shown in Fig. 5 is generally used. The principle of construction is the same as in Fig. 4, but it consists of an outer and inner shell, the space between which is filled with water to keep the metal from being overheated. The water is supplied from a tank, to which it returns after it has passed through the tuyere. Sometimes tuyeres of this style are directly connected with a water tank without the use of pipes.

A simple and inexpensive but very efficient form of air chamber and tuyere for bottom blast is shown in Fig. 6. The air chamber *D* is made from a piece of wrought-iron pipe at least 4 inches inside diameter. On the end projecting through the left-hand side of the forge a reducing coupling *B* is placed so that a pipe of $2\frac{1}{2}$ to 3 inches in diameter can be used to connect it with the air supply. On the other end, which projects on the right-hand side of the forge, a metal cap *C* is used, which closes this end. This cap can be unscrewed at any time for cleaning the air chamber. The tuyere *A* can either be made of cast iron or forged from wrought-iron and is held in position by two U-shaped bolts. Some fire clay or asbestos soaked in water placed between the tuyere and the air chamber provides an air-tight joint when the bolts are tightened. When making a tuyere of this kind it is important that it be spherical or conical in the center and that the blast opening be at the highest point. Clinkers and slag will then collect at the base instead of directly over the opening. With a tuyere made in this way no shaker or other device is required to keep the opening clear. The air chamber is made larger than the pipe supplying the blast in order that a full air supply may pass through even when a small quantity of clinkers or slag have accumulated under the tuyere.

An air chamber and tuyere of somewhat improved design is shown in Fig. 7. The air chamber is cylindrical with a circular opening at the top into which the tuyere fits. A small opening at the left near the top of the air chamber provides an inlet for the blast, and a larger pipe to the right provides means for cleaning. No bolts or other appliances are necessary to keep the tuyere in place, fire clay or asbestos placed under the flange making it air-tight and holding it in position.

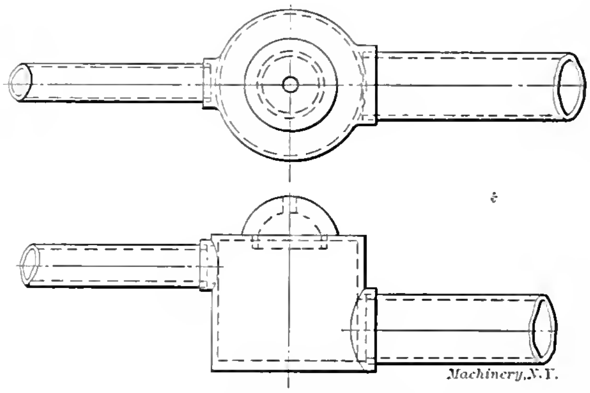


Fig. 7. Improved Design of Air Chamber and Tuyere for Bottom Blast

In shops where the range of work is large and the number of forges is limited, tuyeres with different sizes of openings can be used in the same forges for different classes of work when made as outlined. For heavy work, a low tuyere with a large opening should be used, and enough fuel should be kept between the blast and the work to consume the oxygen before it reaches the work. For light work a high tuyere with a small opening is used, because it saves fuel and tends to keep the fire in a small space.

For machine blacksmithing forges should be from 36 to 42 inches in diameter and from 26 to 30 inches high, the top of the tuyere being from $4\frac{1}{2}$ to 7 inches lower than the top of the forge. As there are no standards or definite data for guidance in determining the size of the opening for tuyeres or the depth at which they should be placed below the level of the hearth, the accompanying table gives what the writer considers to be proper dimensions for work varying from $\frac{1}{4}$ inch to 10 inches diameter, when the blast is delivered

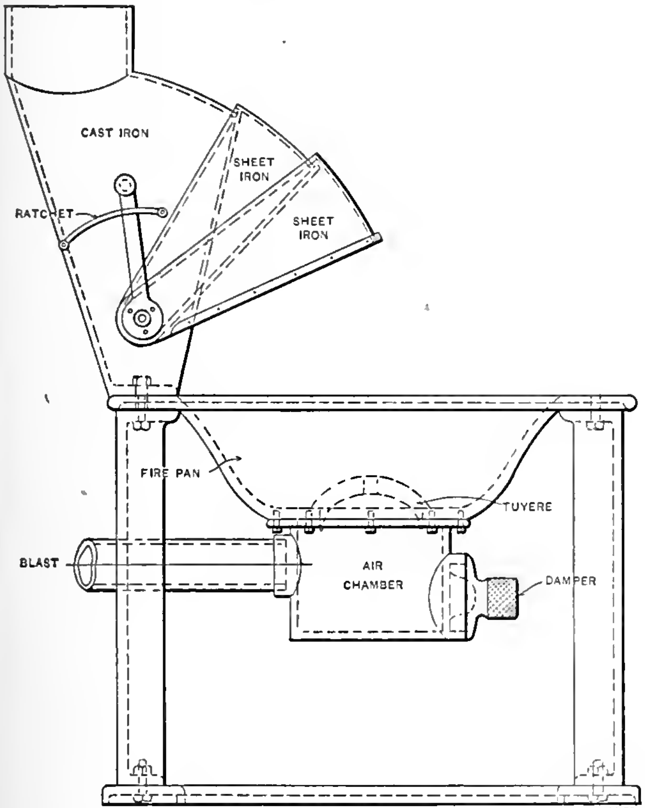
TABLE OF SIZES AND ARRANGEMENTS OF TUYERES

	Inch.	Inch.	Inch.	Inch.	Inch.
Size of opening in tuyere	$\frac{3}{4}$	1	$1\frac{3}{8}$	$1\frac{3}{4}$	2
Distance between top of tuyere and top of forge	4	5	6	7	8
Size of supply pipe.	$1\frac{3}{4}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$
Size of work to be done	$\frac{1}{4}$ to 1	1 to 2	2 to 4	4 to 7	7 to 10

at a pressure of eight ounces per square inch or over. Work over 10 inches in diameter can be more uniformly and economically heated in a furnace.

Carrying off the Smoke from the Forge

The smoke is generally carried off with more or less success by means of a bell-shaped hood suspended over the forge and connected with the chimney. Without exception the bell hood is the worst form to use, as more smoke and gas is admitted at its base than the chimney is capable of carrying off, and the smoke spreads through the shop and escapes by doors or windows after having made conditions uncomfortable for the blacksmiths. Forges without hoods are preferable to the bell hood, provided there are means for ventilation in the roof of the shop, as then the gases can rise freely and escape. Another objection to the bell hood is that it prevents a crane from being used to any advantage over the forge. In order to overcome the drawbacks mentioned some concerns have installed the down draft system in their blacksmith shop. This system has its advantages; no overhead pipes, smoke or gas have to be contended with and the equipment is ideal for training schools and similar places, but for the practical blacksmith shop, where the cost is an item of first importance, it presents disadvantages; it is designed to work in direct opposition to the laws of gravity, and the smount of power necessary to create enough suction to draw the smoke and gases down is too great.



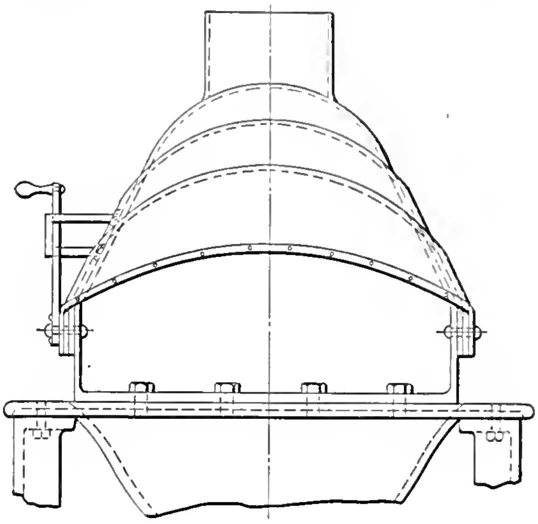


Fig. 8. Skeleton Forge with Cast Iron Hood Frame and Adjustable Sheet Iron Folding Hood

A forge and hood, which give good service both for heating work and for carrying off the smoke when individual chimneys are used for each forge, or when connected with a draft system, is shown in Fig. 8. The body of the forge is of cast iron and constructed on the skeleton plan. This allows of tools or other appliances too large for the tool bench to be kept under the forge. The tuyere and air chamber are practically the same as shown in Fig. 7. The main part of the hood is of cast iron and is placed on the left-hand side of the forge where it is held in position by bolts. The chimney is placed to the left as shown and out of line with the top of the forge, and therefore permits of a crane being brought directly over the fire and the work. The adjustable parts of the hood are made of sheet metal, reinforced at the edges with band iron and joined near the base so that they can be let down close to the forge when a new fire is being built, or folded back to the base of the chimney, leaving the whole top of the forge clear when required. The chimney should never be less than 8 inches inside diameter. The forge here shown was designed several years ago and has been in use continually and has given satisfaction on all kinds of machine blacksmithing from $\frac{1}{4}$ inch to 10 inches in diameter.

* * *

An amusing instance of the peculiar foolishness cherished by some manufacturers in regard to so called "trade secrets" came to our attention a few months ago. A demonstrator and trouble-man, working for a prominent Western machine tool builder, some years ago visited a small concern in the East which had developed a new process of making—well, let us say gimlets, as that is about as near as we can approach the name without telling what the product really is. The process and gimlet were patented and the inventor had no hesitation in showing the process in its entirety to the interested mechanic. In the course of a year or so the gimlet and process were sold to a competing concern noted for its conservatism and fear that any process carried on within its walls would become known to the prying world outside. Our friend having business with the concern in connection with the machines he represented asked the privilege of inspecting its methods of making gimlets and was turned down flat for the reason (?) that a new process had recently been produced which was a valuable trade secret and under no circumstances could he or any other outsider be permitted to see it. A few questions elicited the fact that the secret process was the one our friend had seen in its entirety a year or so before.

It will be noted that we said our friend asked the *privilege* of seeing the methods of manufacture. It is indeed a great privilege we enjoy generally in the United States of being admitted into manufacturing plants and seeing the principal manufacturing methods in which we are legitimately interested. If a manufacturer does not care to grant this privilege to every one he is entirely within his rights. The time and trouble of escorting visitors through a large plant is often a serious tax on the time of men capable of explaining the processes intelligently, and if the advertising that results is not appreciated or desired, the manufacturer is under no obligation to follow the general custom, but if he does not care to follow it he should not take refuge in the threadbare excuse that the privilege is denied because of the existence of trade secrets. This plea brands him as unprogressive and out-of-date, when as a matter of fact, he may be neither.

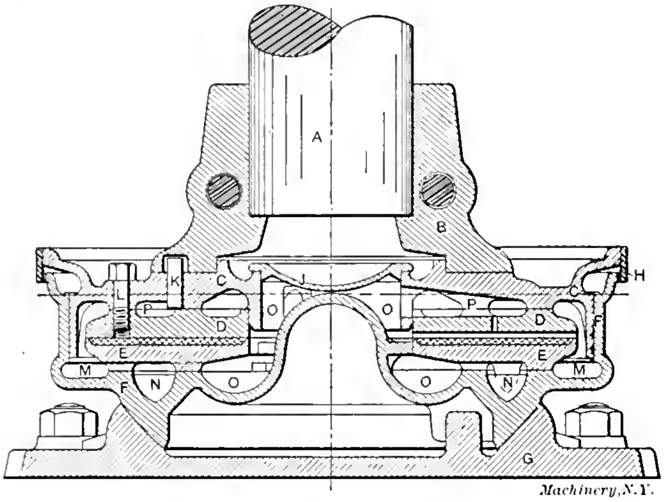
* * *

It is stated in the *Mechanical Engineer* that a British firm, the Hadfield's Steel Foundry Co., has for a long time been experimenting in order to ascertain whether it be possible to cast armor plates. The experiments appear to have been successful, and the company now supplies some parts of armor made by a casting process.

EXAMPLE OF STEP BEARING DESIGN

The thrust or step bearing is a difficult proposition at its best. When heavy service is required of it, the engineer meets with three inherent difficulties in design. These difficulties are: first, insufficient bearing surface; second, difficulty of lubrication; and third, uneven wear of thrust surfaces. In the case of important bearings, such as those for taking the thrust of the propeller on a steamship, multiple thrust collars are used, which obviate the first difficulty; forms of forced lubrication are employed, to avoid trouble from the second cause; and the bearing collars are made comparatively narrow, and enough of them used to give the required area, to avoid the trouble from uneven wear. This, of course, necessitates careful adjustment of the different bearings, so that each has its proper share of the load.

For installations which do not work under quite such severe strain, and on which there is not so much depending as in steamship service, it is common to provide the thrust bearing with a number of washers between the revolving shoulder of the shaft and the seat of the bearing. This does not add to the effective bearing area but does decrease the troubles arising from insufficient lubrication and uneven wear, as a multiplicity of bearing surfaces are provided, one of which automatically goes into action when another commences to run hard from any cause. The surfaces thus take turns with each other as need arises. The question of lubrication is generally settled by causing the rings to revolve in a bath of oil. If the grooves are properly placed, this is sufficient for ordinary purposes.



Machinery,N.Y.

A Submerged Step Bearing for Heavy Service.

The bearing shown in section herewith works under particularly difficult conditions in that it is heavily loaded, runs in an atmosphere charged with gritty dust, and is liable to neglect. The service for which it is used is too rough for the first method of design described above, and too heavy for the second. It is used for supporting the heavy revolving grinding pans, which are used to crush and temper the raw material in clay working industries. The grinder wheels of these pans weigh 5 or 6 tons, not to mention the weight of the clay and the pan itself. There is the further strain of the shock resulting when the heavy grinder wheels roll over large lumps of clay and fall back to the pan again. This constant jar requires a bearing of the simplest construction, without delicate adjustments. The design shown herewith has been in use for a number of years under these severe conditions and has given excellent satisfaction.

As may be seen, a single set of surfaces is used, the bearing taking place between plates *D* and *E*. The upper plate, which is the revolving member, is of close-grained cast iron. It rests on seats formed in the plug *C*, and is caused to revolve with it by means of screws *L* and dowels *K*. The lower plate is a cast iron shell with its wearing surface filled with "Fahrig metal." It rests on finished seats in the bowl *F*, where it is held in a central position and prevented from rotating by lugs which interlock with others on the bowl. This latter member rests in a spherical seat in the base-plate, *G*, so that any irregularities in the alignment of the foundation and shaft are overcome, and any changes of position which may occur are automatically taken care of without springing of the working parts. Interlocking lugs on both the base-plate and the bowl prevent the latter from revolving.

The bowl *F* is, as its name indicates, a receptacle for the lubricant, which rises to the level of the dotted line shown. The plug *C* is finished on its periphery, where it forms a bearing surface with the bowl, while it carries a rim *H*, which extends upward and outward over the bowl, forming an apron which prevents access of dust to the lubricant through the only possible entrance. The circulation of oil is effected by staggered channels in the wearing face of *E*, in combination with circulation grooves in face of the upper plate *D*. When the bearing starts to revolve, the construction of these grooves draws the oil through from inner reservoir *O* to the outer or supply chamber *P*. This movement is assisted by centrifugal force in the upper chambers *O*, which force the oil to pass down through the holes in the plug *C* into the grooves in the plate. This movement of the oil results in an increased head or pressure in the outer chamber *P*, and a corresponding decrease of head in the inner chamber *O*. Since the lower part of the oil body in the outer section is at rest, it is not under the influence of centrifugal force, though under the excess of pressure caused by that part of the oil that is in motion, a return movement is set up toward the central chamber through passages *N*. These return channels are staggered so as to make the path as long as possible. The current passes over ribs which act as riffles to allow the particles of metal in the oil to settle. On account of this construction the oil furnished to the rubbing surfaces is always the purest oil in the bearing.

This apparatus is very compact, it being but 8 inches from the end of the shaft to the foundation. After the split coupling *B* has been removed, it will be seen that there is enough space between the shaft and the top of the step to allow the latter to be removed from the base plate as a unit. This feature is of value in the gritty atmosphere in which the bearing is installed, since it may be removed to a clean place, where it is wiped out, assembled and filled with oil. It is then returned in its assembled condition, so that dirt and dust do not get into it. The oil is poured in through the opening closed by the cover *J*. Enough is poured in to just cover the top of the rounded boss projecting up in the center of this compartment.

It will be seen that in this bearing the requisite area has been obtained by making the rubbing surface of large diameter. To do this and keep the surfaces in good condition, requires that they shall be so supported that the deflections of the metal under the dead weight and under the shock will not cause portions of the bearing surfaces to break through the oil film. The construction is worthy of study from this standpoint. The circulation of oil provided is so thorough as to increase the efficiency of the bearing surface, reducing the area below what would be necessary with the ordinary "squirt can" method of lubrication, with the inefficiency and uncertainty always attendant on it.

The first of these bearings was installed in the Akron Fire Brick Co., 1901, where it has been running ever since without any expenditure for repairs and renewals, aside from breakage due to an accident for which the bearing was in no way responsible. It has been oiled in this service in periods varying from six to fifteen months apart, without giving the slightest difficulty. The grinding pans of the Windsor Brick Co. have also been equipped with the same bearing. They are refilled every six months, though the oil is found to be in good condition at the end of that time. The illustration shows a more recent design, intended to carry a 12-ton load, in which the wear plates are 15 inches in diameter.

An interesting point relating to the efficiency of the device is its saving in oil. The ordinary bearing for this use, which is from 4½ to 5 inches in diameter, running on hardened steel and bronze washers, requires on the average about 6 gallons per year on each bearing, as supplied with a squirt can, and even with this large amount there is rapid wear and constant

trouble. The use of the self-oiling feature is in line with an editorial on the subject published in the July, 1908, issue of MACHINERY. Whatever may be said against the use of this principle under other conditions, it is obviously correct practice for the vertical step bearing, working under severe duty. The designer of this bearing is Edward F. Edgecombe of the Edgecombe Co., Cuyahoga Falls, O.

* * *

COULANGE SYSTEM OF AUTOMATIC INDEXING

The dividing apparatus illustrated herewith, which was recently described in the *L'Alliance Industrielle*, is designed to index work automatically. It requires no more room on the milling machine table than the ordinary universal dividing head, and consequently the distance between the centers is not lessened. Both straight and helical cuts may be taken, with the spindle set to any angle from 0 to 90 degrees, and the work automatically indexed either 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 18, 20, 21, 24, 28, 30, 36, 42, 60, or 84 divisions, by the use of four plates *C* and five counters *O*. It is possible to obtain other automatic divisions by changing the plates *C* and *O*, and multiples of these automatic divisions may also be obtained semi-automatically. This dividing head has, in addition, all the advantages of the usual form of hand dividing apparatus, such as that used for gears, etc., as it is possible to obtain from 0 to 380 indexings, comprising the prime numbers; and also to obtain all these numbers (except the prime numbers) on helical cuts with the spindle set at any angle from 0 to 90 degrees.

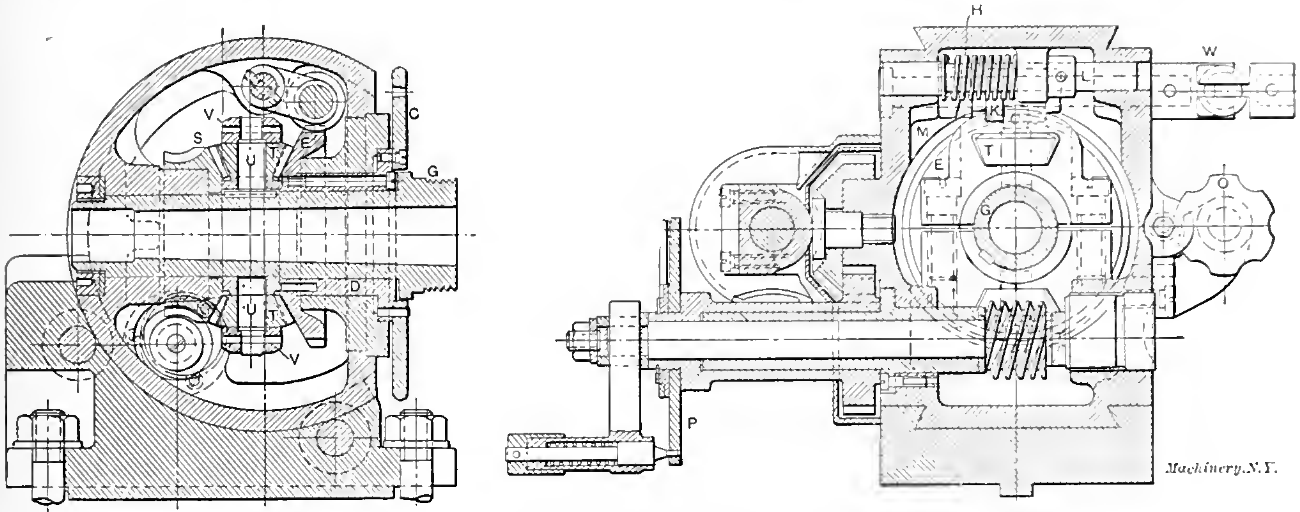


Fig. 1. Dividing Head for Universal Milling Machine which indexes Work Automatically

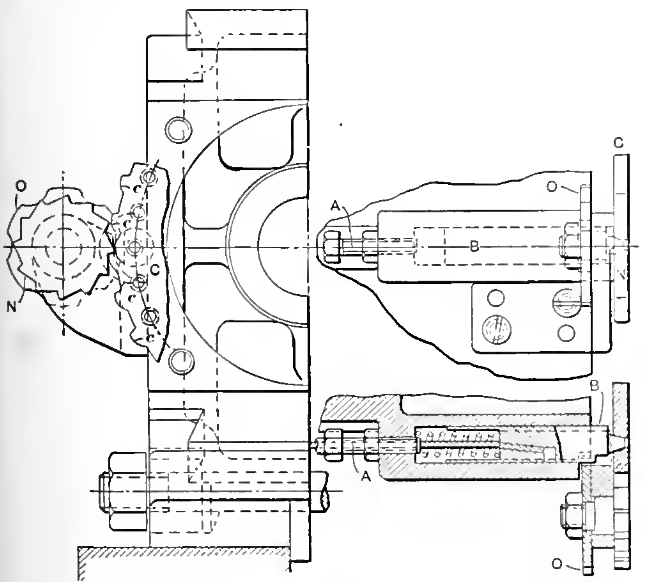


Fig. 2. Detail showing the Locking Mechanism and Plates which control its Movement

The apparatus comprises a differential combining the movement of the dividing plate *C* with the usual dividing plate *P*. This differential includes the plate *C*, the hub *D*, and the bevel teeth formed on gears *E* and *S* which mesh with the planetary bevel pinions *T*, mounted by the pivot *U* on the support *V* which is in two pieces and is keyed to the spindle *G* of the head. In addition, there is an automatic controlling mechanism for the indexing, which includes a spindle *L* driven by a coupling *W*, connected with a special pulley carried in a bracket on the bed of the milling machine; clutch *M* fixed on spindle *L*, and a worm *K*, which is free to revolve on this spindle and which is pressed against the clutch *M* by a spring *H*, rod *I* and finger *J*, when the gear *E* is free to revolve which takes place when the locking bolt *B* (Fig. 2) is withdrawn from the plate *C*. This locking bolt has a spring and Bowden cable which actuate it, the tension of the latter being regulated by screw *A*. The distance which the plate *C* moves at each indexing is controlled by a hole counter composed of the toothed dividing plate *C*, a toothed disk *N* and a stop-plate *O*.

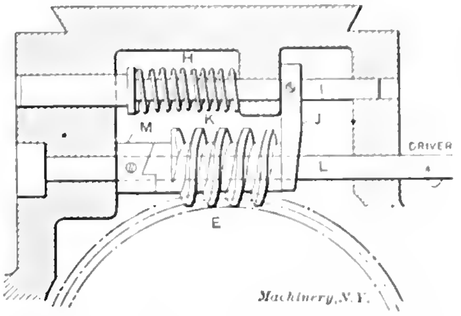


Fig. 3. Detail of the Mechanism which indexes the Work when the Locking Bolt is withdrawn and the Gear E is Free to revolve

The table of the milling machine on which this apparatus is used should be arranged to return automatically. When the cutter has made its first cut, the table returns, and when it is about to finish this return stroke, a suitable mechanism gives a quick pull on the Bowden cable. This pull draws bolt *B* toward the rear, disengaging the dividing plate *C*. The hub *D*, the worm-wheel *E*, the differential and the spindle *G* of the apparatus are thus left free. The pressure of spring *H* gives these parts a gentle movement by the operation of *I*, *J* and the worm *K*. (See the detail Fig. 3.) This last member sliding freely on its spindle *L*, carries the clutch teeth, with which it is provided at one end, into contact with the teeth of the clutch *M* fixed on spindle *L*. Worm *K* thus receives a rotary movement from *M* which it transmits to the differential and to the dividing plate until bolt *B* enters one of the succeeding lock holes in the plate. The division is thus completed, and as the movement of the worm-wheel *E* is arrested, the screw in continuing its rotation is moved backwards, disengaging itself from the clutch *M* and stopping. The dividing plate *C* is provided with a number of teeth *c* (Fig. 2), the number corresponding to the number of its holes. Whenever this plate is set in motion, the first of these teeth strikes the toothed disk *N*.

which is thus made to turn the counter *O*. A solid portion of this counter is thus placed in front of bolt *B* which prevents the bolt from engaging with plate *C* until the required number of holes to bring the cut to the place designated by the counter *O* have passed. The bolt *B* then engages with plate *C* and the division is accomplished. Plates *C*, *O* and *N* are thus furnished with holes and teeth, the number of which depends on the division it is desired to obtain. We show herewith a table of the plates employed to obtain the different automatic divisions mentioned in the foregoing.

[illegible] Plate C	No. Counter	Number of Cuts in the Counter O				
		6	4	3	2	1
12	24	12	8	6	4	2
18	36	18	12	9	6	3
30	60	30	20	15	10	5
42	84	42	28	21	14	7

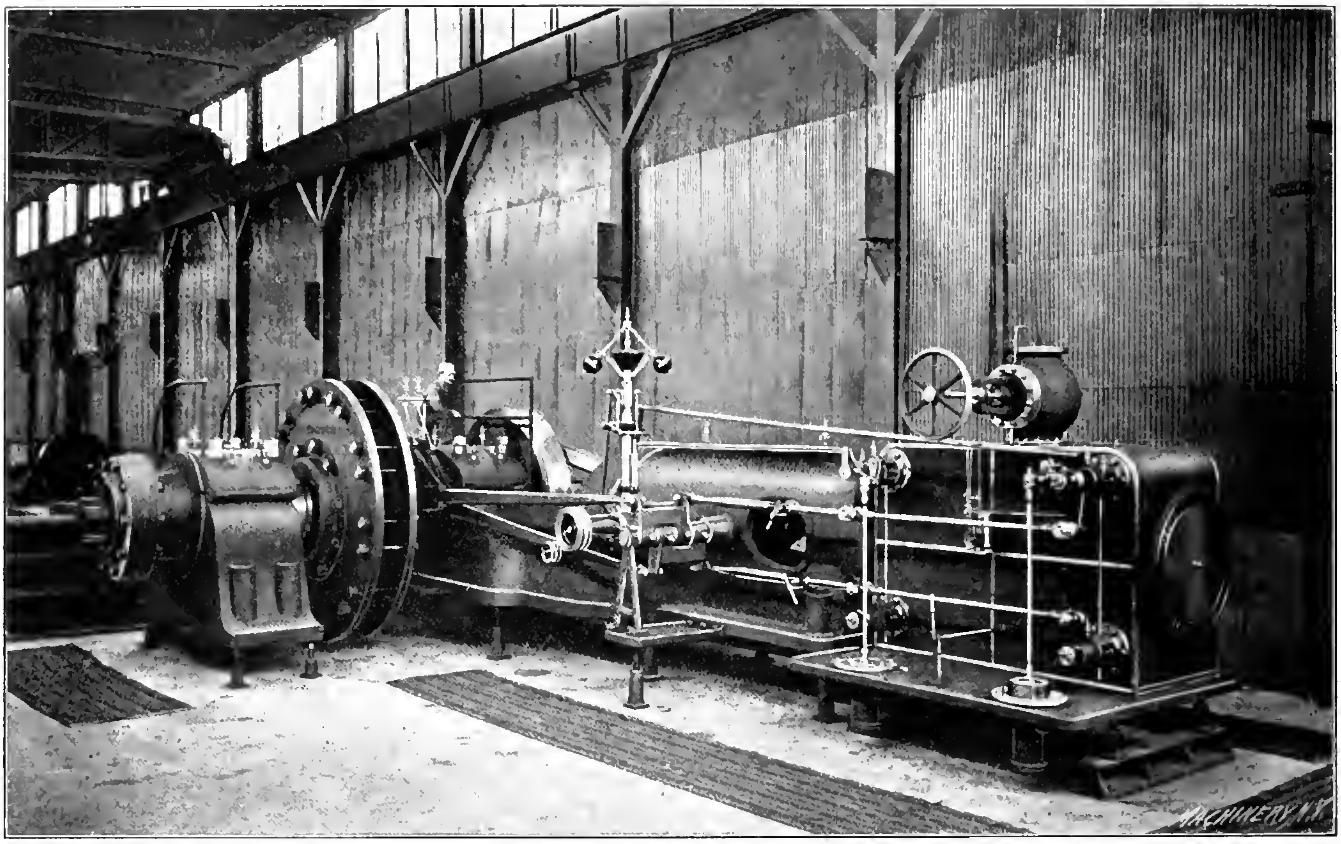


Fig. 1. Rolling Mill Engine built from "Pig Iron to 3500 H.P." in Thirty Days

* * *

THE TRIBULATIONS OF INVENTORS

One of the most difficult persons with whom the honest and fair-minded manufacturer has to deal is the inventor who presents to him an idea for the improvement of a mechanical device, but who lacks, utterly, the ability and the mechanical skill and knowledge to put his idea into a commercially acceptable form. Ofter the manufacturer receives from such an inventor nothing but a very crude idea, the working up of which into practical form must be done entirely at his own expense within his own factory. Under those circumstances it is clear that the manufacturer does not consider himself warranted to offer to the inventor a price for his invention equivalent to the value of the device when it has finally been put into practical working condition. But the inventor in most cases considers himself unfairly treated if his compensation is not based on the ultimate value of the device, and he forgets entirely that he did not himself make the invention commercially successful, but merely supplied a more or less crude idea, which, by itself, would have been valueless.

In fact, most inventions offered to manufacturers by inventors outside of their own shops are of this nature, and inventors should always consider before complaining about unfair treatment whether they themselves actually offered for sale a mechanically perfect and commercially successful device. If that is the case, the inventor is entitled to a full share in the proceeds. If, however, merely a crude idea is offered and the inventor is incapable of giving it mechanical perfection, then he has no just reason to complain if manufacturers do not appreciate his offer and refuse to pay an exorbitant price for something, the development of which still largely depends on their own resources.

When the inventor is employed in a manufacturing concern the question usually has a different aspect. He is then, as a rule, able to make his invention mechanically successful, and the full credit for both the original idea and the commercial application is often due to the inventor himself. Inventors of this class, however, have often more reason to complain than has the other class mentioned, for by reason of their employment they are practically forced to sell their invention to their employer at his own price, and the main compensation that they receive commonly consists merely in permanent employment at reasonable wages. This class of inventors, however, seldom complain, because present economic conditions has taught the majority of men to be content as long as they feel reasonably sure of permanent employment.

* * *

BIG WORK OF THE MESTA MACHINE CO.

In a business note in the April number of Machinery, it was announced that the Engineers' Club of Western Pennsylvania and others made a trip to the works of the Mesta Machine Co., at West Homestead, near Pittsburg, to inspect interesting new machinery, and office, foundry and pattern storage buildings. A special train of nine cars was run from the Union station to the works on the Monongahela division of the Pennsylvania Railroad, and among the 650 visitors were many prominent manufacturers and engineers.

The illustration, Fig. 1, shows the Corliss rolling mill engine referred to, which was built from "pig iron to 3,500 horsepower" in thirty days. The engine completed weighs 400,000 pounds, of which 200,000 pounds are in the flywheel. It was built for the Phillips Steel & Tin Plate Co., Clarksburg, W. Va., and replaces an engine that was wrecked February 24. The old engine drove the twenty-eight-inch steel mill, and this department was at a complete standstill during the interval

required for building the new engine, hence the effort to replace it in record-breaking time.

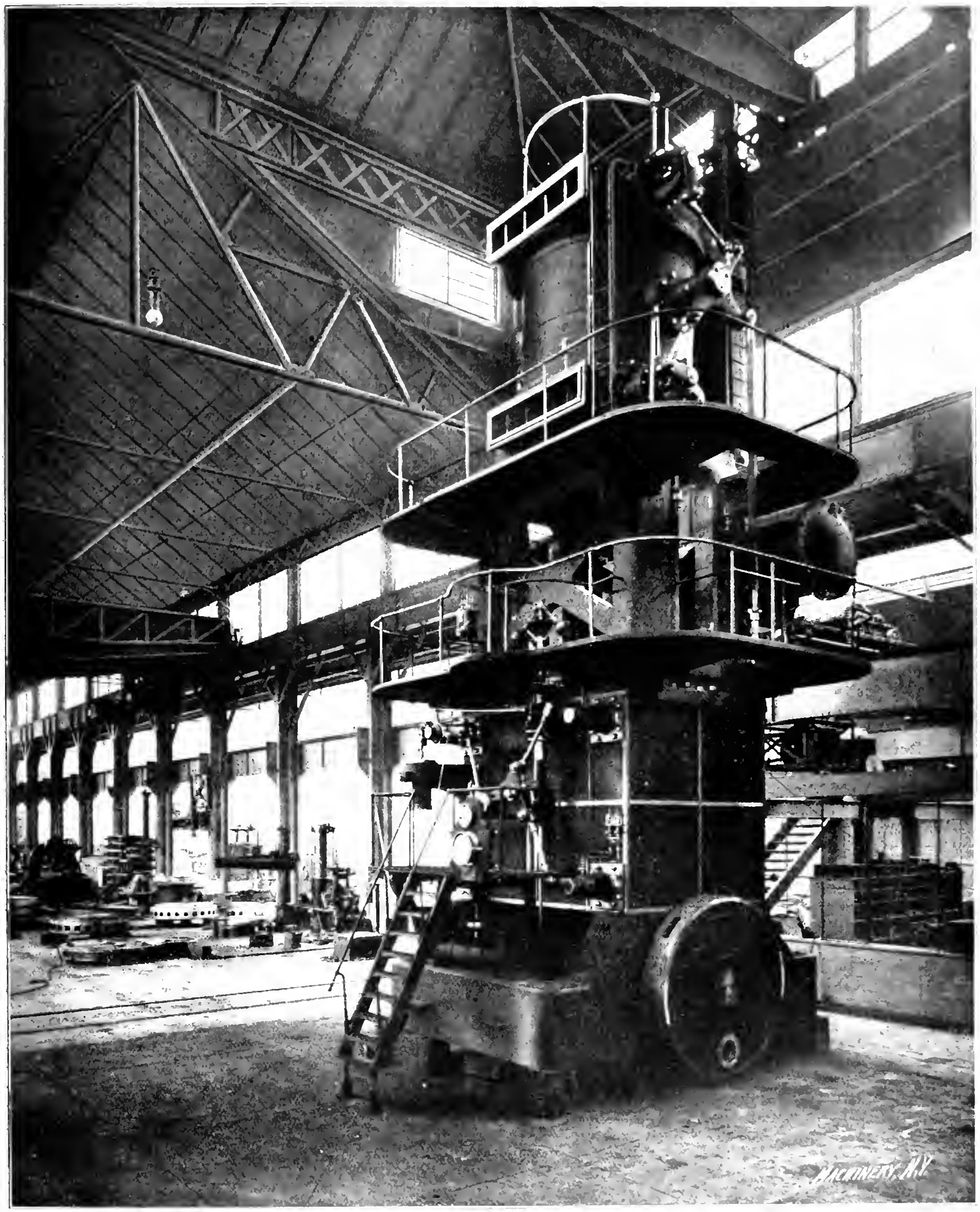


Fig. 2. Long Cross-head Type Vertical Blowing Engine built by the Mesta Machine Co.

The illustration, Fig. 2, is a long cross-head type, low-pressure blowing engine, standing on the erecting floor at the time of the inspection, which had just been completed for the Tennessee Coal, Iron and Railroad Co., Ensley, Ala. The steam cylinder of this engine is 84 inches diameter, air cylinders 84 inches and stroke 60 inches. Twenty-four blowing engines of the same type and size are now in operation at the furnaces of the Tennessee concern, all built by the Mesta Machine Co. The engine illustrated weighs about 250 tons.

Another feature of the machine shop that held the attention of the visitors was the machinery for a 600-ton metal mixer the large [illegible] in size means that the [illegible] of the [illegible] the demands made by the steel [illegible] practically unlimited. [illegible] shown the pouring of [illegible] in use for many years and the [illegible] the Mesta Company. This operation is a revolution in the science of roll-making, as the positive control of the mechanical devices enables the operator to get exactly the depth and hardness of chill desired. In the new iron foundry, an engine frame weighing 160,000 pounds was poured from four huge ladles. This building is equipped with 100-ton traveling cranes for handling ladles and castings.

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GOLD, AND ITS EFFECT ON PRICES

Bankers, financiers, business men, manufacturers, mechanics and, in short, everyone is vitally interested in the production of gold and the effect of the enormous increase in its production of late years on the finances of the world. Two very interesting books have been published lately on the subject, entitled "Story of Gold" and "The World's Gold," which are worthy of the consideration of every man sufficiently interested in monetary conditions to have some appreciation of the subject. The gold question has assumed an entirely different aspect since the demonetization of silver. Improved methods of mining and reduction have made it possible to work gold-bearing quartz rock with profit that only a few years ago Works of Alaska handle half a million tons of rock each year would have been unprofitable. For example, the Treadwell and find it profitable with a total production of gold of only about $2.50 per ton.

The increase of gold production has had a very appreciable effect on prices. Everyone suffers under the high prices of food, clothing and general living, and the majority cannot understand why costs have so greatly increased. Those who have made a study of this question say that it is due to the great production of gold, which in effect has cheapened it and made its purchasing power considerably less than when it was less abundant. To illustrate how greatly gold production has increased, a few statistics are in order: In 1883, 145 tons of gold were produced; in 1890, 200 tons; and in 1906, 608 tons. In other words, the production of gold had more than quadrupled in twenty years. The increased production of gold is even more strikingly apparent if we look at the production during a long period of years. In the time that elapsed since the discovery of America to the discovery of gold in California in 1849, the world's total production of gold was 4,621 tons, and in the forty years following the discovery in California the production was 7,160 tons. The production of forty years was fifty per cent more than in the three hundred fifty odd years preceding! If the production of gold is plotted, the curve will show a strikingly upward tendency during the last twenty years. The prospects are that the production of gold will increase even more during the next twenty years, which means according to monetary experts that prices will keep in step. Investments in stocks, bonds, mortgages and collateral security will depreciate, while investments in land, buildings, factories and other concrete examples of wealth will materially increase in apparent value. The man who buys a house will have good prospects of seeing its value, expressed in dollars and cents, increase greatly during the next few years, if the gold prophets are not at fault.

* * *

LABOR AND TARIFF

At the Tariff Commission convention held in Indianapolis, February 16 to 18, one of the best addresses made was that by Mr. Henry R. Towne, president of the Merchants' Association of New York. Mr. Towne had well analyzed his subject, and his reference to the interest of labor in the tariff is of especial value. "A tariff," he says, "is an indirect tax; its primary purpose is revenue; it may include the secondary purpose of protection. A tariff rate intended to prevent importation ceases to become a tax and becomes a subsidy. In considering any proposed tax, these questions should be considered: 1. On whom will it fall? 2. What revenue will it yield? 3. Whom, if any, will it benefit? If reliable data are available and if the tax is for revenue only, these questions may perhaps be easily answered, but if it is wholly or partly for protection, to foster and benefit certain classes of citizens, at the possible or intended expense of other classes, the problems become vastly complex. * * * In all discussions of the tariff the plea is made that a chief purpose in view is protection to American labor. Are we not liable to be misled by this plea? Does labor actually share, and, if so, to what extent, in the proceeds of the tax resulting from a protective duty? Is it not a fact, known to all employers of labor, that, in fixing any individual rate of wages, no thought whatever is given to the tariff; that in every case the employer takes account solely of the value or efficiency of the workman, and of the current rate of wages in the trade to which he belongs; that the workman is guided solely by his knowledge as to the current rate, and by his needs; and that each makes the best bargain that he can? Is it not true, further, that the rate of wages, in every trade, depends in large part on the cost of living, and that a high tariff, by enhancing the prices of the products which it affects, tends to increase this cost? Finally, is it not true that the real measure of a wage is its purchasing power, and that needlessly high tariff rates tend to diminish the purchasing power of wages?"

Mr. Towne further called attention to the United States as a great example of free trade, and said that nowhere else, at any time in the world's history, have trade and commerce been so absolutely free and untrammeled as they are to-day among the 80,000,000 people of this country.

The following are the more important of the conclusions given by Mr. Towne in his paper: The tariff embodies the heaviest tax which the people of the United States impose on themselves; it yields one-half of the national revenue; the present method of fixing tariff rates through Congressional committees acting chiefly on prejudiced evidence produces inequalities which are unnecessary, harmful and unjust; it is crude, unscientific and outgrown. A tariff influences wages indirectly only; it chiefly influences the cost of living, which in turn, determines the rate of a living wage; the true measure of wages is purchasing power; hence, anything tending to increase the cost of living, lessens wages; therefore, the tariff should be adjusted with regard to all its effects on all the people, not with regard to protected interests only. Mr. Towne considers that the remedy for our difficulties with the tariff would be a permanent, technical bureau of tariff research, which would collect, analyze and report industrial and commercial data to Congress, and that tariff revision should be made continuous and not intermittent. This would make the tariff flexible, and eliminate the bad influence of intermittent revision on business.

THE WASTE OF HUMAN ENERGY

A European state railway system was recently in need of sixteen new passenger locomotives of identical type. In the particular country referred to there are four locomotive building companies, and in order to "provide work" for the hands idle during the present depression the state railway administration divided the order for the sixteen locomotives among the four companies, ordering four from each. Under present economic conditions, when men willing to work are not permitted to do so, this course was undoubtedly a wise one; but one cannot help being impressed by the waste of human energy involved in the construction of the sixteen locomotives in this manner. Four complete sets of designs had to be worked out and approved, four complete sets of patterns made, and special tools required for the manufacture of the engines duplicated in four different places; and, of course, the work could not possibly be carried out under this arrangement as economically as if the sixteen locomotives had been built by one firm.

In England a reduction in the naval program advocated by the government about a year ago, was vigorously opposed by a portion of the press, not on the ground of national defense, but because a reduction in the quota of battleships to be constructed yearly would throw a number of men out of work; so, in order to give these men an opportunity to earn a living, these papers advocated a continuance of the policy of building battleships whether or not they were necessary for the country's defense.

It is not necessarily lack of employment alone that causes poverty, but also such aimless waste of human energy, which could be employed for the production of useful material. It is not necessary to go to Europe for examples of a similar waste of energy. During every period of trade depression we see examples of it in every country, and in almost every community; and this waste is likely to continue until we apply the axiom that men do not actually want *work*, considered by itself; but they do want the *product* of their work; and that wages, or compensation for work, do not come out of a large, indefinite, inexhaustible fund, but from the products of labor. If labor is expended for useless and unproductive purposes, the fund out of which wages must eventually be paid will be that much smaller, and the total reward for all labor must be less, even if no part of the product were diverted into other channels. Wasteful production, whether on a small or large scale, whether caused by individual or national ignorance or by economic conditions, is the worst enemy to progress; and the mere fact that men are paid for useless work in no way justifies the doing of the work.

The main reason for the industrial progress in America has been that human energy was highly valued; and, with all the waste in our natural resources, the percentage of waste in human energy has been smaller than in the old world. At present, the difference between conditions in this respect in the old world and in the United States is not so marked as in the past, and there is now a greater tendency in this country to employ labor in wasteful ways. Of course, non-employment itself is wasteful, whether it be voluntary or enforced; and whatever is done to prevent the waste of human energy is therefore an important step forward. It is fully as important to the progress of industry and the increase of wealth, as is the designing of labor-saving machinery and the development of improved methods of manufacture.

* * *

It is proposed to include a "worked-to-an-adequate-extent" clause in the French patent law. According to the *Times* the new amendment to the law will provide that patent rights shall lapse in France if the holder of the patent does not exercise his rights in France or in French colonies for a period of three years after applying for the patent. It also appears that the patentee will be expected to "exercise his rights" to an adequate extent. Of course, the purpose of this bill is exactly the same as that of the new British Patents Act, and the "exercise of rights" evidently is intended to mean the manufacture of the patented article.

EXPERIMENTS ON TWIST DRILLS—1

At the March 18, 1909, meeting of the Institution of Mechanical Engineers of Great Britain, a paper was read entitled "Experiments Upon Forces Acting on Twist Drills when Operating on Cast Iron and Steel." The paper was prepared by Mr. Dempster Smith of the Municipal School of Technology, Manchester, England, and Mr. R Pollakoff of the Imperial Technology Institute, Moscow, Russia. The experiments, which have covered a period of three years, have been made by the authors of the paper at the Manchester School of Technology under the direction of Dr. J. T. Nicolson Owing to the thorough manner in which these experiments have been carried out and the extensive records made of the results obtained, together with the valuable conclusions that can be drawn from these results regarding the design of twist drills, the paper is of considerable importance, and the following abstract has been prepared with a view of presenting the most essential points. The results obtained in the experiments are the outcome of over one thousand tests.

Previous Experiments

Before discussing the experiments, it may not be out of place to give a brief *résumé* of the most important work done in this field of research. Amongst the first experiments of any note with twist-drills are those recorded by Professor L. P. Breckenridge in the Journal of the Lehigh University Engineering Society for October, 1898. According to these experiments the pressure on the drill when starting to cut is greater than the pressure on the drill when drilling with the full diameter. It was found that a one-inch drill required 1,450 pounds pressure when starting to cut, and 1,000 to 1,150 pounds pressure when drilling with the full diameter. The material cut, however, was not specified. It would appear from the results obtained that the material drilled was cast iron on which the skin or scale had not been removed, so that on this account a greater pressure was required to start the cut than to drill with the full diameter of the drill.

In 1902, Mr. Norris of the Bickford Drill & Tool Co. made several experiments with carbon steel twist drills in order to determine the most economical feed and speed, and also to get an idea of the power required when drilling cast iron. Mr. Norris found that a ¾-inch drill would withstand a feed of 1/16 of an inch per revolution when drilling ordinary cast iron at a speed of 267 revolutions per minute, this being the coarsest feed provided on the machine. It was also found impossible to break drills larger than the above when operating at the same feed and on the same material. These experiments resulted in the adoption of feeds in the Bickford shops, which were about four times greater than those recommended by the Morse Twist Drill Company, at speeds not less than that given by that company. The conclusions from these trials were: The net horse-power per cubic inch of metal removed slightly decreases with the increase of feed for a given diameter of drill and speed. The net horse-power per cubic inch of metal removed also decreases with the increase in diameter of drill. The cutting speed for each drill varied, however, decreasing with the increase in diameter.

From a second set of power trials carried out on a specially rigid machine designed for testing the durability of the drills Mr. Norris arrived at the following conclusions:

When the speed and feed are constant, the power required to drill tool steel is about 1.10 times, wrought iron about 1.65 times, and machinery steel about 1.90 times that required to drill cast iron. When the speeds and feeds remain constant, the power required is approximately proportional to the diameter of the drill. When the diameter of the drill and rate of feed are constant, the power required is approximately proportional to the speed. When the speed and diameter of drill are constant, the power required is approximately proportional to the feed.

A formula closely agreeing with these results, when operating on cast iron at a speed of 30 feet per minute, is:

$$\text{H.P} = \frac{63}{\sqrt{d}}(dt + 0.01)$$

where *d* is the diameter of the drill in inches and *t* the feed in inches per revolution of the drill.

Messrs. W. W. Bird and H. P. Fairfield, of the Worcester Polytechnic Institute, in a paper presented at the New York meeting of the American Society of Mechanical Engineers, December, 1904, gave the results of investigations on the torque and thrust exerted on a $\frac{5}{8}$-inch "Novo" high-speed steel twist drill with varying rate of speed and feed on different metals.

The results of these experiments with a drill having an included point angle of 118 degrees was as follows: No material difference either in torque or end thrust was found by increasing the speed from 140 to 600 revolutions per minute when drilling soft gray iron. When operating on the same material at 420 revolutions per minute at varying rates of feed, it was observed that the torque did not increase as quickly as the feed, but the thrust increased very rapidly with coarse feeds. The torque required when operating on brass, tool steel, and machine steel was respectively 0.715, 1.67 and 2.44 times that required for cast iron. The corresponding thrusts were found to be 0.575, 1.7 and 2.6 times that required for cast iron. By varying the included point angle of the drill from 75 to 140 degrees, the end thrust increased rapidly with the angle, but no practical difference was observed in the torque.

A similar set of experiments were made later at the Worcester Polytechnic Institute by C. S. Frary and E. A. Adams. The results of these experiments showed that with a constant surface speed the thrust was nearly proportional to the diameter of the drill and also to the rate of feed. With different included point angles, the thrust decreased for angles from 150 to 90 degrees, and then increased for any further decrease in the angles. The moment could not be said to be proportional to the angle of the point, but almost proportional to the feed. The drill giving the minimum torque had a point angle of 130 degrees and the torque increased with drills having angles greater or less than this.

The twisting moment for ordinary twist drills is, according to these experiments, approximately expressed by:

$T = 13.5\ d\ (1{,}000\ t + 2.5)$

where

$T =$ torque in inch-pounds,
$d =$ diameter of the drill in inches,
$t =$ feed in inches per revolution of the drill.

The Manchester Experiments

In the experiments made at the Manchester School of Technology, the results of which are reported in the paper referred to above, two forms of apparatus were used. The first apparatus was of comparatively simple character, suitable for use in the ordinary lathe. The experiments with this apparatus had for their object:

(*a*) To determine the twisting moment required for drilling with different diameters of twist drills at various speeds and feeds in cast iron and steel.

(*b*) The feeding force required for the various conditions mentioned in (*a*).

(*c*) To ascertain the twisting force required to enlarge a hole (which had previously been opened with a drill of smaller diameter) at different rates of feed on cast iron and steel.

(*d*) The corresponding feeding force required under the circumstances instanced in (*c*).

Ordinary commercial A. W. high-speed steel twist drills of $\frac{3}{4}$, 1, and $1\frac{1}{2}$ inch diameter were used throughout these trials. The drills were ground on a twist drill grinding machine and the point thinned to about half the thickness of the web. The cast iron operated upon was of medium hardness and had the skin removed. The steel was Whitworth's (fluid-pressed), of medium hardness, having 0.29 per cent carbon and 0.625 per cent manganese.

Description of Apparatus

The arrangement of the lathe used for the first set of experiments is shown in Fig. 1. The lathe was driven by a 120 H. P. direct-current shunt-wound motor. A large air-cooled rheostat connected to the main circuit between the line and brushes allowed of the speed being varied from 100 to 300 revolutions per minute. The motor drove on to a countershaft whereon was mounted a three-step cone pulley similar to that on the lathe spindle. A further reduction of speed could be obtained through the double and triple back-gears in the machine, the ratio of which was 14.9 and 42.5 to 1, respectively, the combined arrangement permitted of the speed being varied from 1.5 to 450 revolutions per minute. A counter fixed to the end of the spindle indicated the revolutions made by the work.

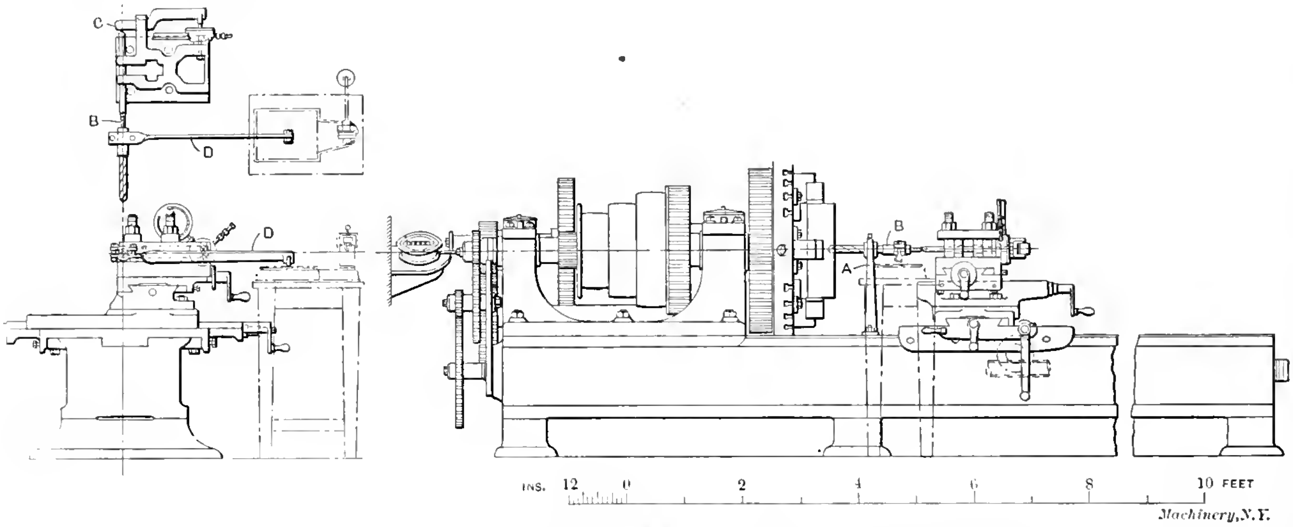


Fig. 1. Apparatus used for the First Set of Experiments to obtain Power required for Drilling

The stand *A*, bolted to the bed of the lathe, supported the drill close to the work. The drill was quite free to slide in the bearing provided in the stand. Suitable hardened steel bushings were used for the various sizes of drills. A small spindle or socket *B* received the tang end of the drill, and the thrust was taken by the knife-edged lever *C* and a diaphragm dynamometer fitted to a cast iron block which was bolted to the top slide rest.

The arm *D* was attached at one end to *B*, while the other end rested on a scale pan, and thus prevented the drill from rotating. As the arm advanced with the drill, the scale pan remaining stationary, the former was fitted with a knife-edged roller to reduce side twist on the drill, due to friction. The force exerted on the pan when multiplied by the length of the arm gives the twisting moment on the drill. By the engagement of the screw-cutting feed mechanism a definite advance was given to the drill per revolution of the work. The diaphragm dynamometer is similar to that shown in section in Fig. 2 and described in connection with the second apparatus. The speed in the ordinary force trials was kept constant at 10 revolutions per minute for each diameter of drills. The revolutions were observed on the counter at the end of the lathe spindle and a tachometer on the motor.

No perceptible difference was observed in the twisting moment and end-pressure with the variation of speed; that is, the cutting horse-power for a given diameter of drill and feed was directly proportional to the speed. The results of the experiments have been reduced to formulas, and are mainly so expressed in the following.

In the formulas given in the following, the notation below has been adhered to throughout:

T = torque in foot-pounds,
d = diameter of drill in inches,
t = feed in inches per revolution of drill,
P = end thrust in pounds,
f = cutting pressure in tons per square inch,
N = revolutions per minute,
V = metal removed per minute in cubic inches.

Results of Experiments with First Apparatus

The results obtained in the first set of experiments are expressed by the following formulas:

Trials (a) on medium cast iron:

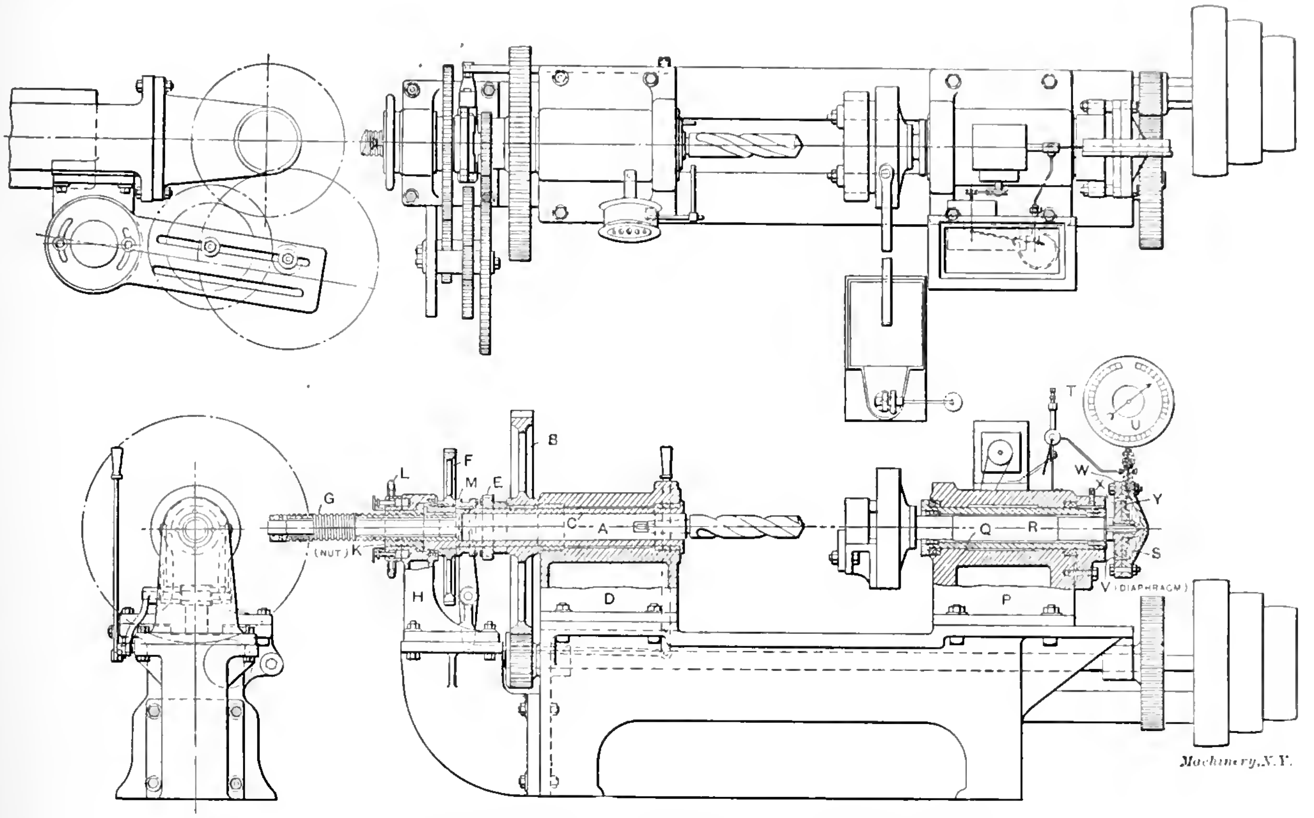


Fig. 2. Section and Elevation of Apparatus used in Second Set of Experiments

$T = 1{,}220\,t + 2.5$ for ¾-inch drill, (1)
$T = 1{,}840\,t + 7.5$ for 1- inch drill, (2)
$T = 3{,}640\,t + 22.5$ for 1½-inch drill, (3)

An equation embracing the whole can be written:

$T = 12\,(d^2 - 0.35) + (500 + 1{,}350d^2)\,t$, (4)

A more approximate but much more simple expression for formula (4) would be

$T = (1{,}800\,t + 9)\,d^2$, (4a)

For the opening out trials (c) on cast iron, the twisting moment is given by the formula

$T = 2{,}812\,t + 17.5$ for opening ¾-inch hole to 1½-inch diameter, (5)

The twisting moment in trials (a) on steel follow a similar law to the cast iron. An expression for each size of drill is given below:

$T = 1{,}530\,t + 15$ for ¾-inch drill, (6)
$T = 3{,}850\,t + 18$ for 1- inch drill, (7)
$T = 7{,}800\,t + 48$ for 1½-inch drill, (8)

An approximate expression for the above which is near enough for all practical purposes is

$T = (3{,}200\,t + 20)\,d^2$, (9)

For the opening out trials (c) on steel:

$T = 1{,}500\,t + 6$ for opening ¾-inch to 1-inch, (10)
$T = 3{,}325\,t + 29$ for opening 1-inch to 1½-inch, (11)
$T = 5{,}025\,t + 31$ for opening ¾-inch to 1½-inch, (12)

The end thrust P is given by the following formulas:

For medium cast iron

$P = 95{,}600\,t - 250$ for ¾-inch-drill, (13)
$P = 93{,}400\,t + 180$ for 1- inch drill, (14)
$P = 154{,}000\,t - 600$ for 1½-inch drill, (15)

and

$P = 115{,}000\,t - 200$ for all diameters, (16)

In the opening out trials (d) in cast iron

$P = 11{,}330\,t + 160$ opening out ¾-inch hole to 1½-inch diameter, (17)

In the medium steel experiments for trials (b):

$P = 26{,}500\,t + 1{,}040$ for ¾-inch drill, (18a)
$P = 90{,}000\,t + 800$ for 1- inch drill, (18b)
$P = 155{,}000\,t + 1{,}300$ for 1½-inch drill, (18c)

and

$P = 160{,}000\,(d - 0.5)\,t + 1{,}000$ for all drills, (18)

For the opening out trials in medium steel:

$P = 15{,}200\,t - 60$ opening ¾-inch hole to 1-inch diameter, (19a)
$P = 25{,}500\,t + 60$ opening 1-inch hole to 1½-inch diameter, (19b)
$P = 30{,}000\,t + 200$ opening ¾-inch hole to 1½-inch diameter, (19c)

In no case did the end force P reach a maximum and then diminish when the drill was fully entered as observed by Professor Breckenridge, and it can only be concluded that he was operating on cast iron having a very hard skin or that the drill had a smaller pitch than those now in common use, *i. e.*, a keener angle. The opening out experiments show the fallacy of a common notion that but for the chisel point the drill would run into the work and break.

The apparatus employed and the results obtained in these first experiments were not entirely satisfactory for the larger drills and heavy feeds. This led to the construction of a second apparatus, and the making of a second set of tests, which will be described in the June issue.

* * *

It is stated in the *Marine Journal* that Sir Oliver Lodge recently succeeded in completely clearing away for a radius of sixty feet, a thick fog, by means of electrical discharges. The method employed consists in discharging electricity into the fog-laden atmosphere at a very high voltage, from a series of disks at the top of poles.

SOME NOTES ON BALL BEARINGS*

ASHER GOLDEN†

Mechanical friction is always a resisting force, whether utilized to effect the stability of structures, or to transmit motion from one part of a machine to another, or even to enable us to walk. In producing these effects, friction is essential and desirable, and means are often taken to increase it; such, for example, as the covering of leather transmission belts with adhesive substances and the covering of icy pavements to prevent slipping. On the other hand, friction is injurious in preventing relative motion of different parts of a machine and producing waste of energy. Under these conditions, friction is a serious disadvantage and its elimination a problem of grave importance. Any discussion relating to ball bearings, therefore, bears directly on the question of eliminating friction, and indirectly on the question of saving fuel and oil, and preventing the wear and tear of machinery.

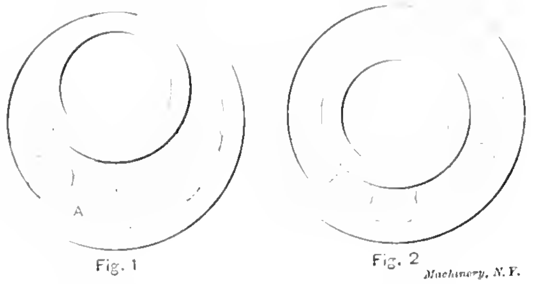


Fig. 1 Fig. 2

Figs. 1 and 2. Method of Assembling a Ball Bearing

One way of minimizing the effects of friction suggested itself to the man who first applied wheels to a road vehicle. It must have been apparent to him that a vehicle would wear better and require less effort to move it if some means were provided to roll it along instead of having to drag it over the ground. This condition of affairs may be exaggerated by assuming that in one case we have two toothed racks in mesh and we try to move one relatively to the other; in the second case, that we replace one of the racks by a gear wheel and move it over the rack by means of a trunnion. The limit of the load required to effect motion in the first case, is that which will break the teeth, and in the second case, the effort required to overcome the comparatively small weight of the wheel and the friction between the meshing teeth. A comparative idea of the advantage gained by substituting rolling for sliding friction may be obtained approximately by taking two smooth blocks of steel, lubricating the surfaces in contact, and then tilting them; one block will begin to slide over the other when the angle through which they are tilted is between 8 and 9 degrees. If now, we replace the oil between the two blocks by a number of steel balls, we find on tilting the blocks, that they will begin to slide over each other when the angle is about 0.08 degree Again, if we take two smooth horizontal blocks of steel, weighing, say 1 pound, it will require a force of approximately 2.7 ounces to move one over the other if the surfaces in contact are lubricated. If, instead of oil, we use steel balls between the blocks, only 0.027 ounce will be required to effect the motion. The only question raised against the use of the concentric ball bearing for stationary machinery and the cheaper grades of automobiles, is in regard to first cost. Aside from this, no one questions the relative advantage of the two-point ball bearing over the plain bearing, or even the roller bearing or cup and cone. In regard to ultimate cost, it may be safely said that the two-point bearing is the most efficient and cheapest. It only remains, regarding the ball bearing as a friction eliminator, to consider some of the inherent mechanical defects found in ball bearings at present on the market. These defects may be put under the following heads: Side slots in the rings for assembling the balls; small number of balls in races owing to absence of side filling slots; separators or spacers made of several disconnected pieces.

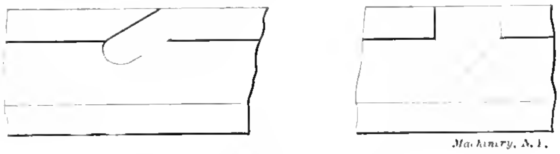


Fig. 3. Two Forms of Filling Slots

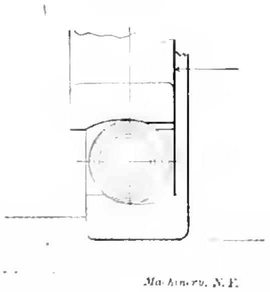


Fig. 4. Displacement of the Rings of a Radial Bearing when it is subjected to an End Thrust

There are employed at present but two general methods of assembling a full or partly full ball bearing. One of these is to arrange the balls and races as shown in Fig. 1, and after placing in the crescent-shaped space *A*, as many balls as can be freely dropped in, the inner ring is shifted, leaving an annular space with the races about half filled with balls, as shown in Fig. 2. The remaining balls are then sprung in through slots in the sides under comparatively high pressure. This process is used extensively by Fichtel & Sachs (F. & S.); Standard Roller Bearing Co. (S.R.B.); and every other manufacturer of ball bearings, with the exception of three or four. The master patents for this process are owned by Fichtel & Sachs. Two forms of these filling slots are shown in Fig. 3. It is claimed by all those who employ the filling slot, that after the balls are assembled, they have practically a continuous race and that the bearing is as perfect as if the slot never existed. It may be said, however, that the existence of a filling slot as a defect is indirectly recognized by every bearing manufacturer. If it were possible to use radial bearings to carry only a purely radial load, almost any ball bearing, no matter how assembled, would give satisfactory service, provided the materials were fairly good and the bearing not overloaded; but, in many instances, radial bearings are used to carry, simultaneously, ordinary radial loads and comparatively excessive thrust loads. This applies particularly to radial bearings used in automobile front wheels, and to some extent in the rear wheels as well. Under these conditions, the inner and outer rings are relatively displaced, as shown in Fig. 4, and it is evident that if a bearing having a side filling slot be subjected to excessive end thrust, the balls are forced into the slot, a treatment which is manifestly

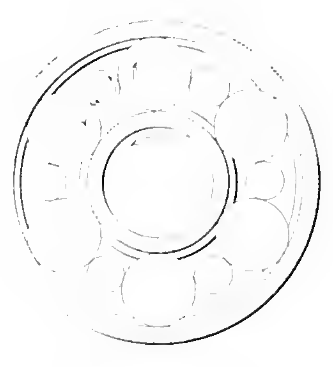
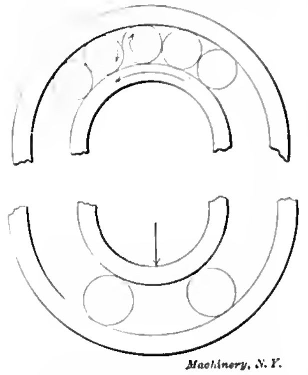


Fig. 5. Bearing Designed to Eliminate Friction



Figs. 6 and 7. Diagrams showing Action of Balls in a Full Bearing

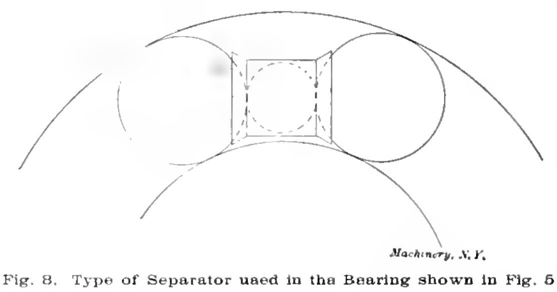


Fig. 8. Type of Separator used in the Bearing shown in Fig. 5

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* For additional information on this subject see the following articles previously published in MACHINERY: Ball Bearings, December, 1907, and January, 1908, engineering edition; The Discussion on Bearings Held at the December Meeting of the A. S. M. E., February, 1906; Designing Two-point Ball Bearings, April, 1906, engineering edition; Ball and Roller Bearings, December, 1906; Ball Bearings, February, 1905.

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not very good for either balls or races. Of course, the extent to which this pinching of the ball in the slot will take place will depend on the depth of the filling slot. The Fichtel & Sachs Co. overcome this difficulty to some extent by employing a slot which is not quite as deep as the ball races. The balls are then forced through these slots under a pressure which is much higher than the thrust loads that can possibly be put on the bearings in practice. This is at least defensible practice, provided that the materials employed are of excellent quality. A bearing may be made without a filling slot, but in that case the limit to the number of balls which may be inserted is set by what will go into the crescent-shaped space *A*, Fig. 1. The balls are disposed around the circumference and some form of separator or spacer used to keep them apart. It has often been stated by those who employ this process, that there is no need of completely filling the races with balls; in other words, that a ball bearing which is only partly filled with balls, is equal to or better than one which is completely filled. One might almost reason instinctively that such statements are erroneous. That they are actually so will be shown.

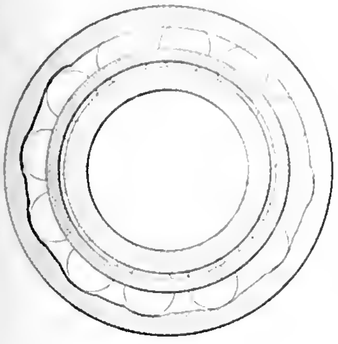
Fig. 9.* Bearing with Outer Ring Grooved to permit the Use of a One-piece Separator

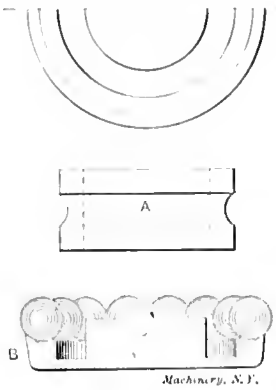

Fig. 10. Inner Race and Section through One-half the Cup used in Assembling the R. B. F. Radial Bearing


Fig. 11. View showing Method of Assembling the R. B. F. Bearing. After the Outer Race is heated with Oil, the Balls and the Inner Race are Forced into Place, after which the Assembling Cup is removed.

The permissible load in kilograms which a two-point ball bearing having one row of balls, will carry is given by the following relation due to Professor Stribeck:

$$P = \frac{K d^2 z}{5} \qquad (1)$$

where *K* is a constant depending on the properties of the material, the form of the ball race and the angular speed of the bearing; it may also be regarded as a factor of safety; *z* is the number of balls; the factor 5 takes account of the fact that only part of the balls carries the radial load; *d* is the diameter of the ball, taking 1/8 inch as the unit. For example:

If diameter of ball is 1/8 inch, $d = 1$
If diameter of ball is 1/4 inch, $d = 2$
If diameter of ball is 7/16 inch, $d = 3.5$
If diameter of ball is 5/8 inch, $d = 5$, etc.

From the above, it is seen that if we take two bearings having the same form of groove and the same dimensions for both of the balls and races, then if P_1 and P_2 are the carrying capacities of the two bearings, and z_1 and z_2 the corresponding number of balls, we have for the same angular speed

$$P_1 = \frac{K d^2 z_1}{5}$$

$$P_2 = \frac{K d^2 z_2}{5}$$

from which

$$\frac{P_1}{P_2} = \frac{z_1}{z_2}$$; or, in words, the carrying capacities of the two bearings are directly proportional to the number of balls. It is seen, therefore, that for a given bearing, other things being equal, the full type has a greater carrying capacity than that only partly filled with balls. While it is seldom stated that the carrying capacity of a radial bearing is some function of the angular speed, it will be seen that such is the case, since, if the speed is zero, the carrying capacity of the bearing is the rupture load of the balls; this load is far greater than the rated capacity of the bearing. For ball bearings made of high-grade material and accurately machined, *K* has the following approximate values for steady loads and uniform speeds.

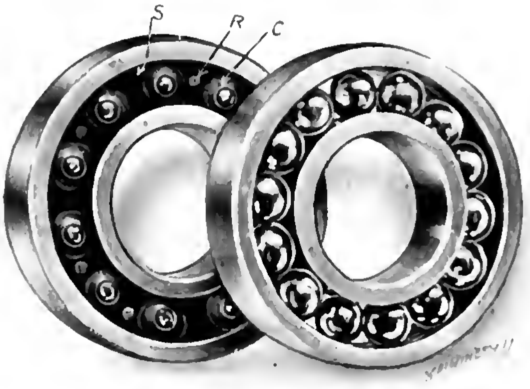

Fig. 12. Radial Bearings with and without Retainer

Revolutions per Minute.	Values of K.
10	20
150	18
300	15
500	10
1000	7.5
1500	5

From these figures, it will be seen that a given bearing will carry only one-fourth the load at 1500 R. P. M. that it will at 10 R. P. M. Since manufacturers employ the same material for all their bearings, and make the ball races of approximately the same form, it would be a simple matter to calculate the carrying capacities after adopting a value of *K* for a definite speed of rotation. There are some manufacturers, however, who assume high values of *K* in order to rate their carrying capacities high. There is no particular harm in this, provided the loads are not excessive. These

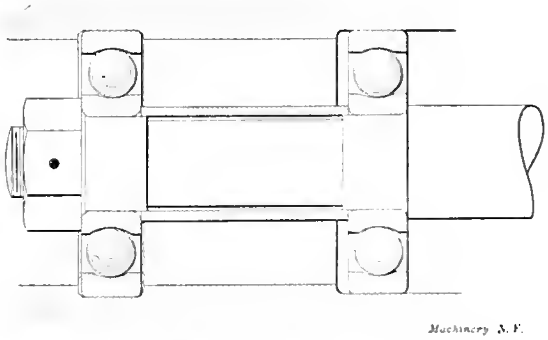

Fig. 13. Radial Bearings Arranged to take Axial Thrust

values of K even vary between the full and silent type of the same size bearings. It may be remarked, however, that the values of K may be the same for all the bearings, and that the capacities are calculated for different angular speeds, but no reason can be seen for such practice. For example, there is no reason why a manufacturer should rate the carrying capacity of his full type bearing, at say, 10 R. P. M., and the silent type of the same size at 300 R. P. M.

To determine the value of K used in rating the capacities, equation (1) is written in the form

$$K = \frac{P}{0.44\,d^2 z} \qquad (2)$$

where P is now given in pounds.

From equation (1), it is readily seen that the load per ball is lower in the full type than in the silent type. It may be argued from this that a full ball bearing will wear better that the other, but it is here necessary to remark that with the better grades of bearings, provided that the load is almost purely radial and within the limits set down in the catalogues, and the mountings made in accordance with the manufacturers' instructions, such a thing as wear is practically unknown, whether the bearing be of the full or silent type. But, as stated above, the load on the radial bearing is never free from end thrust; where this is excessive, the full bearing will give better service than the silent type, since end thrust is taken up by all the balls in the bearing, while a radial load is carried by between one and four balls, depending upon the type of bearing. Hence, everything else being equal, the full bearing is more satisfactory.

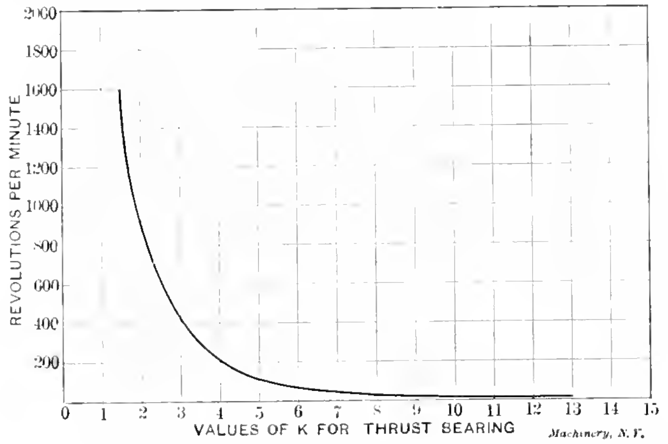

Fig. 14 Diagram showing how the Constant K, which is used in the Formula for Determining the Capacity of Thrust Bearings, varies with the Angular Speed

In regard to the third defect mentioned, it may be said that the employment of the discontinuous spacer, or one made up of several disconnected pieces, is very poor practice. Such a spacer has been used extensively by the D. W. F. Co., but is now being abandoned for a one-piece bronze separator. The discontinuous separator is also used by a well-known American manufacturer, but its use is incidental to the accomplishment of another end, which may be treated under the following head:

"Frictionless" Ball Bearings

Notwithstanding that the friction losses in a full ball bearing are very small, so small in fact as to be negligible, many attempts have been made to eliminate what little friction there is. One noteworthy example is that of the bearing just referred to. Here a series of alternately large and small balls is used, as shown in Fig. 5. This example is noteworthy only because it increases the friction which it is designed to eliminate, and introduces other serious disadvantages not found in the full bearing, or the silent type bearing, having a one-piece separator. Referring to Fig. 6, it will be seen that if the inner race rotates in the direction indicated, the balls will rotate as shown by the small arrows, and in the same relative direction as the outer race. There is in this case practically no sliding, except at the point of contact of every two adjacent balls where, it is seen, the ball surfaces are moving in opposite directions. At first glance, we may be led to infer that, since the balls are in contact and rubbing against each other, there must be an appreciable friction loss and consequent wear and tear. This inference is without foundation, since the balls do not contact under pressure, except in the case of those balls which are not carrying the load; then the pressure is the weight of the ball; this is negligible in comparison with the normal load on the bearing. Referring to Fig. 7, we see that if no load is placed on the inner ring, the balls will come together if the weight of the inner ring is less than that of the balls; but the moment we apply a load to the inner ring, which is in excess of the weight of the balls, there is no pressure between the balls; if there were, they would be together. While it may seem to some that this matter is dilated on to an undue extent, the discussion is nevertheless warranted; this is done in order to correct an impression which seems to be general with those unfamiliar with ball bearing phenomena.

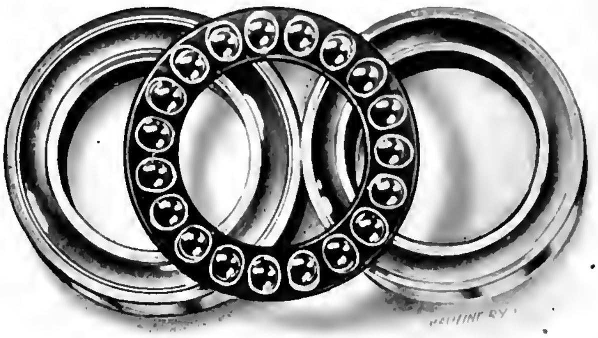

Fig. 15. Upper and Lower Races for Thrust Bearing, and Balls with Retainer having Elliptical Holes

To overcome this imaginary ball friction, this bearing is provided alternately with large and small balls. Referring to Fig. 5, it will be seen that since the small balls are not in contact with the inner race, they are not constrained to rotate in the same direction as the large balls; the small balls, in fact, rotate in the opposite direction, and hence, between every two adjacent balls, there is practically pure rolling; that is, the negligible friction between the balls is eliminated—but at a serious sacrifice. First, since only the large balls are in contact with the inner and outer races, only these balls are useful in carrying the load. As stated in the foregoing, the carrying capacity (in pounds) of a radial bearing is $.44\ K\ d^2\ z$, so that a bearing of this type will carry a load of $.44\,K\,d^2 \times 6$, since 6 is the maximum number of balls that can be inserted in the bearing. A similar bearing when completely filled, will hold about 9 of the large balls; hence, we see that the bearing completely filled with large balls will carry three pounds to every two of the bearing having alternately large and small balls. Second, to sustain the small balls, it is essential that some form of separator be used. The separator used by the manufacturer of this bearing has the form shown in Fig. 8. It will be seen here that the ends of the separator contact with the balls, and that although the friction in this case is admittedly very small, it is considerably greater than in a similar full type ball bearing; the friction is further increased, owing to the fact that the makers of this bearing state that their bearings do not require oil. In addition, if one of the large balls should break, the bearing falls apart. This defect is a very serious one, and is common to all the bearings employing discontinuous separators.

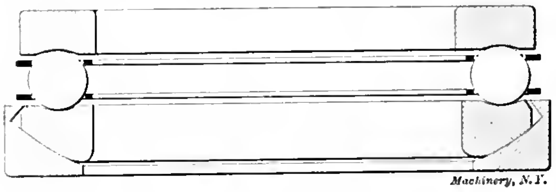

Fig. 16. Section through Thrust Bearing, the Lower Race of which is in Two Parts

As pointed out above, all other things being equal, the carrying capacities of two bearings are directly proportional to the number of balls; hence, it is evident that under all

conditions of service a bearing that is completely filled with balls is to be preferred to one that is only partly filled, provided that the side filling slot can be done away with. Owing to the apparent impossibility of introducing a sufficient number of balls to completely fill the race, most manufacturers have made use of the filling slot, while a few have taken the alternative step of avoiding the filling slot by employing fewer balls. The extent to which some manufacturers may go in order to gain the advantage of a large number of balls, as well as to avoid the discontinuous separator is shown in Fig. 9. This bearing, made by the Auto-Machinery Co. ("A. M.") of Coventry, England, has eight filling slots. The main object in doing this, however, will be best seen from the following abstract of an article in *The Automotor Journal*, January 25, 1908, describing this bearing.

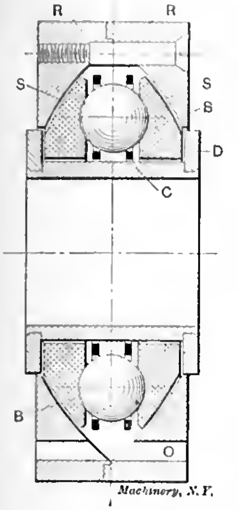

Fig. 17. Bearing Designed for Axial Thrust in Either Direction

"One of the principal difficulties in connection with the use of a cage, is its interference with the process of assembling the component parts. If the balls are inserted separately, they present no great difficulty, but when surrounded by a cage, special provisions are necessary. Some firms have for this reason divided the cages of their bearings, so that they can be fitted in place afterwards, but the Auto-Machinery Co. dislike the use of a divided cage, and have thus evolved a method of inserting the balls and their cage *en bloc*." After the outer ball race is circumferentially grooved, "it has a series of slots cut across its inner surface. These slots, however, are cut on one side only, and do not reach quite to the center of the groove; moreover, they are not provided round the entire circumference. This object is to facilitate the insertion of the balls *en bloc* with their cage * * *."

It is an unfortunate circumstance that the manufacturers of this bearing dislike the divided cage. It may be remarked that the advantage of inserting the balls and their one-piece separator as a complete unit, cannot be readily seen. If there is an advantage, it has been gained, in this case, by a great sacrifice.

We shall now describe the R. B. F. radial bearing made by the Société Française des Roulements à Billes. This bearing is unique in that it has none of the defects discussed above. There are no filling slots either in the full or silent type. The full type contains as many balls as it is possible to get into the races. The silent type has a continuous separator. In the assembling of the R. B. F. radial bearing, two similar steel cups are used of the form shown in Fig. 10. After placing the inner race *A* of the bearing over the central core *C* of one of the cups, the balls are laid around the groove *B*, and the inner race and balls are then covered by the second cup. The outer ring is now heated in a bath of oil, and placed over the assembled ball and cup unit as shown in Fig. 11. This complete unit is now placed in a press and the balls forced into position. After the outer ring has cooled down to normal temperature, it is impossible to detect the slightest axial play. This method of assembling a full ball bearing is an excellent check on the quality of the bearing, since, if the balls are improperly heat treated, they are either deformed or broken, as the case may be, when pressure is applied to force them into the outer race, and are, therefore, rejected. The spacer or separator used by the R. B. F. Co. consists, as will be seen from Fig. 12, of two steel stampings *S*, each having a number of saucer-shaped cavities *C* which serve to engage the balls and keep them apart. The two halves of the spacer are kept apart by a number of distance pieces, and are fastened together by means of rivets *R*. Sufficient room is allowed between the cavities and the balls to provide for a liberal film of grease or oil, so that there is never metal to metal contact under normal running conditions.

Radial Bearings as Thrust Carriers

While ball bearing manufacturers, as a rule, are desirous of limiting the use of radial bearings to their normal function, it has nevertheless become the practice among bearing users to employ the radial bearing to take axial thrust in addition to the normal radial load. To meet this demand, the bearing manufacturer has been obliged to stretch a point and suggest means whereby the radial bearing can also be used as a thrust bearing. To this end, it is considered good practice where two bearings are mounted on the same shaft, to make the inner ring of both bearings a light driving fit on the shaft. The outer ring of one bearing is then made a sliding fit in its seat and clamped up far enough to allow it from 0.5 millimeter (0.0196 inch) to 1 millimeter (0.0393 inch) axial play; the outer ring of the other bearing is also made a sliding fit, but is allowed considerable axial play. The first bearing takes the radial load, and end thrust, and the second bearing, a purely radial load only. This arrangement, shown diagrammatically in Fig. 13, is a preventive against wedging of the bearings, and is an assurance of long life. It is not uncommon, however, to find ball bearing users who are bent on carrying out their own ideas in regard to mountings. It is from these that most complaints come.

It may be said here that although the arrangement just described is considered good practice, it is decidedly poor practice to use a radial bearing to take the end thrust of a shaft having a low speed of rotation. This applies, particularly, where the end thrusts are excessive, as in automobile front wheels. This is the real cause of the complaints heard on every hand as to the unsuitability of two-point bearings in automobile front wheels, and has led many to adopt some form of inclined roller or cup-and-cone bearing, both of which are far inferior to the two-point bearing. The remedy in these cases is very simple. The trouble can be effectively eliminated by making the outer rings of the two bearings a sliding fit and allowing them considerable axial play, so that they cannot possibly take end thrust. This thrust is then taken on a thrust bearing or collar placed somewhere on the shaft, usually between the other two. If the speeds of rotation are very high, say above 1,000, there is no particular harm in taking thrust on a radial bearing, since at high speeds, radial bearings are better thrust carriers than thrust bearings.

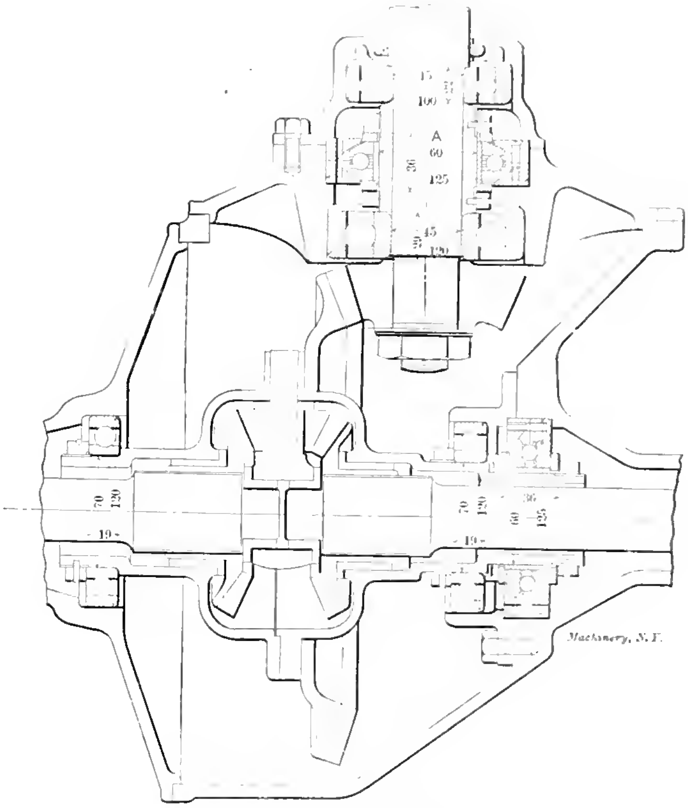

Fig. 18. Automobile Rear Axle and Differential Gearing equipped with the Double Thrust Bearing

Thrust Bearings

For the determination of the permissible load of a thrust bearing, a relation analogous to equation (1) is used. The load P in kilograms is

$$P = K\,d^2\,z \tag{3}$$

This is for steady loads and uniform speeds. This equation is the same as (1), except that the factor 5 drops out, since it is here assumed that all the balls are effective in carrying the load. The curve Fig. 14 shows how K varies with the angular speed. The values of K for speeds usually given in catalogues are shown in the following table:

Revolutions per Minute.	Values of K.
10	12.5
150	4.5
300	3.5
500	3
1000	2
1500	1.5

For parts that execute very little motion, such as crane hooks, K may be taken as high as 18 to 20. For very high speeds above 1500, the ordinary thrust bearing is practically useless for taking end thrusts. Centrifugal force, at these speeds, plays a very important part. The balls are driven toward the outer edge of the race, and against the walls of the ball retainer. To avoid this condition, use is made of a retainer with elliptical holes as shown in Fig. 15. This retainer also permits the shaft to deflect without pinching. It is used in America by the Société Française des Roulements à Billes, and the Hess-Bright Manufacturing Co., who are the only American licensees under the patent. The manner in which the permissible load varies with the speed is seen from the following table constructed for a particular bearing.

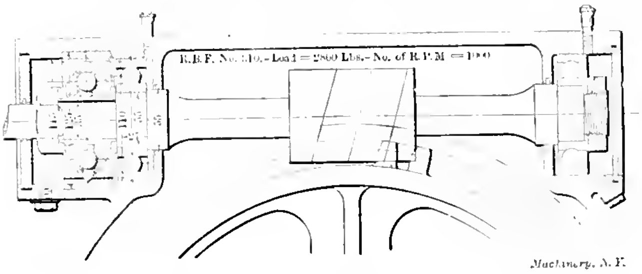

Fig. 19. Double Thrust Bearing applied to a Worm Shaft

Revolutions per Minute.	Load in Pounds.
10	11,000
150	3,740
300	2,640
500	2,420
1000	1,760
1500	1,540

Every shaft, no matter how short, is deflected under load; this deflection, although too small to be seen in many cases, can at least be calculated. In order to take the end thrust of such a shaft, it is customary to provide a thrust bearing having the lower surface of the bottom race of spherical form. The seat for this bearing is machined to the same form. This permits the shaft to deflect and the bearing to move as a complete unit with the shaft. It assures that the plane of the bearing will always be perpendicular to the axis of the shaft, and that the load will be uniformly distributed among all the balls. The use of such a bearing has two disadvantages: first, in the machining of the seat, a special fixture is required to allow the cutting tool to swing over the required radius of curvature of the seat; second, the material of which the races are made is hardened, while the seat for the bearing is machined out of ordinary unhardened material, so that appreciable wear will take place in a comparatively short time. There need be no objection to this bearing, however, if the speeds of rotation are very low, or the loads are very light. To overcome these disadvantages, the Société Française des Roulements à Billes, supplies a thrust bearing having the lower race made of two parts, one floating within the other as shown in Fig. 16. These two parts are made of the same material and heat treated in the same way, so that there is practically no wear even when the speeds of rotation are high and the loads great. All that is necessary to use the bearing, is to machine an ordinary flat seat; no special tools or fixtures are required.

In order to assemble the two parts of the lower race, the bottom portion is heated in oil, and the upper portion forced into position under pressure. The advantage of this arrangement is, that the lower race, although made up of two parts, can be handled as a complete unit. An exterior view of this race is shown in Fig. 15.

It is often desired to take end thrust on a shaft in both directions, as for example, where bevel or worm gearing is used, or on a marine propeller shaft. To do this, it is usual to employ two distinct thrust bearings. Such an arrangement has the disadvantages spoken of above in connection with the single thrust bearing. To permit of end thrust being taken in both directions, the Société Française des Roulements à Billes, manufactures the bearing of which a section is shown in Fig. 17. The bearing consists of two outer rings R, held together by screws, and provided with a number of oil holes O. The inner surfaces of these rings are machined to a spherical form to accommodate the outer surfaces S of the rings B. The rings D are forced on the collar C after expansion by heat in the manner described in connection with the other products of the R. B. F. Co. Every working part of the bearing is enclosed and it is entirely self-contained. One application of this bearing is shown in Fig. 18 in connection with an automobile rear axle and differential, and Fig. 19 shows an application to a worm and wheel.

* * *

THE MACHINING OF MANGANESE STEEL

In an article in the *Railway and Engineering Review*, Mr. James B. Strong refers to some interesting particulars regarding the machining of manganese steel. This steel, whether cast or rolled, is not an extremely hard metal, as most people suppose. It is not as hard as chilled cast iron, and only about 20 per cent harder than high-carbon Bessemer steel; but manganese steel, properly treated, is extremely tough. The particles hang together most tenaciously, and when subjected to severe strains, the metal flows and can endure repeated distortions without surface fractures or cracks. There is practically no loss from the surface of manganese steel in small pieces when subjected to abrasive wear of any nature, except where there is a constant renewal of sharp cutting edges, such as with emery and other grinding wheels. The idea that manganese steel will cut or grind chilled iron or steel-tired wheels is not correct, as a cutting edge of manganese steel will not stand up at all against harder metals.

It is interesting to observe the cutting action on manganese steel of drills or planer tools made of high-grade tool steel which is much harder than manganese steel. The tool takes hold on cast or rolled manganese steel, at first, and cuts, but the chips will not come off as with ordinary steel. They drag, and the tool soon slips, heats up and the cutting edge fuses or crumbles. Cast or rolled manganese steel can be cut slowly, however, by specially shaped and hardened tools in a powerful and heavy machine free from vibration; but even then the cutting edge is very short-lived and must be renewed constantly.

* * *

The strength and elasticity of copper depends to a large degree on its heat treatment. Some experiments to ascertain to what extent the heating and subsequent cooling of copper influences its strength were recently undertaken, the results of which are given in *Engineering*. Ordinary commercial copper wire would stand 44 bendings before breaking. The same wire when heated to bright red heat and suddenly cooled in water would stand 73 bendings, while if it was slowly cooled in the air, after the heating, it would break at 49 bendings. When heated to a dark red heat and cooled in the air it would break at 41 bendings, but, if cooled in water first, at 46 bendings. This seems to indicate that if copper is heated to a red heat it should be suddenly cooled in water rather than by permitting it to cool in the air, if the strength is not to be reduced.

DATA ON HIGH-SPEED DRILLING

GEO. E. HALLENBECK*

The accompanying diagrams show the results of some tests made with high-speed drills on the Baker Brothers high-speed drilling machine. They represent a part of the experiments which have been made at the works of the above company with a view of securing the most efficient design of machine for driving medium size drills, that is to say, drills from ¾ to 2 inches in diameter.

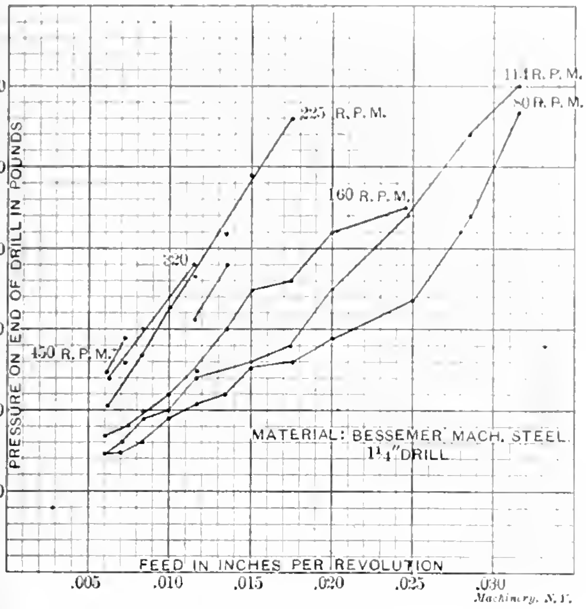

Fig. 1. Diagram showing Relation between End Pressure and Feed in High-speed Drilling

Some of the drilling which has been done on these machines is little short of marvelous. Thus 1¼-inch holes have been drilled through 4¼-inch blocks of cast iron at the rate of 8 2/3 seconds per hole, or a vertical feed of 29 inches per minute. (See MACHINERY, June, 1908.) Several holes were drilled at this speed without necessitating the regrinding of the drill. Some 15/16-inch holes were drilled through a ¾-inch machine steel plate at the rate of 3½ seconds each; a great many similar tests have been made. When we stop to consider that the average punch press when punching a 15/16-inch hole in ¾-inch material will make about 20 to 30 strokes a minute, or, in other words, it will take two or three seconds to punch the 15/16-inch hole which was drilled in 3½ seconds, the really remarkable performance stands out more clearly, especially so when it is understood that a number of holes were drilled at this rate without resharpening the drill. The holes were drilled without lubricant of any kind.

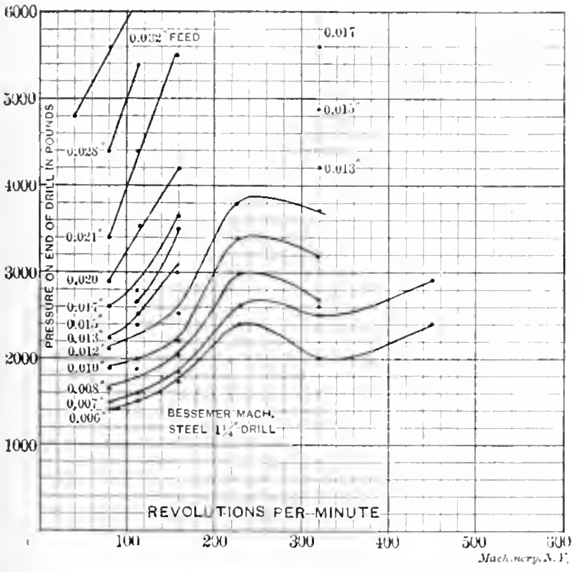

Fig. 2. Diagram showing Relation between End Pressure and Cutting Speeds

Among other things it was desirable to know just what the vertical thrust on the spindle was in order to properly design the thrust bearing and feeding mechanism, experience having demonstrated that the load on the feeding mechanism was far greater than it was ordinarily thought to be.

Fig. 1 shows very clearly the result of some of these tests made with a 1¼-inch drill. The variation of the pressure on the end of the drill is shown in relation to a gradually increasing rate of feed. Several tests are shown at speeds varying from 80 R. P. M. to 450 R. P. M. It will be appreciated that the conditions of these tests are such that nothing more than general conclusions can be drawn from the curves. In the curves shown in Fig. 1, it will be noted that, as a general proposition, the effect of increasing the feed is to increase the pressure of the drill point in a straight line ratio, although the tests made at 80 R. P. M. would indicate that there was a tendency toward an increasing pressure as the feed was increased. So far as it was possible to observe, there was no great variation in the vertical thrust with the increasing depth of hole after the first ¼ inch had been drilled.

Fig. 2 shows the same series of tests as shown in Fig. 1, but here the feed is held constant and the speed made a variable. These curves, together with those shown in Fig. 5, are perhaps the most interesting of the series from the fact that they show a peculiar decrease in pressure by increasing the speed with the feed constant. All the tests show practically the same results in regard to this decrease. It will be seen by referring to Fig. 2 that while it was impossible to drill in the material drilled with a feed of 0.013 inch at 225 R. P. M., it was easily drilled at that and even at 0.015 and 0.017 inch feed per revolution at 320 R. P. M.

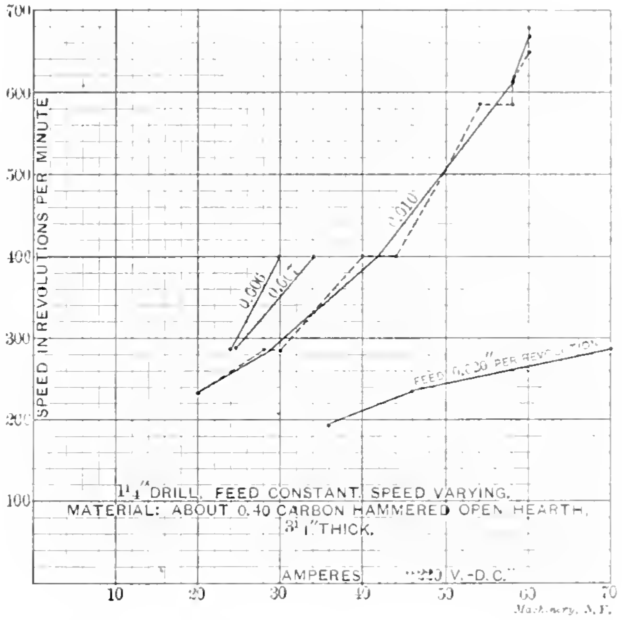

Fig. 3. Diagram showing Power Required for Drilling at Different Speeds

Fig. 3 shows the horse-power consumed and its variation with the variation in speed. It will be noted that at the fine feeds, *i. e.*, feeds of under 0.010 inch per revolution, the amount of power increases in a decreasing ratio as the speed increases, whereas with a feed of 0.020 inch per revolution, just the opposite seems to be true. The ampere readings shown on the diagram represent the total electrical input into the motor, no deductions having been made for either the losses in the motor or in the machine itself, as the data desired is the amount of power which will have to be delivered to the machine.

Fig. 4 shows the variation in power required under a constant speed with varying feed, the increase in power consumption being apparently a constant ratio.

Fig. 5 shows the remarkable increase in production which can be secured by increasing the speed. The curves are plotted showing the maximum feed at which the stock was successfully drilled without destroying the drill. With the next higher feed the drill would be destroyed. In order to

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* Superintendent, Baker Brothers, Toledo, Ohio.

secure as nearly uniform conditions as possible, all of one series of tests were run with the same drill, it being resharpened when necessary. The curve No. 2 shows quite conclusively that the drill would give a greater production without failing at 200 R. P. M. than it would at 250 R. P. M., and also that it would give a much greater production if the speed were still further increased to 440 R. P. M. This may be an index to the solution of the much mooted question of whether a slow speed and heavy feed or a high speed and fine feed is preferable. It would seem that the adherents of each of the above sides of the question would get into trouble as they began to gradually increase or decrease their speed and so would quickly come to the conclusion that they could gain nothing by going in that direction.

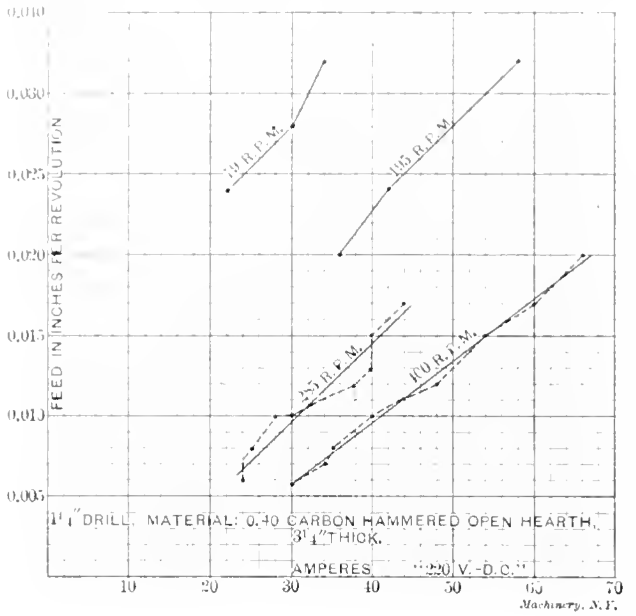

Fig. 4. Diagram showing Power Required for Drilling when Feed Varies

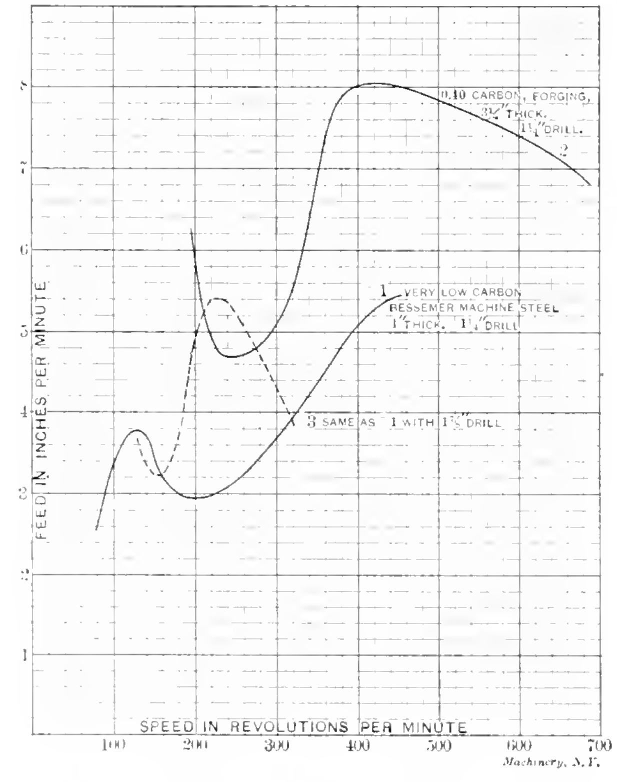

Fig. 5. Diagram indicating Productive Capacity of Drills at Various Speeds

These tests on drilling, although representing many hundreds of drilled holes, are by no means given as conclusive, they having been altogether too few in number to establish permanently the conclusions to which a study of the diagrams would naturally lead; yet they seem to point quite strongly to the conclusion that the best results will be obtained at comparatively high speeds and moderate feeds, as it is possible to carry a heavier feed at a high speed than at the medium speed. It was this fact, often recurring in the writer's tests, that led to making the series of tests the results of which are shown in Fig. 5, for the purpose of demonstrating whether such was actually the case, or whether the apparent increase was due to other causes. In conclusion the writer would add that the majority of the drilling shown on the accompanying diagrams was done with a 1¼-inch drill, and the number of times required to sharpen it were very few.

The Baker Brothers' high-speed drilling machine on which these tests were made is shown in Fig. 6. It is driven by a 4 to 1 variable speed motor, and has a speed range from 70 to 700 R. P. M. By providing suitable gearing a wide range of feeds between 0.006 and 0.032 inch per revolution is secured on this machine. The machine on which these tests were made was provided with roller bearings; outside of this feature it was the regular high-speed drill as now built by Baker Brothers.

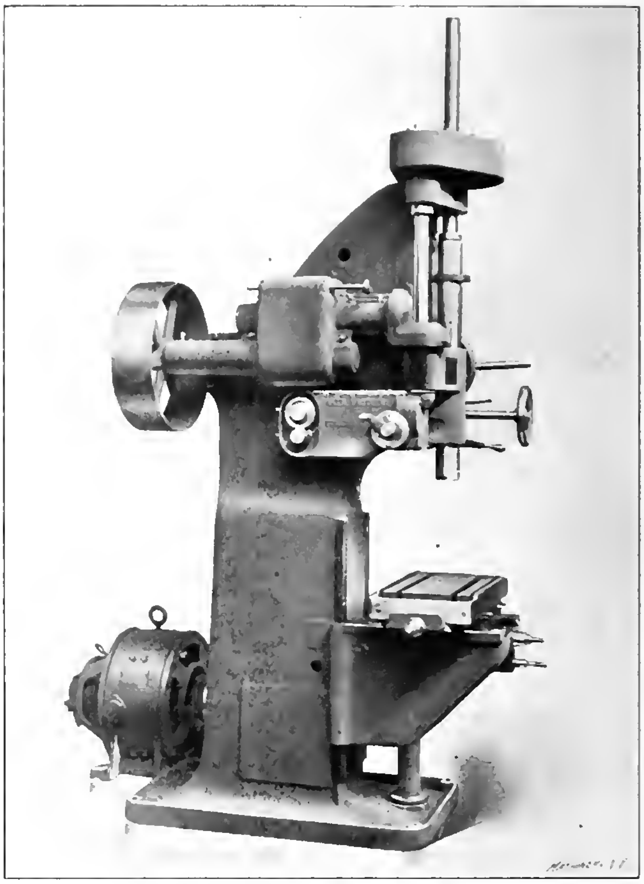

Fig. 6. Baker Brothers High-speed Drilling Machine on which Tests were made

* * *

The five- or ten-cent cotton mitts which are so largely bought by workingmen may be waterproofed by dipping them in melted paraffine; or if a thinner coat is preferred, and only on the palm of the mitts, melted paraffine may be brushed over their surface. For handling damp bricks, for working with plaster, or cement, paraffined mitts are far superior to the original. Leather gloves may be waterproofed in the same way. The coating of paraffine may be removed as often as the surface needs it.

* * *

It is stated by the London *Times* that the British Government has, under the new Patents Act, revoked a patent covering an American invention for the production of a lock-stitch sewing machine "capable of operating at a very high speed with smoothness, ease, and but little noise, upon either thick or thin work." The machines covered by the patent have been wholly manufactured in the United States, and since the new patents act came into force, no steps have been taken to work the patent in Great Britain, and it has therefore been revoked. The patentee must also pay the applicants for the revocation their expenses, amounting in this case to $200.

MACHINE SHOP PRACTICE*

CYLINDRICAL GRINDING—2

In the first installment of this article in the April issue, some information bearing on wheel selection and preparation of work was given; while these subjects are very important, they do not constitute all that is to be considered, if a grinder is to attain its maximum of efficiency. A wheel which is adapted perfectly to a certain grade of steel, for example, will not work satisfactorily if the relative surface speeds of the wheel and work are not approximately correct, as the work speed affects the wear of the wheel which, when excessive, also affects the finish of the surface being ground. The amount of stock that the wheel removes for a given amount of wear, may be increased or diminished by varying the work speed, the wheel wear being excessive when the speed is too high. This close relation between the work speed and the wheel wear makes it possible to use a wheel which is somewhat harder than it should be for a given piece of work, with fairly good results, by increasing the work speed with the result that the grit is dislodged more easily, and consequently does not remain long enough to cause glazing, which would otherwise take place; this practice, however, is not to be recommended. As there are a number of factors, such as kind of material, finish desired, etc., which determine the proper work speed, it is impractical to say just what this should be. A speed of twenty-five feet per minute might be correct for grinding a certain piece of steel, and not correct for another steel piece having a different carbon content. The finish of a ground surface, as stated, is affected by the work speed, and it is possible to grind a very rough or smooth surface by simply varying the speed, depth of cut, and side feed of wheel, the surface becoming smoother as these are diminished. For this reason the speed and feeds (when within, say, 0.002 inch of the finish size) are often reduced before taking the finishing cuts. The best method of ascertaining the proper speed for a given piece of work, and incidentally for determining the wheel best adapted to it, is by experimenting until the desired results are obtained. This does not necessarily mean, however, that whenever a new piece of work is to be ground, considerable time must be wasted, as the speed adjustments are easily made, and besides, experience will soon teach just what the proper combinations are. As the wheel is diminished in size, it appears to get softer, even though the peripheral or surface speed is maintained. This wear is due to the fact that the grit of a small wheel is in contact with the work oftener owing to the increased number of revolutions necessary for the same surface speed.

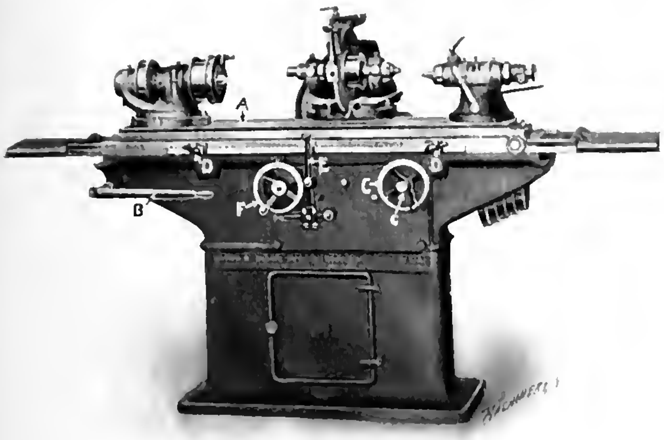

Fig. 1. A Universal Grinder built by the Brown & Sharpe Mfg. Co.

It should always be remembered that the one thing to be sought after is maximum production. If when choosing a wheel, for example, one too hard for the work is obtained with the idea of reducing the wheel wear, the corresponding reduction in the output will much more than off-set the increased expense for softer and more rapidly wearing wheels. The wheel wear, however, should be considered, and as it is dependent upon the work speed, the vibration of work, and depth of cut, these should receive the careful attention of the operator. When certain combinations of speed, feed, etc., have been found correct for a certain kind and size of material, it is advisable to record this information for future reference, for while such data may not always be applicable, owing to a difference in the grade of the material, it will, in many instances, enable one to save considerable time. A speed indicator or revolution counter is a useful tool for determining the proper speeds, especially when used in conjunction with a table giving the number of revolutions and the corresponding peripheral speeds for different diameters. The side feed of the wheel (or of the work) per revolution of the work, and the depth of cut, depend largely upon the construction of the machine. Grinders of the old type were intended for high work speeds with slow side feeds; with the modern machine, the work speed is low, but surfaces are ground rapidly by using wider wheels having side feeds of ¾ to ⅞ of their width for each revolution of the work, except for finishing cuts when reductions in side feed are usually made.

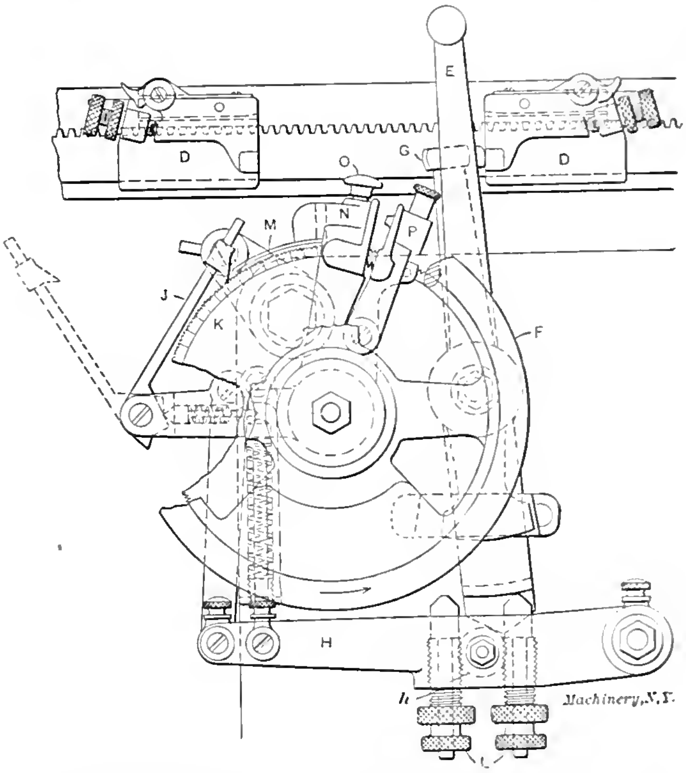

Fig. 2. The Mechanism which feeds the Grinding Wheel at Each Reversal and automatically disengages the Feed when a Predetermined Amount has been ground

Those who read the description of the Landis grinder in the April issue will remember that the grinding wheel of that machine is traversed back and forth past the work, which remains stationary as far as axial movement is concerned. With the machine shown in the accompanying engraving, which is made by the Brown & Sharpe Mfg. Co., this order is reversed, the work and the table *A* moving longitudinally while the revolving wheel remains in a fixed position. This machine is also of the universal type, which, as before stated, is adapted to a wide range of work. The traverse of the table and the rotation of the work spindle may be started and stopped (on the latest design) by the lever *B* to the left. The wheel *C* to the right is used for moving the table back and forth by hand; when so used, the knob *c* is pushed inward. This knob is pulled out when the table is to be moved automatically, and pushed in when such movement is to be stopped. The dogs *D* regulate the stroke of the table, the movement of which may be reversed at any point by the lever *E*. By rotating the wheel *F* in different directions, the grinding wheel is moved to or from the work. The mechanism seen just back of this wheel is that of the automatic cross-feed. The way in which this feed operates will be more clearly understood by referring to the detail Fig. 2. At the

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* With Shop Operation Sheet Supplement.

same time that the dogs *D* strike the lever *E*, thus reversing the table movement, the lever *G* is also actuated, which, through the roll *h*, operates the lever *H* and the pawl *J*. If this pawl is in mesh with the ratchet wheel *K*, the grinding wheel will be fed forward an amount depending upon the position of the screws *L*, which come against a surface on the lever *G*, thus regulating the upward movement of lever *H* and, consequently, the movement of the pawl at the end of each stroke. This automatic feed will continue at each reversal, until the shield *M* (which is attached to the head *N*) intercepts the pawl *J*, and prevents it from engaging with the ratchet wheel *K*. Thus by changing the position of the head *N*, the machine is set to grind any predetermined amount.

For example, we will assume that the automatic feed is to be set to grind the body *b* of the hardened bearing, illustrated in the Shop Operation Sheet accompanying this issue, to exactly four inches. After the machine is started and the stroke properly adjusted, place the pawl *J* in the position indicated by the dotted lines, and then move the wheel *F* in the direction indicated by the arrow, until the wheel is almost in contact with the work. Stop the stroke of the table by pushing in the knob *c* (Fig. 1), and set the pawl in the position shown by the full lines. Raise the latch *O* and move the head *N* around the periphery of the ratchet wheel until the point of the shield *M* has just passed the tooth occupied by the pawl, which will then rest upon the shield. Now when the table stroke is started, press the thumb-latch *P* until the grinding wheel begins to cut. Stop the stroke so that the wheel will be at the foot-stock end, and measure with a micrometer the diameter of the part ground; then press the latch *P* once for each one-quarter of a thousandth to be removed. If, for example, the body *b* measured 4.003 inches, or 0.003 inch over-size, the latch would be pressed twelve times, thus moving the shield *M* far enough away from the pawl to allow the latter to continue feeding until 0.003 inch is removed. The wheel should be stopped at the foot-stock end, as before, when the density of the sparks is about the same as on the cut taken prior to the first measurement. When the work is to be removed, throw out the pawl *J*, and, without changing the position of the shield, turn the wheel *F* to the right about one revolution. When a new blank is in position, the wheel *F* is turned to the left until the grinding wheel begins to cut, when the pawl *J* is again placed in mesh with the ratchet wheel. If, when the feed is automatically disengaged, the work is oversize, due to wheel wear, the latch *P* is pressed once for each quarter of a thousandth reduction required. It will be seen that with the automatic feed the wheel is fed inward, in unvarying amounts at each reversal. This regularity of feed has a decided advantage in that it increases the "sizing power" or the uniformity of the wear of the wheel, which is essential to the rapid production of duplicate parts.

All work that is ground on centers should be supported by suitable rests or steadies, as their use will permit greater feeds and also increase the sizing power of the wheel. If a piece be long and slender, such support is indispensable, and even for work which is short and rigid, rests are desirable to absorb the vibration which increases wheel wear and affects the quality of the work. These rests or supports are fastened to the table of the machine and are equipped with shoes of wood or soft metal, which bear against the piece being ground. The number and position of the rests depend on the form and diameter of the work; a distance between each rest of from 6 to 10 times this diameter will be found satisfactory for piston-rods, shafts and similar parts.

At the point where the wheel is in contact with the work there is considerable heat generated, consequently it has been found necessary, in most cases, to flood the grinding point with a copious supply of water. The pipe for this purpose is seen attached to the wheel-guard in the accompanying illustration. Such a cooling medium is very essential when grinding work revolving upon centers to prevent the radiation of the heat generated at the point of contact, for without an equable temperature is maintained, the part being ground will bend towards the wheel, owing to the elongation on that side; in other words, its axis will be continually changing, and, obviously, inaccuracy will be the result. This effect is even more pronounced when tubes are ground without water, or with an inadequate or intermittent supply, as there is less mass to absorb the heat.

* * *

PRACTICAL TEMPERS FOR TOOLS

J. R. S.

This list of tempers was determined by practical shop tests of the tools mentioned. A record was kept of the number of pieces machined before the tool required sharpening or renewal, and the most satisfactory temper adopted. A thermometer was used to determine degrees of heat, and mutton tallow for the bath.

Degrees F.	Class of Tool.
495 to 500	Taps ½ inch or over, for use on automatic screw machines.
490 to 495	Taps ½ inch or over, for use on screw machines where they pass through the work.
495 to 500	Nut taps ½ inch and under.
515 to 520	Taps ¼ inch and under, for use on automatic screw machines.
525 to 530	Thread dies to cut thread close to shoulder.
500 to 510	Thread dies for general work.
495	Thread dies for tool steel or steel tube.
440 to 445	Circular thread chaser for use on lathes.
525 to 540	Dies for bolt threader threading to shoulder.
460 to 470	Thread rolling dies.
430 to 435	Hollow mills (solid type) for roughing on automatic screw machine work.
450 to 455	Hollow mills (solid type) for use on the drill press.
485	Knurls.
450	Twist drills for hard service.
450	Centering tools for automatic screw machine.
430	Forming tools for automatic screw machine.
430 to 435	Cut-off tools for automatic screw machine.
440 to 450	Profile cutters for milling machine.
430	Formed milling cutters.
435 to 440	Milling cutters.
430 to 440	Reamers.
460	Counterbores and countersinks.
440 to 450	Fly-cutters for use on the drill press.
480	Cutters for tube or pipe-cutting machine.
430 to 440	Dies for heading bicycle spokes.
430	Punches for heading bicycle spokes.
430	Backer blocks for spoke drawing dies.
400	Drawing dies for bicycle spokes.
460 and 520	Snaps for Pneumatic hammers—Harden full length, temper to 460 degrees, then bring point to 520 degrees.

* * *

IDENTIFYING SMITHS

Statistics show that 1.1 per cent of electrical engineers are named Smith. That is, out of every 100 there will be a little more than one Smith. In the office force of a large corporation it often happens that there are so many Smiths holding positions of responsibility that some special means must be taken to identify them. The Crocker-Wheeler Company, manufacturers and electrical engineers, recently had considerable trouble at their main office, at Ampere, N. J., owing to the impossibility of getting their delivery boys to distinguish between the many Smiths there employed. Almost invariably one Smith would receive papers intended for another. This difficulty has been satisfactorily solved by posting on its various bulletin boards the following:

IDENTIFICATION TABLE OF SMITHS AT AMPERE

Initials.	Dept.	Complexion.	Stature.	Characteristics.
J.M.S.	Engineering	Dark	Short	Snappy but smiling
V.T.S.	Engineering	Dark	Long	Handsome and melancholy
L.P.S.	Drafting	Light	Tall and stout	Chubby and angelic
R.W.H.S.	Drafting	Light	Short	Unshaved and grumpy
F.W.S.	Laboratory	Dark	Short and slender	Very nervous
D.S.S.	Sales	Sparse, mixed	Thin	Wide-eyed and serious

(N. B. Shop Smiths will hereafter be numbered.)

* * *

Another feat in wireless telegraphy worth noting is that of the Japanese steamer *Aki Maru*, which, during a recent voyage between Japan and the United States, was in constant communication with land during the whole distance of 4,240 miles. For over 2,100 miles the steamer kept up communication with the Marconi station at Yokohama, and for the remainder of the voyage she was in communication with Seattle.

CYLINDRICAL GRINDING*

It is probably true that there is more misunderstanding among engineers and workmen in regard to cylindrical grinding than in the case of any of the other mechanical arts. Nearly every operator has a different theory; and each maker of grinding machines has his own method of grinding. There is confusion of ideas which can be cleared up by pursuing the investigation to the end. Don't take anything for granted. When you shall come to consider the commercial side of cylindrical grinding, no doubt the first argument you meet will be this one, which is brought forward very often by those who have not pursued the subject to the end. The argument is that, "It cannot be possible that metal can be as economically removed by a grinding wheel with delicate, microscopic cutting points as with a massive steel tool. Metal ground into powder cannot be as economically removed as with a tool that cuts off great chips."

Relative Time Required for Finishing by Turning and Grinding

A shaft 6½ inches diameter, 10 feet long, rough turned, cheaply to within about 1/32 inch of the required finish size, can be finished straight, round and to size by turning with a tool that cuts off a chip removing the 1/32 inch from the diameter and leaving a good surface that requires some filing and polishing with emery cloth, and the time required to thus finish the shaft to a limit of 0.0005 plus or minus, is from seven to eight hours, according to the quality of the cutting tool and of the material in the shaft, and to the skill and ambition of the workman. To remove the 1/32 inch from the diameter and finish the shaft to a limit of 0.0005 inch plus or minus by the grinding method, with a modern grinding machine, requires from one to two hours according to the ambition of the operator, and the finish is superior to the other method. Here is a case where the cutting of the material to a powder with microscopic cutting points was more economical than was the steel tool cutting a chip large enough to be seen and handled.

To be sure, the cutting points of the grinding wheel are small, but in this case there are approximately 1,086,171 cutting points, that cut one thousand times per minute, making, approximately, 1,086,171,000 chips per minute. Although these chips are small, they are essentially the same as cuttings from a steel tool.

The statement that it requires enormous power to grind steel to a powder, while cutting it into larger chips does not, should have careful thought. In the case of the 10-foot bar we use an average of approximately eight horse-power from one and one-half to two hours when grinding the finish cut. When turning to finish, we use about two horse-power from seven to eight hours. In the case of the 10-foot bar we required a nice surface and accurate measurements to a thousandth or less, and in both the lathe and the grinding machine we removed 1/32 inch more or less from the diameter. The production of such a grade of work when removing 1/32 inch more or less, shows greatest economy by the grinding method. When, however, the surface can be very rough and the diameter may vary within much larger limits, a steel tool cutting deeply will remove the same amount of metal in shorter time. If the object is simply to remove a certain number of pounds of metal, turning it off with a steel tool is cheapest. But as we know, nearly all round work must have accurate, or approximately accurate diameter, and from approximately smooth, to very smooth surface. The great majority of round work must finally have a better surface and more accurate dimensions than can be obtained with a steel tool, when it is cutting at sufficient speed and depth to enable it to remove material faster than by grinding. Therefore, the limited amount of material that is removed by the finishing operation on accurate, and approximately accurate work, can be more economically removed by grinding than by turning.

Relative Cost of Grinding and Lathe Work

There are also cases when work not requiring a smooth surface may be more cheaply ground than turned. A case that illustrates this is that of bridge pins, which were from 12 inches to 8 feet long and from 3 inches to 18 inches diameter. These pins are roughly turned from the billet to within 1/32 or 1/16 inch of the required diameter, and then by another, or sizing cut, are completed. The limit of variation from size is 0.010 inch; if the turning tool is made to cut the right diameter at the starting end, the cutting edge of the tool must not wear off quite 0.005 inch when doing the work of removing the steel from the entire length of the pin. Now, in order to ensure that the tool shall not wear away enough to cause an error beyond these limits, it becomes necessary to revolve the work so slowly that the same results can be obtained more quickly by grinding, although the surface may be far from smooth. Grinding is accomplished by a number of rapid cuts, and during the final or light cuts, the grinding wheel does not wear at all, so that we are enabled to produce work of uniform diameter regardless of the length. We are now prepared to grind work up to 22 feet long to a limit of 0.0005 plus or minus.

While practically all round work is turned before grinding, there is a portion of such work that is most economically ground without turning. Owing to certain shapes, or structural weakness, it sometimes becomes difficult to turn; in such cases grinding is more economical than turning. An extreme case of this kind is that of a shaft, or bar of steel, 9/16 inch diameter and 10 feet long, with 1/16 inch to be removed from the diameter to produce an accurate ½-inch bar within a limit of 0.0005 inch plus or minus. It is easy to understand how difficult it would be to turn this bar. We, however, find it very easy to grind such a bar to the limits, and in short time. The roughing cuts that take the place of the turning easily remove the stock to within a few thousandths in about ten minutes, while hours would be consumed in turning such a bar to even coarse limits.

Advantage of Grinding Slender Work

Automobile crank-shafts are of such shape that certain portions of them are difficult to turn rapidly, and at the same time secure accuracy. Therefore we are enabled to grind the pins and short bearings direct from the drop forging in less time than we can turn them, and we secure better work. The long, frail crank-shafts for agricultural machines are also very difficult to turn rapidly, and at the same time secure good work. Many of these shafts are 7 feet long by 1¾ inch diameter of stock, with bearings and pins reduced to 1 5/16 inch diameter. We find it most economical to grind all short bearings and pins without turning, while we find it best to first turn the long part at one end, grinding it afterward.

In the case of slender work that springs badly when it is turned, we can, many times, grind the same work more quickly than it can be turned and ground; because, when grinding off the material, the spring is ground out as it occurs, owing to the many cuts, or passes, of the grinding wheel; while when it is turned, with one cut over, it must be straightened before the finishing cut is taken. It is true, however, that the majority of work should be turned before grinding. I have been quoted as saying that we "grind without turning." I never said so. I did say, as I have done here, that *sometimes* we grind without turning, but *usually we do not.*

Poole Form of Cylindrical Grinding Machine

The earlier attempts at cylindrical grinding were made by mounting grinding wheels on the carriages of engine lathes, and there are those to-day who innocently suppose that the engine lathe produces perfectly cylindrical work, and that they have simply to add a grinding wheel to get a smooth surface on an otherwise perfect cylinder. This was proved to be untrue some thirty years ago, and I trust you will not lose any of your valuable time attempting to secure perfect work with turning lathes. Mr. J. Morton Poole, of Wilmington, Delaware, discovered that it was impossible to secure perfect cylinders by grinding with wheels on engine lathes, and, as a result of his study of the problem, the J. Morton Poole grinding machine was invented in the year 1867.

Mr. Poole's invention was unique, in that it enabled him to grind rolls of perfectly uniform diameter from end to end, regardless of the imperfections of the traversing carriage

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* Abstract of address made by C. H. Norton, president of the Norton Grinding Co., Worcester, Mass., before the third-year class in mechanical engineering at Columbia University, April 16, 1907. For note on these lectures, see "Elements of Machine Manufacture," by Fred J. Miller, April, 1909.

ways. His invention came at a time when the art of scraping to master plates, and master straight-edges, was practically unknown, and when mechanics had little if any idea that such perfection could be obtained; much less maintained for any considerable time; also when few could appreciate the difference between the results he obtained and those obtained by the ordinary methods. The Poole machine, however, depends for success upon the use of *two* grinding wheels; one on either side of the work, and has, therefore, limited application. It has always been used for roll grinding. (See MACHINERY for January, 1897, and February, 1901.)

The modern grinding machine has ways that secure perfect work with a *single* wheel, thus giving the machine a wide field, covering all work that revolves on its axis, whether rolls, small or large, shafts, spindles, piston rods, work long or short, large or small, and having one single diameter, or many sizes on the same piece. The Poole machine gave accuracy. The modern machine, if rightly constructed, gives both accuracy and large production. Having but one wheel, and being open toward the operator, it is conveniently operated, and work is quickly placed or removed. I make this comparison not to depreciate the Poole machine, for I consider it one of the most important inventions in the development of the art. I wish, however, to have you realize that the development of the art of scraping, and straight-edge making, has made possible the use of very massive, long grinding ways that are really straight, and will remain straight for years. That such a thing was unknown when Mr. Poole made his very valuable and original invention to obtain perfect cylinders without perfect guiding ways.

The Lathe not a Perfect Finishing Machine

One of the most important facts in connection with cylindrical grinding for the young engineer to get clear in his mind is that all perfection in this world is relative, and that this is most certainly true of cylindrical grinding. This being true, to what in the mechanical world should he turn to fix the relation when deciding upon the quality of cylindrical grinding for the various uses it is intended? Why, most certainly to the lathe; because the grinding machine is no more and no less than a grinding lathe. Now, if its product is an improvement on the product of the ordinary lathe, then it has proved its right to the field. The lathe was never a polishing and buffing machine; neither was it a lapping machine. We used its centers and spindle on which to revolve work while we filed and polished, or lapped it; but there was nothing about the lathe that contributed in any way to the quality of the filing, lapping or polishing; that was a matter of hand work entirely. Therefore, when we wish to judge as to the merits of grinding, we must compare it with turning alone, not with turning, filing and lapping. Now, if we can, with the grinding machine, take the finishing cut of the lathe in less time than the lathe, and at the same time produce a better surface and nearer absolute cylindrical perfection, then are we warranted in adopting the grinding machine in place of the lathe for all finishing cuts, or sizing operations. If occasionally we require an absolutely perfect cylinder, we must lap it in addition; and the grinding machine, if well designed and constructed, is a perfect lapping machine also. We should not, however, expect perfect lapped work from any grinding wheel. We can, by taking time enough, produce a polished surface with a grinding wheel, but the same time, spent with a genuine lapping wheel, would produce more perfect work. Glossy surface by grinding wheels means imperfect cylinders. We can secure the closest approach to perfection by the use of grinding wheels that cut without perceptible pressure; thus they must be soft or free cutting, and, therefore, produce a surface without much gloss. He who desires really round work with uniformly distributed contact over its entire area, should use free-cutting wheels of broad face; and the truest work will show, not a bright, glossy surface, but a good surface and broad feed lines, when rubbed strongly through a round, straight hole; but no feed lines before such rubbing.

All cylindrical grinding by whatever method will show lines of cut and feed when rubbed in a round hole or when lapped in any other way. There is a difference between a cylinder with uniformly distributed contact, when tested in a perfectly round hole; and a really *perfect* cylinder. A really perfect cylinder is one whose surface molecules are every one the same radius, or all touch the inner surface of a perfectly round ring when it is passed over the entire length of the cylinder. Such perfection can be obtained, approximately, by some form of lapping. Any one who shall look for such perfection from grinding, will be forever disappointed. Grinding, however, does give us vastly more points of contact than turning or even careful filing to a micrometer and polishing with emery cloth—the method used by those who do not grind.

Broad Cuts Produce Most Accurate Surfaces

Feed lines are caused by the "lap" of the wheel cutting twice on that portion of the surface, i. e., we do not traverse quite the exact width of the wheel at each revolution, but as near as safe and avoid ridges. The wheel cutting twice over this narrow place leaves a different grain, therefore a different color, even though the measurable diameter there be no different than elsewhere. In my apprentice days, we used to plane all work with a very fine feed, and considered the best work that which showed no feed lines. But Mr. William Sellers showed us that the surfaces we produced that way were not perfectly flat surfaces, while he produced a more uniformly distributed contact, tested with a perfect surface plate, by using a wide tool and a broad feed line. The surface he produced was *not so smooth* but it was nearer a perfectly flat surface. No one disputes his theory to-day; all plane with a coarse feed.

Rough Turning Desirable for Economy in Grinding

Another fact in connection with cylindrical grinding that it is well for young engineers to get clearly fixed in their minds when leaving college and starting out in practice, is this: that to secure the greatest economy by the use of grinding machines they should pay less for all turning than when the work is to be finished in the lathe. With well constructed grinding machines, the coarser the turning the quicker the grinding can be done. It is no longer necessary to turn either smoothly or correctly to size. A variation of 1/32 inch more or less on large work is of no moment, and on small work a variation of 1/64 inch more or less is permissible, and the surface may be very rough in all cases.

A large part of the economy is secured by cheap turning. You will find it difficult to secure such turning, owing to prejudice, ignorance, opposition, and fear on the part of many workmen, foreman, and superintendents. As engineers, you will find the greatest problems are not mechanical, but that the solving of the human problems will require everlasting study, and to secure the full economy by grinding you will need generalship in a high degree to get work turned rightly for grinding. All traditions must be upset if work is rightly turned. I think there are few places where grinding machines are used that the turning is done as cheaply and roughly as it should be. I have never been able to secure what I desired in this respect.

About the relative cost of finishing to size by turning or by grinding, it varies greatly in different works, but the grinding method shows a saving according to the sympathy and intelligence that goes into the enterprise and the nature of the work. There is much opposition to grinding in some places, where the saving is small; but where a systematic and intelligent effort is put into it, the saving is large. A manager recently told me that the saving was sixty per cent over their former lathe method of sizing and finishing.

There are not enough good operators to run machines now installed, and the success of these machines is held back owing to the large amount of ignorance of grinding machines and grinding operations on the part of foremen, superintendents and managers. The art is yet new and invites the aid of young engineers in placing it in a still more useful position in the world's service. Cylindrical grinding is, however, firmly entrenched in this country, and, in many lines of manufacture, all round work is ground. All first-class automobiles have every round part ground; all sewing-machines, typewriters, phonographs; large machinery is also ground to a considerable extent.

The cylindrical grinding machine has taken its place as a practical metal-cutting tool to be used by progressive manu-

facturers as a labor saver; and manufacturers to whose attention its possibilities have been brought by practical demonstrations, have accepted it as a settled method of sizing cylindrical work.

* * *

PAT'S PROMOTION

C. TUELLS

Just how Mr. Roland Thompson came to be in charge of the foundry at the Morton Steel Company no one seemed to know. In some ways he was admirably capable; he had a prepossessing appearance, his personality was wonderful, and his command of the English language would have enabled him to convince anyone that black was white. As a salesman he would have been a tremendous success, but his lack of knowledge of the foundry business made his success in that line rather dubious. In a nutshell, Mr. Thompson's "bluff" was his stock in trade, and whether it was a case of refusing his best molder a raise or explaining to the super why the production was not greater, his "bluff" always stood by him.

"Pat is still trucking castings from the foundry"

Pat Morrison was the laborer who trucked the castings from the foundry to the machine shop at one dollar and fifty cents per day. It kept him hustling all day to get the finished castings off the foundry floor, and when the foundry was busy the casting pile looked much like a mountain to poor Pat, for it was his daily task to remove that mountain. It was kind of a lonesome job, too, for there were few to talk with on his trips to the machine shop, even if he had the time, so he had plenty of opportunities to think over his trials and tribulations.

One morning when his mountain of castings looked larger than ever he evolved the idea that his job was worth more than fifteen cents an hour, and the more he thought it over, the heavier his truckloads of castings became, and the surer he became that he was right, so about half-past ten he could stand it no longer, and marched up to the foundry office.

Mr. Thompson was just finishing a well-worded letter to the super telling him how hard the foundry was working to ship a rush order of castings, when Pat came in, and stating his case asked for a raise of five cents an hour, which would make his wages two dollars per day. After listening gravely to Pat's request, Mr. Thompson assumed one of his most patronizing airs and addressed Pat as follows:

"Mr. Morrison" (before he had always been Pat), "I have had your case under consideration for some time, and I have decided to promote you. From now on I want you to take entire charge of trucking these castings from the foundry to the machine shop; I want you to personally attend to every detail of this important work, to see that they are properly loaded, safely carried over and deposited in their proper places, and in fact, devote your whole time to this work. Now, if I can safely entrust this great responsibility to your care you can readily see how much better off you will be than if I should give you an increase of a few cents an hour."

As he proceeded Pat commenced to look important, and as he finished, thanked him for the "promotion" and walked out of the office, his head high and chest thrown out, his thoughts concentrated on "Mr. Morrison" and his new job, which was simply his same old job at the same old pay,—trucking castings at fifteen cents an hour, described in flowing terms.

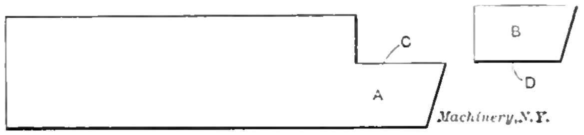
Pat is still trucking castings from the foundry, and for the same money, but he is doing some heavy thinking as a side line. Through the policy of Mr. Thompson the foundry office is being looked upon as a magnificent example of "bluff" by the rest of the works, and over in the machine shop there is tacked upon the wall a little parody that, if we except Pat, seems to fit the foundry situation to a tee.

Everybody works but the foundry,
  They sit around all day.
Always writing letters,
  Expect to ship next day.
Customers keep on waiting,
  New stories we must tell.
Everybody works at the foundry,
  Yes, they do, like ——.

* * *

WELDING A HIGH-SPEED STEEL CUTTER TO A MACHINE STEEL BODY

A method for welding high-speed steel cutters to machine steel bodies or shanks has been patented by Mr. Paul A. Viallon, 102 Avenue Parmentier, Paris, France. The process, as described in the *Mechanical Engineer* of January 29, is comparatively simple and inexpensive, and if it should prove successful, would undoubtedly be valuable in the metal trades. The machine steel shank is indented about as shown at *A* in the accompanying illustration, and the high-speed steel cutter may have the appearance shown at *B*. The surfaces *C* and *D* are well finished, and the shank and the cutter are both heated to a cherry-red heat. Solder is applied on the surface *C*, the cutter is placed on it, and the two parts are forced together by heavy pressure. This operation has the effect of melting the soldering material and producing adherence between the cutter and the shank. The tool is now carefully put into the fire, from where it is withdrawn when it has reached a yellow heat (2,000 to 2,400 degrees F.). The weld is now completed by hammering at the top of the tool, first lightly, and then with heavier blows. The tool is permitted to cool slowly, and may then be dressed and finished and re-heated to the required hardening temperature for high-speed steel, and hardened. When the welded-on part of high-speed steel is worn down so that it must be replaced by a new cutter, the old cutter may be detached without injuring the machine steel shank, by heating the cutter and the shank at the joint, and then removing the cutter by pressure applied on its side.



High-speed Steel Cutter to be welded to Shank of Machine Steel

* * *

Coke for locomotive fuel is being tried by the Illinois Central R. R. for the purpose of eliminating smoke at its Chicago terminal. It is stated in the *Engineering Record* that the results obtained indicate that the use of coke will be successful, but the trial has been conducted for so short a period that no general conclusion as to the relative cost of the coke as fuel can be drawn. The city has demanded the electrification of the company's Chicago property, but the favorable outcome of these experiments may lead to the adoption of coke fuel, at least for some time to come.

* * *

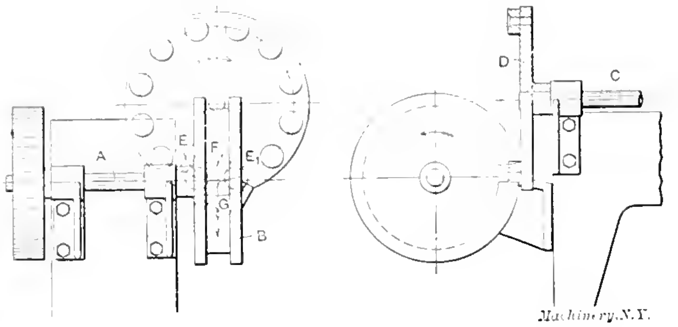
The New York Central established a new record from New York to Chicago with the Vanderlip special, which made the run March 26-27 in sixteen hours and seven minutes, including twenty-four minutes allowance for six stops to change engines.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

A SEMI-GENEVA DRIVE

To drive a shaft continuously from another shaft also running at a constant speed, the two shafts being placed at right angles to each other and in different planes, is an every-day experience, and can be done by belt, worm gears or spiral gears; but to connect these two shafts so that the driven shaft makes only a part of a turn and then comes to a positive standstill while the driver still runs, is probably out of the ordinary. The illustration shows a drive of the latter type (which was adopted as a feed mechanism on an automatic machine) which worked satisfactorily.



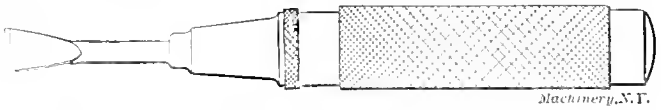
An Intermittent Drive for Two Shafts at Right Angles to each other and in Different Planes

On the outer end of the driving shaft *A* is a cam *B* having a face groove, open on both sides. On the outer end of the driven shaft *C* a disk *D* is fastened, on which are mounted rollers *E*. As the cam *B* revolves in the direction indicated by the arrow, the cam surface *F* pushes the roller *E* over to the left, causing the disk *D* to turn, and the roller E_1, which is pushed over to the central position by the cam surface *G*, is engaged. Roller E_1 remains in the groove until the cam has made one revolution, when it is also disengaged, another roller at the same time entering the groove, and so on.

This drive takes the place of a "Geneva movement" which, in this case, would be quite difficult to arrange. E. P.

ANOTHER USE FOR THE AUTOMATIC CENTER PUNCH

The automatic center punch, though sometimes used merely as a novelty, is nevertheless a very handy and time-saving device when applied to the marking of a large number of holes, as when laying out press tools. The tool's usefulness does not end here, however, for it may be used to even better advantage when equipped with a chisel tip, as shown in the illustration. One is sometimes in a very awkward position when a piece of work has to be graduated which cannot be done in a machine, and when the only tools available are a hand-hammer and chisel. With the automatic chisel we can avert that nervous moment between the setting of the chisel and the dropping of the hammer, which often proves so disastrous, as the eyes can be kept on the work, and the chisel easily held in the proper position. When a line needs to be made which is longer than the width of the chisel tip, it can be extended to any required length by setting a straight-edge in position and sliding the chisel along its edge, repeating the blows. E. W. H.



Automatic Center Punch equipped with a Chisel for Hand Graduating

FISH-TAIL MILLS

About a year ago the writer had a cylindrical piece like the one shown in Fig. 1 brought to him with directions to put a slot through it as shown. Along with the work came the instrument shown in Fig. 2, which was introduced by the foreman as a "fish-tail mill." I had never seen one before, and after inserting it in an ordinary milling machine and living right with it for some hours, I heartily desired never to see another. The cutter speed was about forty feet per minute, the cut three-thousandths and the feed about seven inches per minute, or thirty-thousandths per revolution of the cutter. Since then there have been several jobs of splining and slotting to be done with fish-tail mills. Half a dozen of us took turns at one or another of them. The last one that came to me made me decide right off to get a cushion for my stool at the machine. There were 160 keyways three-sixteenths of an inch wide by an inch and a quarter long. I didn't get any cushion though, as it would have been conducive to undue levity among the kids, and, besides, I had something better. I took the mill shown at *A*, Fig. 3, and ground it as shown at *B*. I was then able to take a cut of five-thousandths instead of three-thousandths, and a table feed of twenty inches per minute instead of seven.

Of course, where spline millers are in operation everybody knows how to grind the fish-tail mills, but this was new to me and apparently not known to any of the several Yankee tool-makers who ground and used the mills at one time or another. The small mill I ground by hand, but the next one I shall grind square the same as any other end mill by using the cutter grinder. The corners and centers are, of course, touched off free-hand. A cutter like *B* makes chips instead of crumbs, and they say "You can tell a workman by his chips." J. C. T.

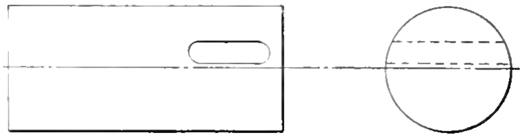


Fig. 1

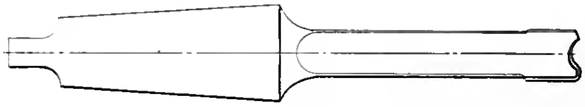


Fig. 2

Fig ?

Fig. 1 The Work Fig. 2. The Fish-tail Mill Fig. 3. Incorrect and Correct Methods of Grinding

A CAM WITH SOME SPECIAL FEATURES

In Fig. 1 is shown an arrangement (which is not entirely new) for economizing space in a special machine. The general scheme is as follows: The drum cam *E*, which is pinned to its shaft, is required to turn 90 degrees while it moves lengthwise 6 inches, and to resume its original position as it returns. The cam is shown in its central position. When it is at the extreme left, the roller *A* is in the groove while the roller *B*, which is 3 inches to the right, is freely suspended. When the cam moves toward the right, the groove will engage the roller *B*, and, as the cam continues to advance, it will leave the roller *A* and move under control of the roller *B*. As the cam is 3½ inches long, and has a movement of 3 inches on each side of its central position, the entire space which it occupies is 9½ inches, while if a single roller were employed, the cam would be 6½ inches long and would require a space of 12½ inches for action; thus a saving of 3 inches is made. This arrangement causes extra wear in the cam groove to compensate for this, but extra grooves may be cut around the periphery of the cam when it is being made, and these grooves may be brought into use by resetting the cam on the shaft, when necessary.

In order to secure satisfactory results, it is essential that the rollers *A* and *B* be aligned properly in the path of the cam groove. It is the method of locating these rollers that

is of special interest to mechanics. The stud *W*, for the roller *B*, was located without difficulty directly over the center of the cam shaft. A ⅜-inch hole was then drilled in the bracket *H* as near the position of the stud *X*, for the roller *A*, as could be done easily. The spiral groove in the cam being cut and finished, the two rollers *A* and *B* were made and ground so that they could be crowded under pressure into this groove. The cam was then placed on its shaft under the bracket *H*, and the stud *W* set in position, holding the roller *B* in the groove. The roller *A* was then pressed into the groove on the left side of the cam. Before this roller was placed in the groove, however, a 5/16-inch bushing was driven into the half-inch hole in its center. Into this bushing a test-bar, *Y*, of straight 5/16-inch drill rod, was carefully fitted. With the two rollers in position under the bracket *H*, an attempt was made to put the test-bar through the ⅜-inch hole (which had already been drilled in the bracket) and into the bushing in the roller. In order to do this, it was necessary to enlarge the hole at one spot with a file, after which the bar was set in the bushing. The assembled mechanism was then taken to the drill press, and, after some adjusting, the test-bar was brought to a vertical position directly under the drill press spindle. The bar was then removed, and a 7/16-inch counterbore with a long pilot which reached into the bushing in the roller, was used with care to enlarge the hole for the stud *X*. Proceeding in this way, changing counterbores several times, the hole was finally reamed to size. The rollers were then ground to a good running fit, and reassembled in position. This method of procedure made the alignment of the two studs *W* and *X* perfect. It is unlikely that this result would have been obtained in any other way, except at a cost of much more time and effort.

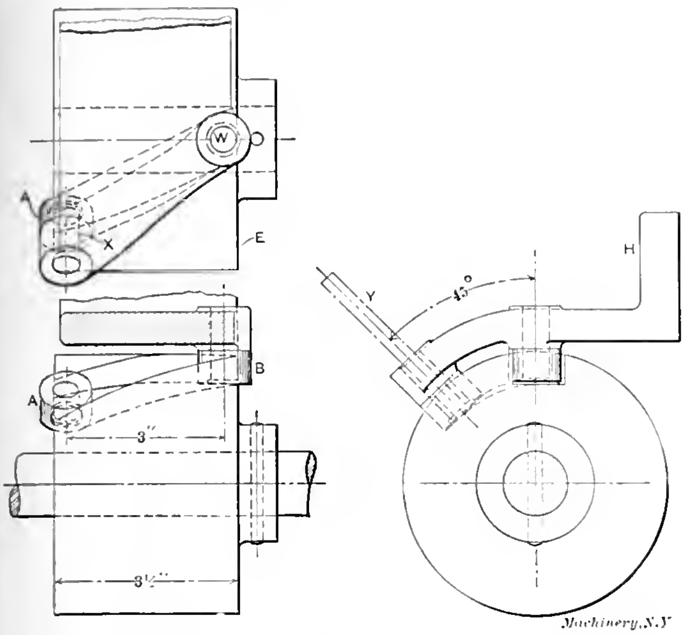


Fig. 1. Cam with Two Rollers which reduce its Longitudinal Movement

In Fig. 2 is shown a type of roller stud which also is not new, but which is not in such general use as its advantages warrant. The sketch explains itself. When it is desired to remove a roller, the clamping screw *A* is loosened; the operator then places the end of the screw-driver into the groove in the stud and easily draws it out of the lever. This is a much simpler matter than is usually the case with the old type of studs which are held by set-screws. The screw generally makes a burr on the stud, which causes all manner of trouble for the machinist. The stud shown is especially convenient when soft rollers are used in the cam race-ways, as these, of course, wear much faster than hardened steel rollers. The practice of using soft, rather than hard rollers, is growing as it is being more widely realized that there is greater economy in frequently renewing cam rollers than in occasionally renewing cams. There are comparatively few cam movements which will not admit of some wear in the rollers, without serious inconvenience. HERBERT C. BARNES.

Brooklyn, N. Y.

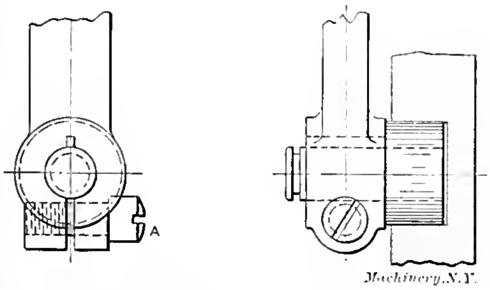
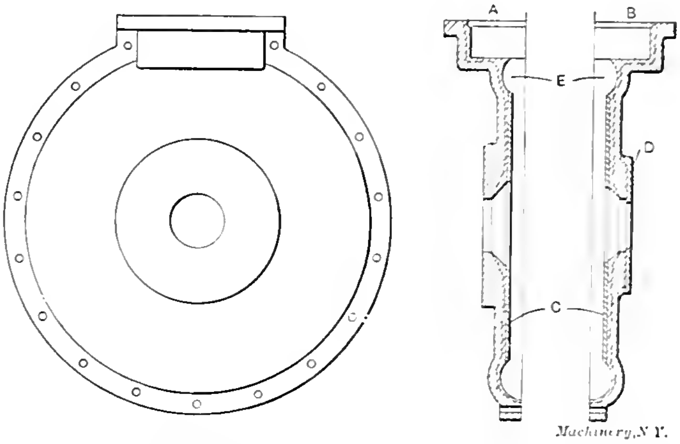


Fig. 2. Type of Cam Roller which is easily removed

SMITHERS' PATTERN EXPERIENCE

I dropped in on Smithers the other day and while there saw an iron pattern for a centrifugal pump casing which had been made from the old casting. Smithers said he had acquired considerable experience through that pattern, for while the casting was badly eaten away on the inside, as indicated by the dotted lines in the engraving, the outside was in good condition and so he thought he could save time and money by using the casting instead of making a new wooden pattern. The shrinkage did no harm, since one side of the pump wore out as soon as the other and the new halves were always finished and bolted together. As the flange on the casting *B* was smaller than the one on the casting *A*, he decided to use *B* for a pattern. Plugs were driven in all the bolt holes and the strips for the finished surfaces of the flanges secured to them. Holes were also drilled through the pattern to secure the wooden plate to make up the necessary thickness at *C*. The central holes were cored and a loose flange *D* slipped over the hub made the pattern right for casting *A*. Two core-boxes were required for the central openings. The irregular shapes at *E* gave Smithers some thought, but he decided to fill them with composition and hold this composition in place by means of wire pins. These were driven in holes drilled in the castings, and were cut off slightly below the surface of the finished castings. Now, Smithers knew that in a jobbing shop patterns did not always get the same careful handling that they do in manufacturing shops, and, as from time to time he would have castings made from this pattern he wanted a composition that would harden and would not crumble nor peel off. After looking over a large number of receipts he found one which he thought would answer the purpose. This called for 10 parts of iron filings, 3 parts chloride of lime, and enough water to make a thick paste. The formula says that if placed between surfaces under pressure it will harden in 12 hours, and the casting will break elsewhere than at the joint. Smithers thought that if it did that it would surely work all right on his pattern. Not being able to secure sufficient lime in town he sent away for it; then made up the mixture, and applied it to the pattern. At the end of 24 hours it was still as soft as ever; at the end of 48 hours, no better; and at the end of 72 hours he got disgusted and scraped it all out. Two or three weeks later he came across some



The Iron Pattern for Centrifugal Pump Casing

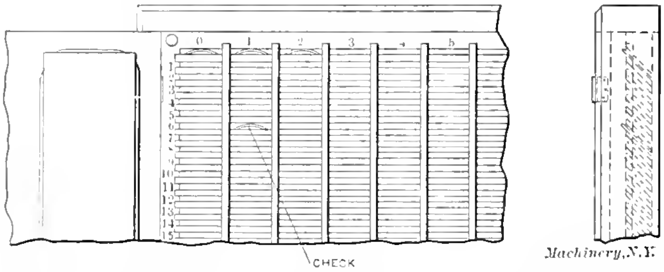
of it in the yard, and found that while it had dried it was simply a crumbly mass, with no strength. His pattern-maker wanted a chance to try his hand and made up a new mixture consisting of $3\frac{1}{2}$ parts Portland cement, $3\frac{1}{2}$ parts iron filings, 2 parts common sand, and 1 part common salt. This was thoroughly mixed together, and made into a thick paste by the addition of water. Smithers said this composition worked like a charm. It was slicked up smoothly, shellaced, and sand-papered, and made a fine-looking job. He showed me some of this composition, which was hard and seemed to have considerable strength. It stands the usage around the foundry, and also the handling to and from the pattern store-house. Smithers says that while the experience cost him something he was willing to stand for it, as the composition will come in handy on other similar jobs.

Covington, Va. WM. SANGSTER.

CHECK SYSTEMS FOR THE TOOL-ROOM

There are many tool checking systems in use in the modern machine shop, but those which are not complicated are more or less conspicuous by their absence. Tool checking plays an important part in the up-to-date shop; therefore the writer will endeavor to bring to light a very good method of procedure in handling checks to the best advantage. In some shops tools are given a certain classification letter or number. In this case the tools are numbered consecutively, in much the same manner as the shop blue-prints are. Fig. 1 will give an idea of the construction of the cabinet for the checks. There are ten vertical rows of slots which, as will be seen, are numbered at the top. By combining these numbers with those seen on the left-hand side of the board, different checks are located. For example, if we want check No. 61 we read down six figures on the vertical row to the left and move to the right under the row of slots with the figure 1 above. It takes less time to number the slots in this manner and the usual maze of figures generally found on the check boards is eliminated, thus facilitating the location of checks placed therein. The slots are at an angle of 45 degrees, as shown in the end view, so that the checks will stay in their respective places. The size of the slots will depend, of course, on the diameter of the checks, but the depth should be somewhat less than the diameter, to allow the checks to be lifted out easily. By using this type of board the tool supply man will have all checks under lock and key, and the tools given out under constant observation, so that the chances of their disappearance to places unknown is eliminated. L. H. GEORGER.

Buffalo, N. Y.



Board for Keeping Tool-room Checks which are numbered consecutively

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After having had an experience of more than twenty-five years in machine shops and in some of the largest factories in the country, I was surprised to read the article by Mr. Hadun in the March issue, where he states that he abandoned the check system whereby the workman has the check in his possession. In the following article I shall give a description of a system in use in the large supply room of a certain company, which has proved effective, and which may contain some points of interest.

When a new man enters the employ of this company, he receives a brass admittance check with his check number on it. This check is always in his possession and must be shown to the watchman at the door on entering. A white tag 1 7/16 inch in diameter (see Fig. 2) is received by the foreman of the tool supply room from the office. On one side of this tag is the man's name and admittance check number, on the other side is stamped the date when the check is received by the foreman of the supply room. On the check board there are a number of checks (usually fifteen or twenty-five) corresponding to the number on the admittance check. The number of checks found on the hook is then written on the white tag under the date. The new man must show his admittance check before he can receive his tool checks.

The check board shown in Fig. 1 is mounted on a ball-bearing so that it revolves easily. There are eight spaces, as shown in the plan view, each of which contains 200 hooks, making 1,600 in all. When a man leaves, he must return the number of checks charged to him on the back of the tag. If he does not have the required number and they are not found in the supply room, blue-printing room or jig room, he must pay for them. He understands this when he receives his check on entering the employ of the company. The attendant of the supply rooms enters the lost checks or tools on the tag, and the man takes the tag to the office; without this tag it is impossible for him to receive his money. When a man is transferred from one department to another, he receives a new admittance check, the old one being taken from him. He must return all checks, and if they cannot be found, the attendant charges those which are lost against the man on the old tag, which is sent to the office so that the loss may be taken from his pay. If at any time any of the lost checks are found, the money paid is refunded. A new tag is received by the foreman with the man's new admittance check number, and after dating and writing the number of checks that is on the hook on the tag as before, the man is given a new lot of checks.

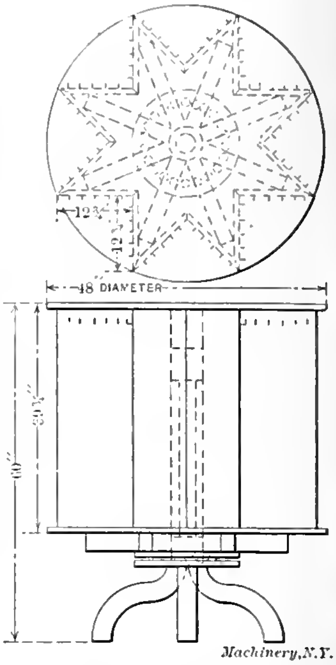


Fig. 1. Revolving Check Board

All tools, such as drills, reamers, taps, etc., are marked alphabetically, and a brass strip with the letters stamped on it and filled in with black shellac is tacked on the tool cases. There is also a hook under each letter to hang the man's check on. The advantage in marking the tools is this: a workman cannot return another man's drill, reamer, or any tool having another letter than the one on which his check hangs. When the men become acquainted with the system of marking the tools, they seldom bring in a wrong letter. If a workman loses a tool of any kind and does not remember the letter, he can find out what it is at the tool-room; then he has a perfect right to take the tool wherever he finds it and bring it to the tool-room and receive his check. Taps of all sizes are set on end in a hardwood block, three in a set, and the block is marked with a letter and placed in the case over that particular letter. The machine screw taps are arranged in a block with a full size drill, a tap drill, and two taps. Tags about one inch in diameter and of different colors are used for broken tools, lost tools, tools being repaired, and also for those that are sent out on the road with the erecting gang. The tool inspector's bench is located just

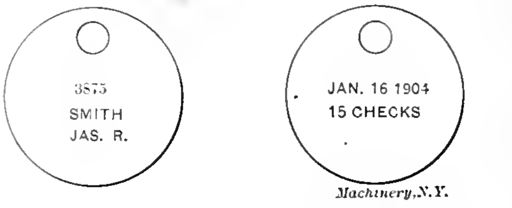


Fig. 2. Tag which is filed in the Tool-room, giving Name and Number of Employe, and Number of Checks in his Possession

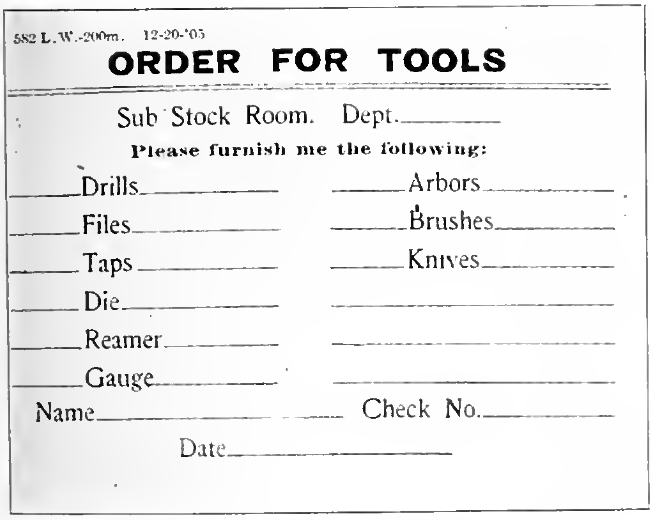
back of the delivery window, and all tools received are placed on this bench so that they may be inspected and any errors corrected before the tools are put away. All gages that are received at the supply room are tested on a Pratt & Whitney 80-inch measuring machine before being put in their cases.

Every four weeks each tool has to be accounted for, and on the Thursday morning of the fourth week a card is posted announcing that the following Saturday is check day. On this particular Thursday half-round checks are hung over the checks that hang on tools, and a wire clip is attached to the checks where a number hang on one hook, such as those used for bolts, straps and other such tools which are not lettered. As the tools are returned, the half-round checks and clips are put in a box, no account being taken of them. The different foremen are supplied with a printed form for the use of those workmen who cannot return their tools. This printed form must be filled out with the workman's name, check number, name of tool, and letter, and signed by the foreman. No account is taken of tools that are given out after the half-round check and clip are put on. The checking is done after one o'clock Saturday afternoon, as the factory stops work at noon. The first operation in checking is to write on a small slip of paper, the size, letter and check number of all tools on which a half check is found. The slip is then hung on each hook corresponding to the tool and number, after which the slips are collected and arranged in hundreds. The printed forms for the tools in use and the corresponding slips on which the different tools are checked, are compared and if found correct are put aside. Lists (with carbon copy) are then made out and a copy is sent to each foreman containing check numbers and list of tools charged to each workman under him, and these tools must be accounted for or the workman must pay for those which are lost. A list of all lost tools which are paid for in this way is kept in the office, and if a tool is found at any time, the office is notified, and the workman receives his money. The small number lost, however, was surprising when the men became acquainted with the system. Albert C. Sawyer.

Dorchester, Mass.

It is evident that Mr. Hadun, judging from his article on Check Systems for Tool Rooms in the March issue, has had considerable trouble in determining *the* system for checking tools. I have been up against the same proposition, but my conclusions are somewhat different from his. In the first system mentioned in the article referred to, each man kept his own checks. This, I think, is the most common method and seems to give the greatest satisfaction, all things being considered. When the workman realizes that in the event of his services being dispensed with his pay will be held up until all the checks are accounted for, he will see that his checks tally with the tools in his possession. If they do not, as a rule he will immediately take steps to see that the matter is straightened out, and usually, if taken in time, it is a simple matter. I have worked in many shops where this system is in vogue, and have yet to learn of an instance where a man used another man's check dishonestly. For one to count the tools and checks in hand in order to see just where he stands, is simplicity itself. I fail to see where the written slip has any advantage over the first system mentioned as it is as easy to forget to have the slip removed from the card case as it is to ask for the check—then there is the extra expense. There are, however, some who prefer the printed slips and for those who do I show herewith the form used by the General Electric Co. in the tool room at Lynn, Mass. Each man is furnished with blocks of probably fifty, and as these are used, more are furnished at the tool room window.

Lowell, Mass. William B. Hubbard.



582 L.W.-200m. 12-20-'05

ORDER FOR TOOLS

Sub Stock Room. Dept.______

Please furnish me the following:

___Drills_____	___Arbors_____
___Files_____	___Brushes_____
___Taps_____	___Knives_____
___Die_____	
___Reamer_____	
___Gauge_____	

Name______ Check No.______

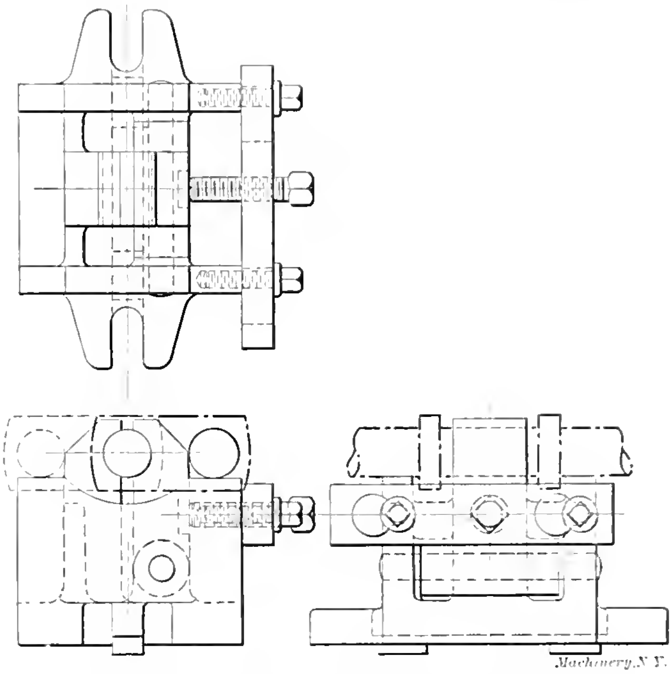
Date______

Printed Slips used by the General Electric Co. at Lynn, Mass., to insure the Return of Tools to the Supply Room

A MILLING FIXTURE FOR THE WEBS OF CRANKSHAFTS

The accompanying illustration shows a milling fixture intended for milling the webs of crankshafts on both sides at practically one setting. It will be seen that by using this fixture the webs will be milled at equal distances from the center on either side. The crankshaft is held in position by its center journal by a vise-like clamp. After milling one side, it is only necessary to loosen the set-screw shown, and twist the shaft until it rests on the opposite side of the fixture. The set-screw is then again tightened, and the opposite side milled. When the shaft is to be removed, the two collar-head screws are loosened, and the strap on the right-hand side slid towards the right, which permits it to be pulled over the collars of the screws, and one of the jaws holding the crankshaft to be folded back so that the crankshaft can be taken out and a new one put in place. S. H. Sweet

Bridgeport, Conn.



Fixture for Milling the Webs of Crankshafts

BLUING METALS

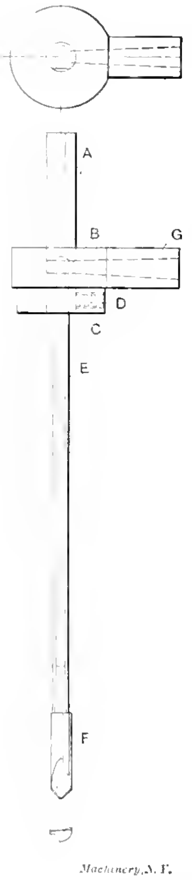
In answer to C. L. L.'s question in the March issue for a formula for bluing metals, the following method is submitted. A good color may be obtained on small articles by the following solution, which, while particularly intended for obtaining a gold color on brass, is frequently used for imparting a steel-blue color on brass or other metals. The solution consists of water, one gallon; sugar of lead (acetate of lead), four ounces; hyposulphite of soda, four ounces. The sugar of lead is dissolved in water previously heated nearly to boiling, and then the hyposulphite of soda is added. The solution has a milky color from the precipitated hyposulphite of soda, but it should not be filtered out. In order to get the best results, the solution should be heated to a temperature of 200 degrees F., or just short of boiling, when it turns black. When immediately made, the white precipitate in the

solution is fine and adheres to the articles being colored, but after heating for five or ten minutes it collects and settles to the bottom. It is then that the best results are obtained in coloring brass. After some time the solution does not work so rapidly and finally a new one has to be made up. A large quantity of work can be passed through, however, as the color is a mere film.

The brass to be colored should be cleaned in the usual manner, and may be polished and then dipped. The articles are immersed in the hot solution (nearly boiling) and carefully watched. It takes a few seconds for the first shade of color to appear and it is then very light. Soon a darker yellow forms and then a brownish gold shade is produced. The articles are removed as soon as the desired color is reached and should not under any circumstances be allowed to remain, as the shade rapidly darkens and becomes purple. By allowing to remain longer, a blue and finally steel black can be produced. Rinse first in cold, and then in hot water, then dry in sawdust. The articles are then lacquered.

Plainfield, N. J. JOSEPH WEANER.

TOOL FOR DEEP-HOLE DRILLING



Drill for Deep Holes

The line engraving shows a drill used by the Waltham Watch Co., which has proved to be a very useful tool for drilling deep holes. The feature of this tool is that the chips are carried away from the point of the drill by compressed air. Many of the machines in the shop are operated by compressed air, and for this reason it is very handy to apply the air for the removal of the chips as well. The drill shank *A* is held in the collet of an upright drill. The collar *B* has a running fit on the lower end of the shank. The air connection is attached to the lug *G*, projecting from the side of *B*. The collar *B* is held in position between the collar *C* and the end of the drill collet. The collar *C* is simply held by a screw *D*. The part *E* is a seamless steel tube extending into the shank *A* to the air inlet or groove around the shank, and is soldered in place. The shank *A* is solid above the air inlet. The drill proper is shown at *F*. This drill is provided with a taper shank soldered into the tube *E* and having a hole drilled through the taper shank connecting with two small holes in the drill point as shown in the end view. It is easily seen that the air supplied through the nozzle *G* to the tube *E* will exhaust through the holes in the point of the drill, and by this means the chips are removed.

These drills are commonly made of different lengths to drill deep holes in succession. The first drill is four inches long, the second eight inches, etc. Extreme care must be used to have the drill start central with the center punch mark for the drill. Holes have been drilled with this tool four inches deep in one minute through ordinary cast iron. The air pressure used is 35 pounds per square inch.

Waltham, Mass. FRANCIS P. HAVENS.

SAVING TAPS AGAINST BREAKAGE

Taps frequently break off while tapping out holes with a drill press, thus ruining the tap. A method which has proved its value for saving taps against breakage is illustrated in Fig. 1. The device is simply a safety pin which provides a breaking point that will give way or shear off when the tap gets stuck, before the strain is sufficient to break the tap, which will occasionally happen through carelessness or otherwise. If the drilled hole is too small, or if the tap reaches the bottom of the hole sooner than expected, the safety pin will shear off and thus save the tap. As shown in Fig. 1, the shank of the tap fits nicely into the bore of a sleeve and through both sleeve and shank is the safety pin, which is a light drive fit. The outside diameter of the sleeve is made to fit into the holder shown in Fig. 2. The sleeve is provided with two keyways which fit keys in the holder, which do the primary driving. The holder may be fitted with a shank suitable for the drill press spindle. The taps which go with each holder may have the same outside diameter of sleeve, but the shank of the tap and the bore of the sleeve, and the diameter of the safety pin will be of the sizes given in the table. HARRY L. RAMBO.

Milwaukee, Wis.

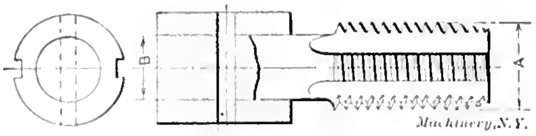


Fig. 1. Safety Arrangement for Saving Taps against Breakage

TABLE GIVING DIAMETERS OF SAFETY PINS FOR TAPS.

Diam. A of tap, inch.	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2
Diam. B of shank, in.	5/8	11/16	3/4	7/8	7/8	7/8	1	1 1/8	1 1/4	1 1/2	1 1/2	1 1/2
Diam. C of pin, inch.	3/16	7/32	7/32	1/4	1/4	5/16	5/16	5/16	3/8	3/8	3/8	3/8

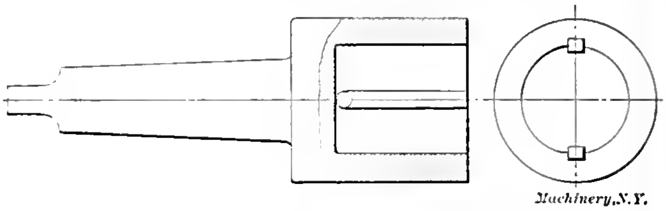


Fig. 2. Holder into which Sleeve over Tap fits

SIZES OF WORKING DRAWINGS

In the March number of MACHINERY, engineering edition, Mr. William Breath in his article on "Sizes of Working Drawings," advocates the use of small drawings for detailing. His plan may be all right, but I think that he carries it too far. For instance, in his illustration of the drawings for a cast-iron bed, he puts the outline drawing on one sheet and the various section drawings on separate sheets. If there are two sections to be shown, this makes three sheets for showing the detail of one casting. Now this particular detail drawing could have been put on one sheet and the following advantages obtained: The man machining this casting would have the whole thing before him all on one sheet, from which he could more clearly see into the construction of the piece; he would not lose one of the sheets, since he has only one; the draftsman would not have to tack down but one sheet; he would not have to repeat some of the dimensions; the work could be done faster, as some of the lines could be projected from the outline view to obtain the cross-section view; there would be only one title and one number to put on the drawing and one record to make in the number book or card index; the checker's work would also be facilitated; the man who approves the drawings would only have to write his initials once; and the blue-print boys would have less work. I agree with Mr. Breath that it is much easier on the draftsman to work on small drawings, but I am in favor of using medium-size sheets for such work as has just been described, and a small scale where dimensions are not too numerous.

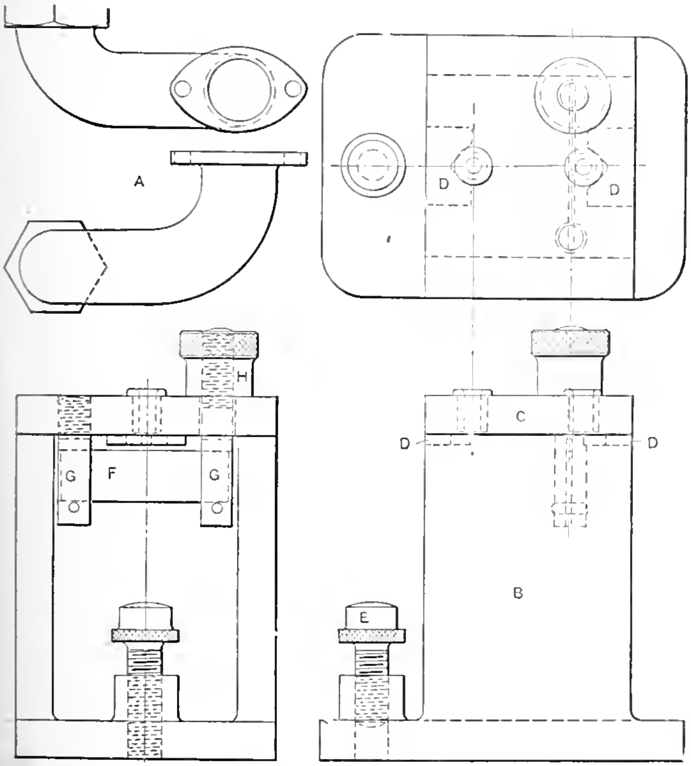
In the drawing room in which I am employed we have four standard drawing sizes. The largest is 21 × 33 inches, the next 16½ × 21 inches, or just half the large size, and the smallest 8¼ × 10½ inches. We generally use the large size for assembly drawings and the next size for details. The sizes are designated by letters, which always follow the drawing number. If there is more than one sheet the numbers are put on the drawings in the following manner: No. 536-A-Sheet 1; No. 537-B-Sheet 2; etc. We use no tracing cloth, but instead the best grade of bond paper; it blue-prints well and does not turn yellow from age. This paper does have a tendency to curl and after being rolled up it is difficult to straighten it out, but this difficulty is overcome by filing the drawings away in large envelopes made from heavy wrapping paper.

By doing this we can file a great many drawings in one drawer; they are easily gotten out, and the drawings are well kept. We mark each envelope on the outside for 100 numbers; for example, one envelope will be marked from 500 to 600. Suppose drawing number 267 were wanted from the file; it would be found in the envelope marked from 200 to 300. The beauty of this scheme is in putting the drawing back in place. Those who have had to file drawings under a big stack of other drawings know how hard it is to get them in place without turning the corners down or disarranging the other drawings. When a new drawing is completed, its number is entered in a book with the subject, the initials of the draftsman and the date. Then cards are made out for the card index, which are filed alphabetically. When the foreman of the machine shop puts several men onto the same job he gets a blue-print for each man and marks with a red pencil the details each man is to make up. J. E. WASHBURN.

Cleveland, O.

SPECIAL JIG FOR DRILLING ELL FLANGE

In a factory which manufactures one of the popular makes of automobiles, it was desired to produce more of the pump outlet elbows shown at *A* in the accompanying engraving. Therefore, to facilitate the drilling, a jig was designed as shown in the three views, which, after a thorough test, proved practical and did accurate work. The ell casting, which was of brass, had but one finished surface, which was that of the flange to be drilled. The two bolt holes had to be at right angles with this surface and the holes in all the elbows had to be drilled alike, in order to make the parts interchangeable. The body *B* and the cap *C* of the jig are held together by fillister-head screws. There are two steel V-blocks *D*, located so as to receive the flange of the casting. A thin bar of steel *F*, held by pins through the split ends of the studs *G*, clamps the work in place. The thickness of this clamp is only ¼ inch, as there is not room for one of greater width. One of the studs *G* is stationary, while the other is drawn upward by a knurled nut *H*. When a casting is to be clamped in the jig, one end of the flange is inserted over the bar *F*. The nut *H* is then tightened, and, at the same time, the screw *E*, upon which the casting rests, is also adjusted to the proper height, in order to bring the finished face of the flange against the plate *C*. In this way the casting is clamped square and firm in the jig with little loss of time. Usually when the nut *H* is loosened in order to remove the work, this may be accomplished without changing the adjustment of the screw *E* owing to the uniformity in the castings and the thinness of the V-blocks *D*. JIG AND TOOL DESIGNER

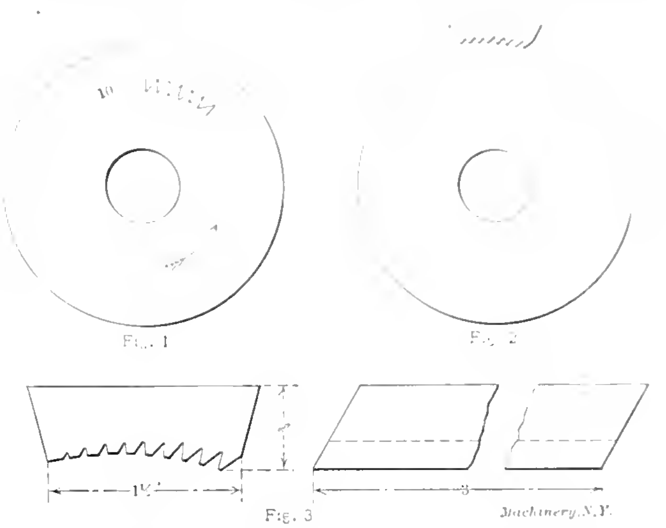


Elbow which has Little Gripping Surface, and Jig for Drilling it

GROOVING CHILLED FLOUR MILL ROLLS

The following matter is submitted in answer to the inquiry of K. A. T. concerning the grooving of chilled cast iron flour mill rolls, published in the "How and Why" column of the March, 1909, issue of MACHINERY.

When the rolls arrive at the shop for grooving, they should be unpacked and correctly marked as to the number of grooves per inch, and the direction in which the teeth are to lean. (See Fig. 1.) It is essential that the rolls be marked when taken out of the boxes as the box is often marked with the words, "fast roll" or "slow roll," "1st break," "2nd break," etc. This marking avoids confusion since it would be impossible to identify the rolls. The marks are stamped on the ends of the journals, or proper tags attached. The journals are inspected for truth and smoothness. If they are scored, the roll is put into a lathe and the journals turned, previous to grinding.



Figs 1 to 3. Tools for Grooving Chilled Flour Mill Rolls

The grinding machine consists of a bed with two V-grooves to receive and guide the carriage or wheel slide. On one end of this bed is mounted a driving mechanism for operating the carriage and roll, being connected to the roll with a universal coupling. The carriage is actuated by a lead-screw within the bed, and the traverse of the carriage is reversed by a shipper rod on one side of the bed. On the carriage are mounted two emery wheels each on its slide, on opposite sides of the roll to be ground. One wheel may be very coarse and rather hard for roughing down the old corrugations, and one wheel must be soft to produce a good finish. The roll is placed in two V-bearings between the grinding wheels, which bearings are adjusted to allow very little end play of the roll. The roll may now be ground true and parallel, using a copious stream of water. The emery wheels are driven by belts from an overhead drum.

After grinding, the roll is put into a roll-grooving or corrugating machine. It is assumed that the roll is properly chamfered to prevent breaking out at the ends. The roll is held in the corrugating machine between centers, and it also rests on V-bearings, which are placed near the roll proper. It is of paramount importance to have the work rigidly supported.

The machine platen has a head-stock mounted on one end, which carries the feeding mechanism, and through which the helical motion is transmitted. The spiral attachment is similar to the taper attachment of a lathe, and by intervention of a rack and pinion the motion is imparted to the live spindle of the head-stock. From the foregoing it will be understood that the teeth are helical (or spiral as commonly expressed).

The spacing of the teeth is not by the dividing method, but by the feeding method, as it might be termed. For example, a nine-inch divided roll is to be grooved ten corrugations

per inch. Now we find it requires five teeth of the 150-tooth ratchet wheel to move the nine-inch roll one-tenth inch on its periphery. When the machine is properly adjusted and tool set (Fig. 2) the cut is started by making only slight scratches on the roll for an inch, after which the tool is sunk to full depth, yet not reducing the diameter more than a few thousandths inch. When the roll comes near to the starting point again, a pair of dividers are set in the corrugations to get the proper pitch, then the dividers are set in the corrugations, bridging or spanning the remaining blank portion. If the dividers fit correctly the feed may continue until finished, otherwise the roll must be adjusted to make the teeth match properly.

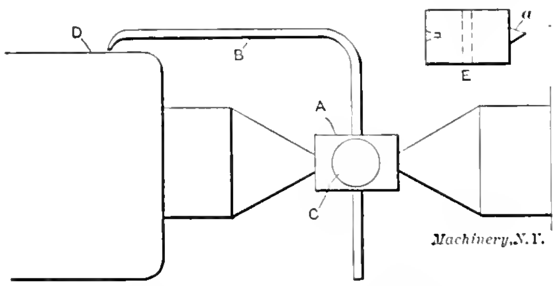
The cutting speed may be anything from twenty-four inches to thirty inches per minute. The steel used for tools should be of a very high carbon steel. The following brands are good: "Crescent Double Special," A1 temper and Firth-Sterling Extra Special," highest temper. High-speed steel is not good because it cannot be made hard enough.

The tool as shown in Fig. 3 will give the best results, since the flat chip is more easily curled than a chip of half round cross-section. The best over-all shape for these tools is that shown in this engraving. M. B. Stauffer.

Scottdale, Pa.

INDICATOR FOR ALIGNING LATHE CENTERS, ETC.

The indicator shown in the sketch is useful for aligning lathe or milling machine centers, or for setting a center punch mark or jig button central with a boring mill spindle. The gage consists of a short cylindrical piece *A*, accurately centered in each end, through which the adjustable gage wire *B* passes. This wire is held in place by a knurled thumb-screw *C*. When two centers are to be aligned, the gage is placed between them, as shown. The gage wire *B* is adjusted close to the concentric surface *D* and then slowly revolved. When the centers are in alignment, the pointer will follow the surface *D*. If the center of a circle is to be set in line with the axis of a boring mill spindle, a center in the latter is essential. The cylindrical piece *E* is then used instead of *A*, and the male center *a* is inserted in the center punch mark of the scribed circle. The gage wire *B* is then swung around to come in contact with the surface of the work, which must have been previously set square with the axis of the spindle. When the pointer, as it revolves, follows this surface, the center of the work and the spindle axis are in alignment. To true up a jig button, it will be necessary to have the corner ground to the same angle as the center in the piece *A*, which will have to be enlarged for a button of any size. H. W.



Indicator for Aligning Lathe or Milling Machine Centers

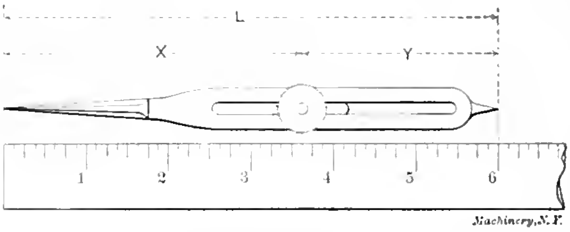
USE OF A LATHE CONSTANT FOR CALCULATING CHANGE GEARS

I wish to suggest a change in Machinery's Data Sheet No. 10 under the head "Change Gears for the Engine Lathe," in the paragraph beginning "Frequently the lathe is designed." Instead of finding out the ratio of the spindle and the stud by counting the number of teeth in the gears of the head-stock, simply look at the index plate and see what thread is cut when the gears on the stud and lead-screw are of equal numbers of teeth. For example, if a screw, three threads to the inch, is cut with equal gears, then call the lead-screw 3 to the inch, notwithstanding what number of threads to the inch it actually has. This we call "the lathe constant." Then if $12\frac{1}{2}$ threads to the inch are to be cut, multiply by any convenient number, 6, for example, and we have $12\frac{1}{2} \times 6 = 75$, and $3 \times 6 = 18$, the numbers of teeth that are required in the lead-screw gear and stud gear, respectively. I have used this rule for many years and have found it very convenient. James Eaton.

Burlington, Vt

TO OBTAIN RATIOS NOT PROVIDED ON PROPORTIONAL DIVIDERS

Users of proportional dividers have, at one time or another, had use for them when a ratio was required other than was provided for by the graduations thereon. To obtain this ratio, I have tried the tightening nut in many different positions before the proper setting was obtained. After doing this recently, for the last time, I concluded that a little calculation would do away with all this trouble. A scale can be used as shown in the illustration, from which to measure to the tightening nut. The position of this nut for any ratio may be found by simple proportion as follows: $R + r : R : : L : X$ or $R + r : r : : L : Y$, where R and r represent the antecedent and the consequent of the ratio; L the total length of the dividers, and X or Y the distance from the ends to the center of the nut. For example, the distance X for a ratio of 0.68 to 0.44 would be obtained thus: $0.68 + 0.44 : 0.68 : : L : X$. C. E. J.



Setting the Nut on the Dividers after the Proper Position has been found by Calculation

BLUE-PRINT PROTECTOR

The plan of covering blue-prints used in the shop with celluloid, as suggested by Mr. L. H. Georger in the February issue of Machinery, and the accompanying editorial note referring to the varnishing method, brought to the writer's mind a method used in the factory of the Coates Watch Tool Co., Springfield, Ill. In the watch-part department of this plant, all the working blue-prints are 5 x 7 inches in size, and are enclosed in strong oak frames, the face being covered with glass. The frames are very similar to cheap picture frames, but heavier, and have a screw-eye at the top to hang them up by, a hook being placed above each machine for this purpose. While this method could not very well be used for large drawings or blue-prints, it is unexcelled for small ones which are in constant use, and the drawings will last indefinitely when protected in this way. E. V.

WOMAN MACHINE SHOP PHOTOGRAPHER

In looking over Machinery for April, we notice under the "Personal" notes a statement to the effect that Miss Mimmette Ives Meade is the only woman in the United States who is making a specialty of machine shop photography. We would like to point out that for the past ten years our photograph department has been under the control of Miss Emma G. Moerlins, and we believe that she is the first woman in this country to fill such a position. J. A. MacIntyre,

West New Brighton, N. Y. C. W. Hunt Co.

LOCATING FINE CRACKS IN STEEL

Fine cracks in tools or other metal surfaces are often difficult to discover as even the microscope frequently fails to disclose them clearly. Their presence and extent, however, are easily detected by moistening the suspected surface with petroleum, and then wiping it clean and covering it with chalk. Some petroleum enters the fissures and afterwards sweats out, moistening the overlying chalk. The cracks can then be readily traced. O. M. B.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

The following questions are referred to the readers:

J. A. J.—How are rolls for rolling silver and gold ground and lapped? What kind of a grinding wheel is used and what diameter and speed are best? At what speed should the work be run? The rolls that I wish to grind are four inches diameter. How much larger should the roll be ground in the center than at the ends to compensate for the deflection caused by the pressure of the stock rolled?

F. W. B.—I would like to ask the readers of MACHINERY for information regarding a reliable and economical method for brazing a large number of conical tubes, which are formed of sheet copper. These tubes are 4 inches long, and have inside diameters at the ends of ½ inch and ⅜ inch, respectively, as shown by the illustration. The seams where the edges come together must have a butt joint, and must present a neat appearance.

C. K.—I will have a large number of pipe thread dies to recut when they are worn. They are of the inserted or adjustable type 16, 11½ and 8 threads per inch. What is the best and most practical method for doing this work in the average shop? What special appliances are necessary besides the hobs and the holders for the dies.

This question is also submitted to the readers, and an article illustrated with sketches or photographs will be acceptable.

GRINDING BRASS VALVES—TURNING SHAFTING FOR SCREW CUTTING

F. L. Z.—1. What is the proper way to grind and lap brass valves used for steam, water and air, and what material should be used for the operation? 2. What is the best way to turn small shafting, say, four or five feet long, ¾ inch diameter, on which a screw thread two feet long is to be cut?

A.—1. The valves and seats of brass valves for any purpose should be carefully trued on a lathe before grinding. The seats or bearing surface should be made narrow, and very little grinding should be done. Too much grinding tends to destroy the accuracy of the seat, and defeat the object of grinding. Use powdered glass sifted through a cloth bag, mixed with oil. Grind the parts together for a few moments, oscillating the valve and lifting it from the seat slightly so as to prevent scoring and scratching the seat. After a few moments grinding, carefully wipe off the grinding material and note where the bearing is. If all parts appear to be ground alike, put on a little clear oil and grind a few moments longer, and then test the valve, if possible. The watchword in grinding valves is to grind as little as possible. Accuracy must first be obtained by machining operations and the grinding should be limited to just enough to smooth down whatever roughness may be left by the cutting tool. 2. Small shafting of the kind described, should be carefully centered, the centers being drilled and reamed with a combination tool. Turn the shafting in an engine lathe using a back rest to steady the work under the pressure of the cut. Take a roughing and finishing cut, and then cut the thread. The back rest should have two jaws made of brass so as to prevent marring the work.

TO FIND THE DIAMETER OF A CIRCUMSCRIBED CIRCLE

J. F. P.—Three hardened and ground plugs are placed in position as shown by the three inside circles in the accompanying engraving. What is the radius R of the circle which will be tangent to all the three plugs? The only dimensions known are the distances P and C, shown in the illustration.

A.—To solve this problem, we first require the radii of the three plugs. The radius b of each of the two smaller plugs equals one-half of C. The radius a of the larger plug must be calculated. It will be seen that $a = mn - b$, but $mn = \sqrt{mh^2 + hn^2} = \sqrt{P^2 + (\frac{1}{2}C)^2}$. Having thus determined the radius a, we can now proceed to determine the radius R, which is the quantity to be ultimately found in the problem.

Assume that the center of the large circle to be found is at o. The length om, which is not known we call x. We can now write two equations which can be simplified so as to contain only the two unknown quantities x and R. We first have

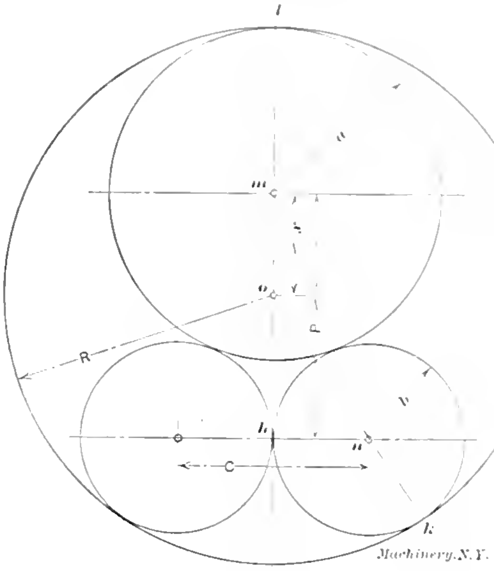
$$R = om + ml = x + a.$$

We also have

$$R = on + nk = \sqrt{oh^2 + hn^2} + nk = \sqrt{(P - x)^2 + b^2} + b.$$

As the members on the right-hand side in both of these equations equal R, they are also equal to each other. Thus we have

$$x + a = \sqrt{(P - x)^2 + b^2} + b.$$



To Find the Diameter of a Circumscribed Circle

If this equation is solved for x, we get,

$$x = \frac{P^2 - a^2 + 2ab}{2a - 2b + 2P}$$

and

$$R = a + \frac{P^2 - a^2 + 2ab}{2a - 2b + 2P}$$

Assume, for example, that the problem was given with the dimension $P = 1.2$ and $C = 1$ inch. Then $\frac{1}{2}C = b = 0.5$ inch. Radius $a = \sqrt{1.2^2 + 0.5^2} - 0.5 = \sqrt{1.69} - 0.5 = 1.3 - 0.5 = 0.8$.

If we now insert the values of P, a and b in the expression for R above, we have

$$R = 0.8 + \frac{1.2^2 - 0.8^2 + 2 \times 0.8 \times 0.5}{2 \times 0.8 - 2 \times 0.5 + 2 \times 1.2} = 1.333 \text{ inch.}$$

COMPARISON OF FIXED AND VARIABLE SPEEDS

M. S.—Two steamers start from New York at the same time for Liverpool. One steamer makes 18 knots and the other 16 knots. Upon its arrival at Liverpool, each steamer immediately returns to New York; the steamer that made 18 knots continues to make 18 knots on the return trip, but the steamer that made 16 knots makes 20 knots on the return trip. Apparently both steamers should arrive at New York at the same time, as the steamer which makes slow time on the outward trip, makes fast time on the return trip, and the average speed is the same as the speed of the 18-knot steamer. I have seen stated, however, that the 18-knot steamer will arrive at New York first. How can that be explained?

A.—The steamer making 18 knots continuously will arrive at New York first, due to the fact that the average speed of the other steamer which makes 16 knots on the outward trip and 20 knots on the return trip is not 18 knots, as would first appear. The time required on the outward trip by the 16-knot steamer is greater than the time required when returning at 20 knots, so that it is going at 16 knots considerably longer than it is going at a 20-knot speed; consequently the average speed for the time required for the combined outward and return trip is not the arithmetical mean between

16 and 20. Expressed as a formula, the average speed equals:

$$\frac{16\,T + 20\,T_1}{T + T_1} = \text{average speed,}$$

in which T = number of hours required for the outward trip,
T_1 = number of hours required for the return trip.

As an example, assume that the total distance from New York to Liverpool is 3,040 knots, then T will equal 190, and T_1, 152, and the average speed would equal:

$$\frac{16 \times 190 + 20 \times 152}{190 + 152} = \frac{6080}{342} = 17.77 \text{ knots.}$$

There is a common application in ordinary shop work of the principle involved in this problem. A planer has a cutting speed of 20 feet per minute, and a return speed of 60 feet per minute. At first thought it may seem that the average speed of the planer platen is 40 feet per minute, but that conclusion is not correct. For simplicity, assume the exaggerated condition in which the stroke of the planer is 60 feet. The cutting speed being 20 feet per minute, the forward stroke will require 3 minutes; and the return speed being 60 feet per minute, the return stroke will require one minute. The total time required for one forward and one return stroke is thus 4 minutes. During this time the platen has traveled two times the stroke, or 120 feet. The average speed thus is 30 feet per minute. The formula for finding this could be expressed:

$$\frac{2\,S}{\dfrac{S}{C} + \dfrac{S}{R}} = \text{average speed per stroke,}$$

in which S = length of the stroke in feet,
C = cutting speed in feet per minute,
R = return speed in feet per minute.

This formula can be simplified so as to take the form:

$$\frac{2\,C\,R}{R + C} = \text{average speed per stroke.}$$

If we substitute the quantities of the planer problem above in this formula, we have:

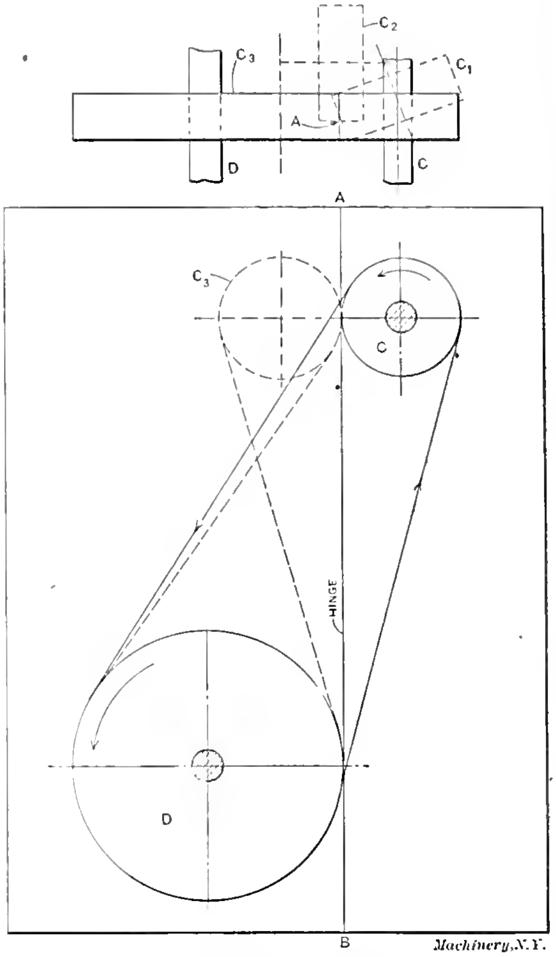
$$\frac{2 \times 20 \times 60}{20 + 60} = \frac{2400}{80} = 30.$$

It should always be borne in mind that the average speed is the arithmetical mean between two given speeds only when the periods of time, during which each speed is in operation, are equal. In this case of forward and return strokes at different speeds, one stroke is made in a shorter time than the other, and the average speed is *not* expressed by the arithmetical mean of the two speeds.

LOCATING ANGLE BELT DRIVES

F. O.—What is the general rule for locating a driving and driven pulley on shafts not parallel?

A.—Reference to the accompanying sketch, which is based on one shown in Spooner's "Machine Design, Construction and Drawing," will make the problem easily understood. First, suppose pulley C to be driven by a straight belt from pulley D on a parallel shaft, and that the vertical line AB is tangent to the middle planes of both pulleys. Now, imagine that the right-hand part of the diagram is bent backward on AB as a hinge. Pulley C and its shaft successively take the positions C_1, C_2, etc., until C_3 is reached, when the shafts of C and D are again parallel, pulley C having been swung through an angle of 180 degrees. In position C_3 the belt would be twisted as indicated by the dotted lines. The belt will run in the twisted position required by C_3 or any intermediate position including the common right-angle position C_2, provided its direction of motion is that shown by the arrows. Hence, the general rule: *Pulleys connecting horizontal shafts out of parallel must be so placed that a plumb-line dropped from the center of the upper pulley face will touch the center of the lower pulley face; and the retreating part of the belt from each pulley must follow the direction of the tangent (AB) to the pulley faces.* When the belt is twisted as shown at C_3, the shafts then being parallel, the belt will run in either direction, and, of course a face of the upper pulley need not be directly above a face of the lower pulley. In case it is desired to run an angle drive from a horizontal shaft to a vertical shaft, the same rule can be followed as given in the foregoing, except that AB will not be a plumb-line, but will be a horizontal line tangent to the middle planes of a driving and driven pulley face.



Locating Angle Belt Drives

LARGE GAS ENGINES

A comprehensive table referring to large gas engines developing over 1,000 horse-power appeared in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure.* According to this table 628 gas engines of 1,000 horse-power and larger and representing a total amount of power equal to 1,035,700 horse-power, have been built or are under construction at the present time. Of this total, 412 engines of 613,200 horse-power, or considerably more than one-half of the total, have been built in Germany; 154 engines with 337,500 horse-power in the United States; 33, with 42,200 horse-power in Belgium; 9, with 16,800 horse-power in France; 10, with 13,600 horse-power in Austria; and 11, with 12,400 horse-power in Great Britain. It is rather difficult to explain why the building of large gas engines has made so little progress in so highly developed a country as Great Britain, unless we ascribe this to the traditional conservatism of the Briton. The average size of the engines built in Germany was 1,500 horse-power; in the United States, 2,200; in Belgium, 1,300; in France, 1,900; in Austria, 1,400; and in Great Britain, 1,100 horse-power.

* * *

DATA SHEET CORRECTIONS

We soon shall publish a revised edition of MACHINERY's data sheets, and it is desired that the typographical and other errors in the first edition be corrected. We ask the cooperation of readers using these sheets to help make the new edition free from all mistakes, no matter how trifling. For the best list of corrections and criticisms we will give a prize of $5, and for the second best, $3.

INDUSTRIAL TRAINING THROUGH APPRENTICESHIP SYSTEMS*

The financial statement of every organization summarizes the assets and liabilities of that organization, and details with more or less accuracy the items composing them. Good form forbids the inclusion of any but tangible assets and actual liabilities, yet every organization is dependent for its success on the personnel of its executive and working force, which may be an asset if efficient and aggressive, or a liability if inefficient and decadent.

Efficient organization is the keynote of success. All available sources are exhausted by the modern business manager for material to construct his product, for means for financing his operations, and for energetic men to develop and execute his ideas. We frequently hear that Mr. Blank is a great man; he is identified with a dozen or more corporations; his name alone insures success to those who associate with him. We ask: How can he intelligently direct so many widely diversified industries? Why do his subordinates succeed? The answer is plain: He is a judge of men. He selects the right man for the place, reposes confidence in him, and through him controls an industry as a general through his subordinates controls an army. He recognizes the fact that these men are an asset of his business as much as is the capital invested, and he makes provision to supplement them as necessity demands, just as he provides for a future supply of raw material or sufficient capital to carry out his projects.

He may be able for a time to secure all the men he needs from others who have trained them, just as he may be able to borrow money for the development of his business, but he will have to make both men and money before his success is assured. Every enterprise requires men skilled in the manipulation of its affairs, versed in its various details and operations. The supremacy of an industry, a community, or a nation, is dependent upon the skill and intelligence of its working people.

Prior to the recent business depression, the utmost difficulty was experienced by employers of labor in securing sufficient numbers of skilled workmen. It was no uncommon experience for a concern to hire and discharge five men for every one retained. Really skilled men were not to be had at all in certain lines, and development was arrested on account of the inability to get desirable men. On the other hand, inefficient and unskilled help was plentiful. It is admitted by all that we need more skilled men and that some means must be devised for developing the inefficient and unskilled so that they may be valuable to themselves, their employers, and the community.

The supply of skilled men is not equal to the demand. Our public schools do not educate for any particular trade; our colleges educate broadly but not specifically; our technical schools lay the foundation for engineering professions, but relatively few men have an opportunity to avail themselves of the courses offered. Ninety-five per cent of the children who enter the public schools never reach high-school, and less than twenty-five per cent go above the fifth grade. This means that less than six million out of twenty-four million children in our public schools in 1907 will learn more than is taught in the primary grades. The average child in the United States attends school for less than five years. What does this mean industrially? It means that if we are to have industrially intelligent workers, we must devise means independent of our public school systems for training and developing them.

What Would Apprenticeship Systems do toward Raising our Standard of Industrial Intelligence?

Carefully devised apprenticeship systems operated in the majority of our factories would do much to augment the existing supply of skilled workmen. The need to employers of skilled workmen has already been pointed out; but not only are they necessary as producers—civilization itself has advanced along mechanical lines in such gigantic strides that there is a tremendous demand for, and a serious lack of, skilled men, simply to keep going the wheels of modern life; our towering buildings, our enormous ships, our great bridges—the thousands of mechanisms which are required to transport, to house, to feed, to clothe, to light, to heat, and amuse our people, present an immense field for trained men.

Apprenticeship systems would insure workmen being educated along *definite lines*, thereby meeting the demand for competent leaders. It is of the utmost importance that those who are to occupy executive positions should have familiarized themselves with the various details of the work under their supervision; they should be able to decide whether the judgment of their subordinates is sound, whether the operations required to make some particular piece are correctly performed, whether the quantity and quality of production for which they are responsible is of the required standard. This knowledge can be gained only by actual contact with the work, and a personal study of the conditions under which it is performed.

Apprenticeship systems would offer to young men of limited means, who would otherwise be forced into that large and growing class of unskilled labor, an opportunity to learn a trade. Poverty, disease, and crime are frequently the result of ignorance and environment. Every individual, workman or capitalist, is buoyed up, spurred on, by hope. Picture to yourselves the unskilled workman, earning the minimum wage on which a man can live and support his family. His greatest anxiety is concerning steady employment for himself, his one hope, an opportunity for his children. Where is this opportunity to be found? Not in an education which yields no immediate return, for he cannot support them during that period. His sons must find work, and that as soon as the law will permit, and it must be work which will support them from the beginning, for the father cannot. This means that these boys must take situations which require little, if any, skill; situations which pay practically as much at the beginning as at the end; unskilled work, unskilled wages, with no chance of advancement in either skill or remuneration. So they go on through all their lives, bequeathing to their sons what their fathers bequeathed to them—ignorance and poverty, possibly disease and a tendency for crime. What have they to hope for, to buoy them up, to spur them on? Give boys of this class an opportunity to learn a trade, to be skilled workmen and in demand, rather than unskilled and not in demand, and you solve a large problem in American economics. Apprenticeship systems offer this opportunity.

Do apprenticeship systems pay the employer? Most emphatically *yes*. Many successful concerns who have had apprenticeship systems in operation for a period of years are unanimous in their statements that apprenticeship systems do pay. If properly instructed and intelligently directed, the employment of apprentices is more profitable than the employment of the so-called skilled workman who has been available in the past. Apprentices pay as producers during their term of service; as skilled journeymen when they have completed their course; and as intelligent foremen and executives later on. Those boys who leave at the termination of their apprenticeship become staunch supporters of the mother-shop; always ready to say a good word for it; as loyal as college graduates to their *Alma Mater*; an unequalled advertising medium.

Does it pay the employe to serve an apprenticeship? I firmly believe that it does. He is raised from the ranks of unskilled labor and given an earning power which he could not otherwise command. He is taught to work intelligently and to apply his mind to his work, thus increasing his opportunity for further development and advancement.

What Provisions should Apprenticeship Systems Make for the Employed?

Apprenticeship systems should provide for a proper term of service to insure ample time for thorough instruction. A distinct proportion should exist between the period of time required to learn a trade, and the degree of skill required in the trade. Apprenticeship systems should provide for sufficient remuneration to support the apprentice during his term of service. Applicants for apprenticeship courses will, in the majority of cases, come from the working classes—from the farms in many instances; and they must of necessity have an opportunity for self-support during their period of apprenticeship.

Apprenticeship systems should provide instruction in the technique of the trade and allied studies. The average boy

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* Paper read by E. P. Bullard, Jr., before the National Metal Trades Association Convention in New York, April 15, 1909.

begin to learn his trade between the ages of 14 and 17 years. He has not advanced beyond the fifth grammar grade, and probably could not pass an examination on any subject which he has studied. He has not been taught to reason or apply such knowledge as he has. If he is to become a skilled mechanic, it is essential that he should be well grounded in the elementary studies which are allied to his trade. He should be taught the mathematics of his work, the technical terms usually employed, and sufficient reading, writing, and spelling, to supply the deficiencies of his common school education.

Apprenticeship systems should provide instructions in the manipulation and care of the appliances of the trade. I believe there are many who either own or are responsible for valuable manufacturing equipment which is practically at the mercy of unskilled employes or uninstructed apprentices. The average employer would deny this statement, believing as he does that the foreman supervises and instructs his workmen and apprentices. As a matter of fact, the foreman seldom has time to explain to each man or boy such items as the necessity and economy of sufficient lubrication, the function of each mechanism, and the means which should be employed to obtain the most economical results. Being occupied with what are to him more important matters, he is content to let the boy find out these things for himself—an expensive and inefficient system. Every large plant maintains a repair department at a cost which is no inconsiderable portion of its operating expense. Instruction in the care and manipulation of the appliances which it uses would do much to reduce this item.

Apprenticeship systems should provide for the fostering of a spirit of ambition and desire for increased knowledge. Let the apprentice see that his diligence will be rewarded, that he may in time be foreman, superintendent, or manager, if he applies himself to his work, and no difficulty will be experienced in securing all the boys required. If there is anything in a boy this will bring it out; if not, get one who will appreciate his opportunities.

As the employes of any industry may be divided into two classes, producers and non-producers, workers and executers, and as there is need for trained men in each of these classes, I recommend that apprentice courses be arranged to meet these conditions. Let the boy who is bright and ambitious, and who otherwise shows the necessary qualifications, become more than a mere workman, have an opportunity to learn the full trade, including instruction in the studies allied to the trade. Impress upon him the fact that he is given an exceptional opportunity, and demand in return exceptional interest and effort. Advance these boys systematically through the course and weed out such as are not up to a high standing. Select your executives as far as possible from among their number, and thus show them that their efforts will be rewarded.

As the workers outnumber those having executive ability, it is fully as important that as much attention be paid to the development of the former as the latter. Relatively few applicants for apprentice courses have any expectations of ever becoming more than skilled specialists. Why then waste time and money in teaching the full trade to a boy who has neither the intelligence nor ambition to become more than a mere specialist? Provide special courses for these boys covering the various branches of the trade; make the time of service relatively short and wages high as compared to the full apprentice course; give graduates of these special courses an opportunity to learn the full trade later on if they show special ability, allowing credit for the time already served on the special course. The full apprentice course would train boys to fill executive positions. The special courses would develop skilled workmen with a minimum expenditure of time and money.

What is the attitude of labor unions toward the apprentice system? No labor union having the welfare of the workingman at heart can be opposed to well-organized and well-conducted apprentice courses. They may as well be opposed to our public school system on the ground that education is dangerous. The labor union which sets its seal of disapproval upon well-organized and well-conducted apprentice courses admits its ignorance of industrial and social developments and requirements. It cannot have the welfare of its members or the working classes at heart. It should be recognized as hostile to the best interests of employer and employe alike and should not be tolerated in any community. Labor unions can in no way more conclusively show their interest in the welfare of the workingman than by endorsing and furthering the adoption of apprenticeship systems and schools. The apprentice school is a necessary adjunct to any well-organized apprentice system. Few concerns are large enough to support a school of their own as is done at Lynn and Schenectady, and not every community is prepared to establish a technical school such as Wynona or Cincinnati University. Fortunately, however, like industries usually locate in the same neighborhood, so that it is possible for manufacturers employing a similar class of labor to cooperate in the establishment and maintenance of apprenticeship schools.

In Bridgeport, Conn., this has been done very successfully. The members of the local manufacturers' association, working in conjunction with the Y. M. C. A., have established a school for apprentices, who attend two hours per day five days a week. The boys are paid regular wages for the time they spend in the class-room, and the expense for the instructor, who is especially employed for this purpose, is borne by the manufacturers who have boys in the school. The Y. M. C. A. was selected, as the building was provided with class-rooms and had all facilities for carrying on the work. The courses are laid out by a committee of manufacturers, and the work is directly under their supervision. The expenses are nominal and the results secured thus far are satisfactory.

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SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The American Society of Mechanical Engineers will hold its Spring meeting in Washington, D. C., May 4-7. Professional sessions will be held at which papers on the conveying of materials, gas power engineering, steam turbines, the specific volume of saturated steam, oil well pumping and various other subjects will be discussed.

At the reception, which will be held in the New Willard Hotel, an address of welcome will be made by the Hon. B. F. Macfarland, President of the Board of District Commissioners, with a response by Mr. Jesse M. Smith, President of the Society. During the convention President Taft will hold a reception for the members at the White House. The War Department will give a special exhibition drill of the U. S. troops at Fort Myer, to which the members and guests will be invited. At the same time, if the conditions are favorable, an ascension of a dirigible balloon will be made and probably also that of an aeroplane. An address will be given by Rear-Admiral Melville, retired, Past President of the Society, and former Engineer-in-Chief of the Navy, the subject being "The Engineer in the Navy." This evening will be made the occasion for the presentation to the National Gallery of a portrait of Rear-Admiral Melville presented by friends and admirers. It will be received for the National Gallery by Dr. C. D. Walcott, Secretary of the Smithsonian Institution. F. H. Newell, Director of the Reclamation Service, will deliver an illustrated address on "Home Making in the Arid Regions." Trips will be made to various points of interest about the city and a number of pleasurable excursions have been planned. The papers to be presented are as follows: "A Unique Belt Conveyor," Ellis C. Soper; "Automatic Feeders for Handling Material in Bulk," C. Kemble Baldwin; "A New Transmission Dynamometer," Prof. Wm. H. Kenerson; "Polishing Metals for Examination with the Microscope," A. Kingsbury; "Marine Producer Gas Power," C. L. Straub; "Operating System for a Small Producer Gas Power Plant," C. W. Obert; "A Method of Improving the Efficiency of Gas Engines," T. E. Butterfield; "Offsetting Cylinders in Single-Acting Engines," Prof. T. M. Phetteplace; "Small Steam Turbines," Geo. A. Orrok; "Oil Well Tests," Edmund M. Ivens; Safety Valve Discussion; "Specific Volume of Saturated Steam," Prof. C. H. Peabody; "Some Properties of Steam," Prof. R. C. H. Heck; "A New Departure in Flexible Staybolts," H. V. Wille.

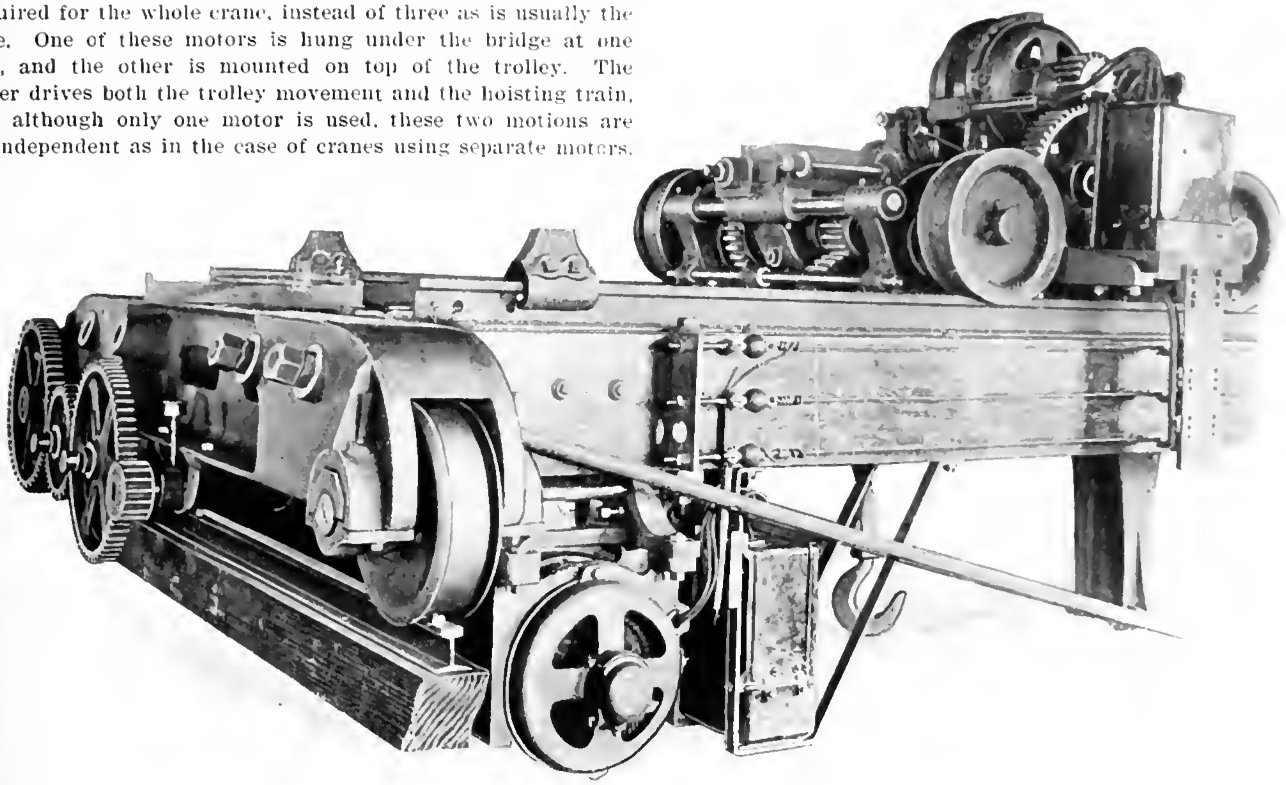
NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

NEW ELECTRIC TRAVELING CRANE

The electric traveling crane illustrated herewith is built by the Lane Mfg. Co., Montpelier, Vt. It is a radical departure in design from usual types, particularly in its use of non-reversing motors. In the conventional electric crane the motors must be stopped, reversed and again brought up to speed for each and every change of movement. As the armatures are heavy and run at high speeds, this means a large consumption of energy in doing useless work.

In the crane here shown, this waste is avoided, and the motor armatures serve as flywheels of considerable capacity in compensating and equalizing the varying demands for current, especially when loads are applied suddenly. The reverse motions are effected by means of bevel paper-and-iron friction wheels, and these are so combined that only two motors are required for the whole crane, instead of three as is usually the case. One of these motors is hung under the bridge at one end, and the other is mounted on top of the trolley. The latter drives both the trolley movement and the hoisting train, and although only one motor is used, these two motions are as independent as in the case of cranes using separate motors.



An Electric Crane with Power Movement in all Directions, operated by Two Non-reversing Motors

The motors are of a special, enclosed dust-proof type, made by the General Electric Co., and are connected to the friction wheels by rawhide spur gearing. The paper frictions are the driving members in all cases, thus doing away with any tendency to wear into ridges or get out of round. They are of the same type as those long and successfully used on rope-driven cranes made by the same company under the Anderson patents. The starting boxes of both motors are controlled from the operator's seat, which is located at one end of the trolley. From this position the driver always has an unobstructed view of his work, and he is not dependent on signals from those below.

The hoisting train is driven by a worm and worm gear running in an enclosed chamber filled with heavy grease and flake graphite, and provided with stuffing boxes to prevent the lubricant working out in hot weather. Owing to this form of drive, a brake is almost unnecessary, but one is provided to prevent racing of the worm in lowering heavy loads. In addition to the customary oiling arrangements, grease cups are provided at all important points, and most careful provision made to prevent the dripping of oil or grease from any part of the crane.

With the exception of the hoisting rope and hook, all parts of this crane are designed with a factor of safety of five. These two elements are purposely made weaker to insure the more expensive and important portions of the machine against serious overloading, as well as to insure that such overloading would be indicated by a gradual failure of the rope or hook rather than by the sudden yielding of some more rigid member. As evidence that only good material and workmanship enter into their construction, the makers state that these machines have on several occasions lifted and carried overloads of more than 2½ times their rated capacity; and while they do not advise such practices, or guarantee the machine for more than its rated capacity, they state that this was done without apparent effort or injury to any portion of the mechanism.

So far these cranes have only been made with bridges of Southern pine, trussed with wrought-iron rods, but the makers expect to be able to offer them at an early date with steel bridges, when these are required. For spans not exceeding fifty feet the timber bridge has proved perfectly satisfactory, and when this type of bridge is used these cranes are sold at prices far below those at which such machines have usually been marketed.

These electric cranes are fully guaranteed by the makers, who claim great economy of their machines in current consumption, as based not only on the argument set forth above, but also on tests made in actual operations.

PROVISIONS FOR WATER COOLING ON THE COLBURN BORING MILL

In the January issue of MACHINERY we printed a little story, at least 95 per cent true, entitled "The Adventures of a Water-Cooled Boring Mill." In this story was described the evolution of an effective guard to retain water or other lubricant used for cooling the tool and the work, when using high-speed steels in the boring mill. The Colburn Machine Tool Co., of Franklin, Pa., has sent us a description and photographs, herewith reproduced, of an arrangement of the same kind as that we described, which it has applied to one of its latest 34-inch boring mills.

The essential features in a guard of this kind are: First, it must thoroughly protect the operator and catch all the lubri-

ant, it must thus extend above the highest and below the lowest part of the revolving chuck or table. Second, it must be so designed that it will not be in the way of the wrench in the clamping or unclamping of the chuck, and it must not interfere with the placing or removing of the work. These conditions are fully met in the device shown in Figs. 1 and 2.

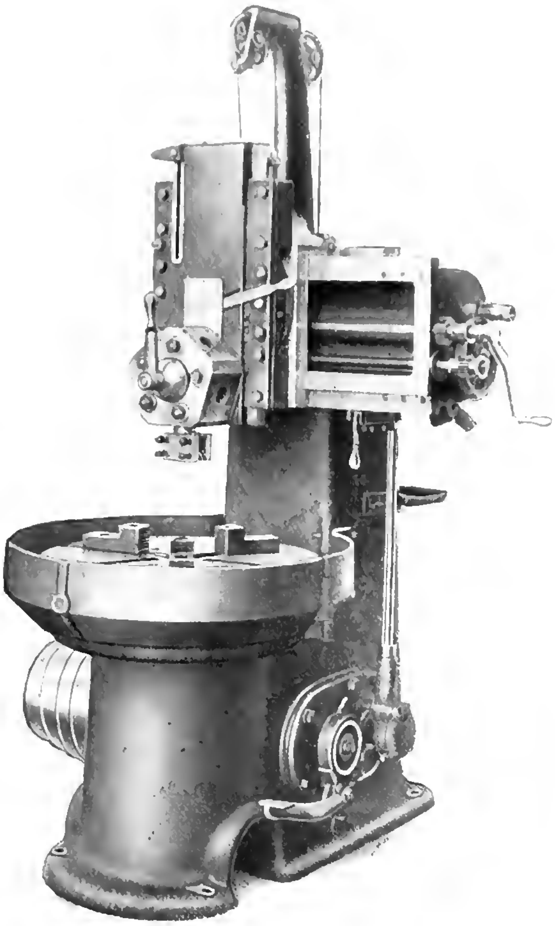


Fig. 1. The Colburn Boring Mill, as arranged for Water Cooling

As may be seen in Fig. 2, the guard consists of four pieces. Two supporting brackets are bolted to the frame of the machine, one on each side. These brackets form part of the guard and are of the same shape as the front part. The stationary brackets encircle one-half of the entire table or chuck, and at their outer ends have hinges to which are attached the front sections of the guard. These two front sections, or wings, may be opened and swung backward as shown in the illustration. When in this position the chuck is perfectly accessible for opening and closing the jaws, and for putting on and taking off work.

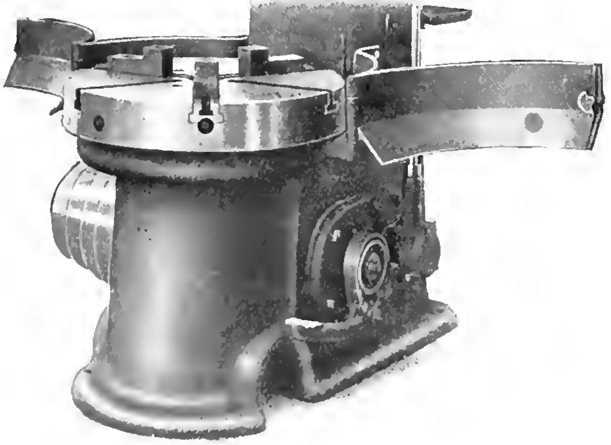


Fig. 2. Construction of the Guard for the Water or other Cooling Liquid

When closed, as shown in Fig. 1, the two wings are locked together by means of a latch operated by the handle or knob in front. A suitable trough made of sheet metal can be attached underneath the guard to drain off the lubricant and catch the chips, or the chips and lubricant can be allowed to fall to the floor into a large pan under the entire base of the machine. By using a large pan of this kind, all the lubricant and chips falling from the guard, as well as through the hollow spindle, can be caught, and by means of a suitable pump the lubricant can be carried back to the work again.

This provision greatly increases the capacity of the boring mill on certain classes of work, such as the machining of steel and aluminum, where it is very advantageous to use oil, water, kerosene or other lubricant adapted to the particular material in hand. This is regular practice in certain kinds of lathe and screw machine work, and suitable means for taking care of the liquid are regularly provided. The same advantage results from their use on the boring mill, though it is not so easy to make effective guards. This arrangement, however, appears to serve its purpose well, and should thus be of material advantage in increasing the output of the machine.

NEWARK GEAR-CUTTER GRINDING MACHINE

The illustration presented herewith shows a form of cutter grinding machine especially adapted to the sharpening of gear cutters, which has recently been devised by the Newark Gear Cutting Machine Co., 66 Union St., Newark, N. J. The cardinal points aimed at in the design are a combination of simplicity and accuracy in operation, and the supplying of a machine which is always set up for grinding gear cutters, without the use of special, loose attachments as required by universal grinding machines.

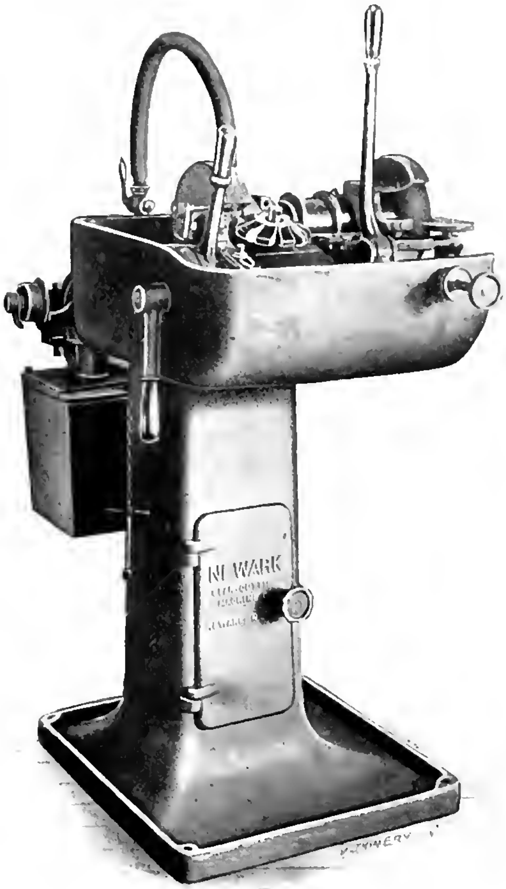


Fig. 1. Special Water-cooled Grinder for Sharpening Formed Gear Cutters

The cutter to be ground, *A* in Fig. 2, is mounted on a fixed stud to which it is fitted by bushings which are part of the equipment. The table in which the stud is fixed is adjustable parallel to the axis of the grinding wheel spindle, so as to set the edge of the wheel in line with the center of the cutter stud *A*. The stand *B*, upon which the table is mounted, is adjustable upon a horizontal trunnion *C*, thus providing means for tilting the table up and down. This allows coarse-pitch gear cutters, as shown in Fig. 2, to be ground in two corners

between the teeth, without changing the wheel or removing the cutter from the stud. It also affords a quick adjustment for placing the cutter central with the wheel to suit the different thicknesses of cutters used. This tilting adjustment is controlled by the upright handle at the left of the machine, and is locked by the handle hanging down on the outside of the pan at the left. The feeding of the wheel in toward the cutter is effected by the vertical handle at the right. A stop screw is provided for this movement.

There is a pawl on the cutter table which is adjusted to touch the back of the tooth to be ground. After being once set, the cutter can be rotated from tooth to tooth past the pawl. After cutting once around, an adjusting screw shifts the pawl so as to rotate the cutter slightly, giving a little deeper cut. This adjustment, which constitutes the feed, always results in a radial tooth after the wheel is once set in line with the center of the stud. No dials are used for indexing, as the pawl operates on the backs of the teeth of the cutter itself. For this reason it is not necessary to count the number of teeth in the cutter, or to select suitable dials for that number. This makes the action of the machine very rapid, the makers claiming that it is possible to grind the cutter while the indexing mechanism of other machines is being set. Its simplicity also gives it the advantage of being less subject to the wear which is bound to occur in a grinding machine of any kind.

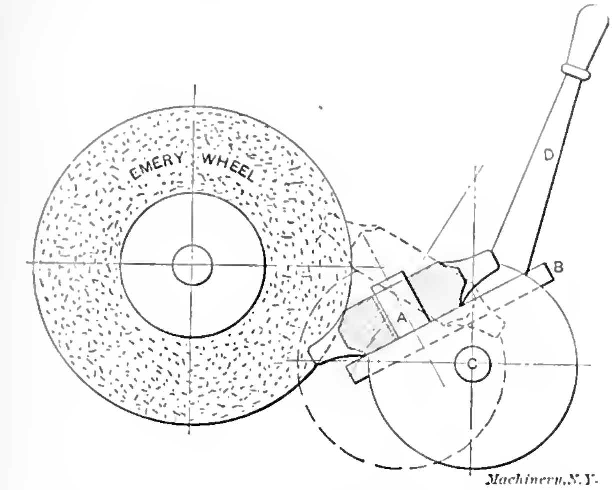


Fig. 2. Adjustment of Table, permitting Grinding the Sides of Large Cutters

As may be seen, this machine is arranged for water cooling. The liquid is supplied by a centrifugal pump supported at the rear of the column. Baffle plates are provided for separating the grinding dust from the water. The large pan is a splash basin merely; the water does not remain in it but flows into a reservoir. Among the other conveniences furnished with the machines is the provision of fixed handles, largely avoiding the use of wrenches, and facilitating the use of the machines. Where wrenches are required, they are fastened to the base of the machine by chains, as shown, to prevent them from being lost or taken away for other machines. This arrangement was found advisable in the shop of the builders, as it is a great advantage to have this machine always ready for instant use. The column is of box form and contains a cabinet for cutters, grinding wheels, etc.

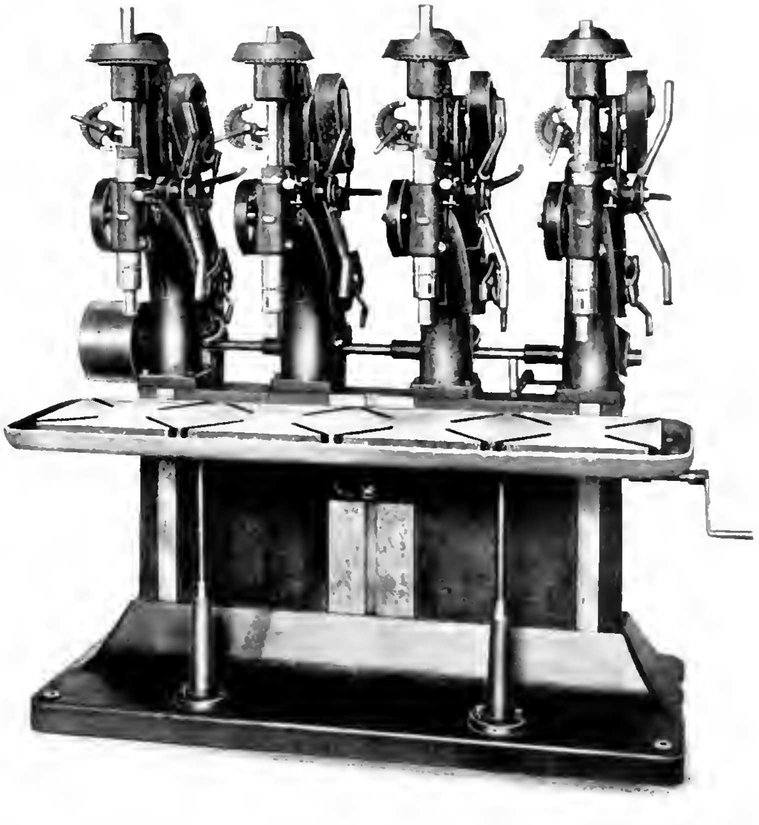
The machine will take cutters from $1\frac{3}{4}$ up to 8 inches in diameter. The grinding wheel is 8 inches in diameter with a 1-inch hole, and is of dished form. It is mounted on a hardened and ground spindle running in bearings of phosphor bronze adjustable for wear. The end of the spindle at the right, outside of the water basin, is used as a hand tool grinder, and will use up wheels after they are worn too small for the gear-cutter grinder. A hand rest is provided for this end of the spindle. The regular equipment includes two grinding wheels, the diamond truing device, and bushings which, in connection with a $\frac{7}{8}$-inch stud, will take cutters having $\frac{7}{8}$-, 1-, $1\frac{1}{16}$-, $1\frac{1}{2}$-, $1\frac{3}{4}$- and 2-inch holes. An overhead countershaft is also furnished.

BARNES DRILL CO.'S GEAR-DRIVEN GANG DRILL

The geared drive drill press made by the Barnes Drill Co., 602 S. Main St., Rockford, Ill., was described in the New Tools department of the May, 1908, issue. On this drill press a gear box giving four changes, and a back-geared drive which doubles this number to eight, are used, eliminating the use of cone pulleys entirely. Positive and quickly obtained feed changes are also provided, ranging from 0.001 to 0.025 inch. Four of these tools have been combined by the makers in the form of the gang drill shown herewith, for use on work requiring several operations.

The four spindles are driven by a single shaft passing from side to side through the machine. Any single spindle may be instantly stopped by throwing the speed-changing lever into the central position, thus throwing the transmission gears out of mesh. All the changes of speeds and feeds are made instantly by the operator from the front of the machine, without stopping the spindle. This holds true with the back gears as well as the regular changes. The feed-changing lever is shown at the left of each spindle, centered on the ratchet-faced segment by means of which it is set. For tapping, any or all of the spindles will be furnished with reversing friction clutches. The spindle at the right of the machine in the engraving is so equipped.

The table is surrounded by an oil channel as shown, and is supported by two screws, thus making it very rigid for heavy pressure on large work. The table is raised and lowered by means of a crank at one end. When desired, this gang drill will be furnished with independent columns for each spindle to sit on a heavy bed base with separate tables, either round or square. Either style of machine can be furnished in two, three, four or six spindles.



A Four-spindle Gang Drill, with Independent Gear Speed and Feed Changes

General strength and convenience have been carefully looked out for in this machine. Each spindle has the same capacity as the makers' all-geared 20-inch drill—that is to say, it will properly handle 1-inch twist drills in steel without back gears, or $1\frac{1}{2}$-inch drills in steel with back gears. It will drive a tap up to 2 inches in diameter in cast iron. Each head has a

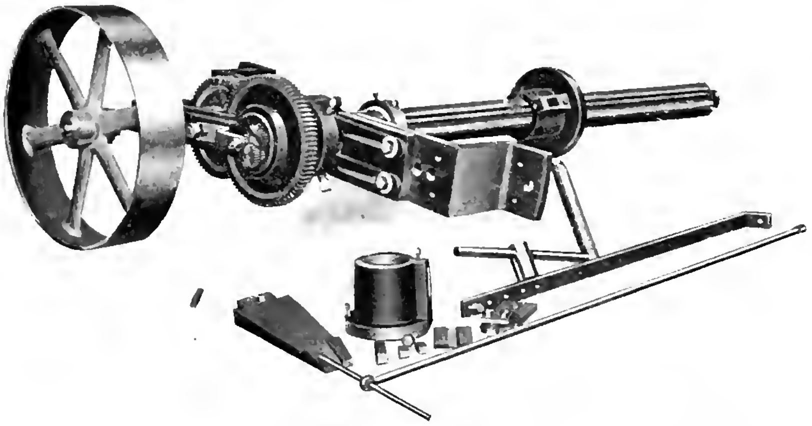
back brace which adds greatly to its strength and stiffness. The driving gearing is unusually large and strong, as is also the spindle, which is double splined. A No. 3 taper is regularly furnished on the spindle, but a No. 4 will be supplied when desired The drift hole is placed below the sleeve, so that it is unnecessary, when removing the drill, to rotate the spindle to match a hole in the sleeve.

The machine stands 72 inches high in all, and the spindles are spaced 5 inches from center to center. Each of them will drill to the center of a 20-inch circle. The vertical travel of the spindle is 10 inches, and of the table 11 inches, giving a maximum distance from the spindle to the table of 27 inches. The planed surface of the table for the 4-inch spindle machine measures 14 by 60 inches. The four-spindle machine is driven by a pulley 12 inches in diameter and 5 inches wide, running at 100 revolutions per minute.

NAPPANEE PORTABLE BORING BAR

The boring bar illustrated herewith is made by the Nappanee Iron Works, of Nappanee, Ind. It is designed for general boring, though especially adapted to the re-boring of cylinders up to 36 inches in diameter. By the use of this tool the cylinders of all kinds of engines, air compressors, steam hammers, pumps, blowing engines, Corliss valve seats, etc., can be re-bored in place in any position and in cramped quarters if necessary, such as are met with on board ship.

This tool is of the construction which provides for the supporting of the boring bar at one end by bushings in the stuffing-box bore, and at the other by a universal adjustable support, fastened usually to the flange of the cylinder. When supported in this way, cylinders can be re-bored in less time than it would take to remove them from their fixed position. All steam connections, studs, anchor bolts, etc., remain intact. Enough cutter heads, arms and tools are furnished with each size of bar to cover the full range. The bar is powerfully geared and can be driven by hand or power. The steel feed-screw is firmly mounted in the bar, giving a strong and rigid movement. The feed nut is made of brass, and is accurately fitted with a square thread, 8-pitch feed-screw.


A Portable Rig with Automatic Feed, for Re-boring Cylinders of Steam and Gas Engines, etc.

The features to which the builders desire to call particular attention are the compactness, strength and simplicity of construction. The wide range should also be noted. The No. 3 size will bore from 7 to 36 inches in diameter. The simplicity of construction enables the device to be sold at a low cost. Inquiries addressed to the manufacturers will be referred to the nearest dealer handling these machines.

LATHE GRINDING ATTACHMENT FOR INTERNAL AND EXTERNAL WORK

The accompanying illustrations show an electric grinding attachment for the lathe which may be arranged for either external or internal grinding, provision for the latter operation being made by the use of an internal attachment similar in principle to that applied to regular cylindrical grinding machines. This tool is built by the United States Electrical Tool Co., of Cincinnati, Ohio.

The grinding spindle, and the motor, of which it forms the armature shaft, are adjustable on a horizontal slide, which is, in turn, vertically adjustable on the face of a knee clamped to the swivel of the compound rest of the lathe. This method of supporting gives a feed at any angle by the adjustment of the compound rest base, and the operation of the lead-screw on the horizontal slide attachment. It also permits the centering of the wheel spindle with the center line of the lathe by the vertical adjustment of the motor and slide on the knee.

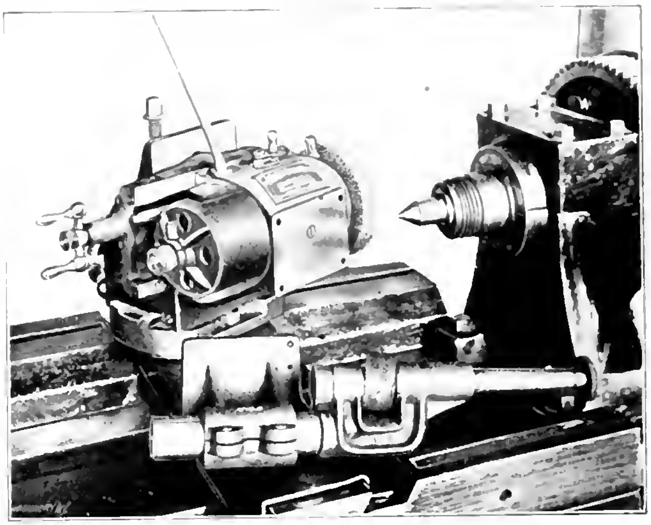


Fig. 1. Electric Grinding Attachment Mounted on Compound Rest Swivel of Lathe

Fig. 1 shows the device as used for external grinding. In this particular case the compound rest has been set at an angle to true up the live center. The wheel is fed back and forth for this operation by the feed-screw of the attachment. When arranged for external grinding, it may also be employed for sharpening reamers and cutters in the lathe, and in finishing mandrels, dies, etc., in a lathe, planer or shaper, it being evidently adaptable to surface grinding as well as to cylindrical grinding.

Fig. 2 shows the internal grinding attachment (which is dismounted in Fig. 1) attached to the face of the motor and in use grinding a hole in a die. Conical, dust-proof bearings, adjustable for wear, are also used in this attachment as well as on the main grinding spindles. The device is belt-driven by means of a large pulley on the armature shaft and a small pulley on the grinding spindle. When a 1¼-inch wheel with a ¼-inch face is used on the latter, it may be speeded up to 18,000 revolutions per minute. When arranged for internal grinding it is adapted to the finishing of dies, gasoline engine cylinders and internal grinding of all kinds.

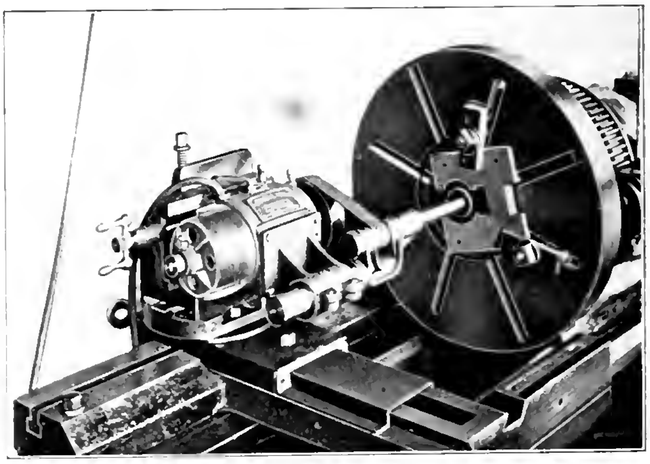


Fig. 2. Internal Grinding Spindle in Use

This grinder can carry emery wheels ranging from 4½ to 12 inches in diameter throughout the range of the four sizes for which it is made. Internal grinding attachments which will grind holes varying in depth from 4½ to 8 inches will be supplied. The motor is wound for 110 or 220 volts direct

current, or for the same voltages on a 60-cycle, one-, two-, or three-phase alternating current circuit.

GRAHAM PRESSED STEEL GRINDER CHUCKS


Fig. 1. A Chuck for a Face Grinding Wheel having a Pressed Steel Body

The Graham Mfg. Co., of Providence, R. I., has placed on the market an all-steel chuck designed for holding ring emery wheels. While intended primarily for use on machines of the disk grinder type, they are adapted also for any other machines in which the side of the wheel is used for the grinding. The main points of interest in this device are the use of a body of pressed steel without any projections to speak of, the provision of an adjustable backing flange for setting the ring out as it wears down, and the provision of a simple and effective clamping device. Care has also been taken to make the design of the centers on which the chuck is mounted such that they will readily fit machines of widely varying construction.

A reproduction of a photograph of the chuck is shown in Fig. 1, while Fig. 2 gives details of its construction. The body *A*, as has been mentioned, is made of pressed steel, turned and finished all over. While very light this has all the strength required for the work it has to do. In this respect, it is much more reliable than cast-iron or steel castings, owing to the small amount of stock which has to be removed and the avoidance of blow holes and other hidden defects.

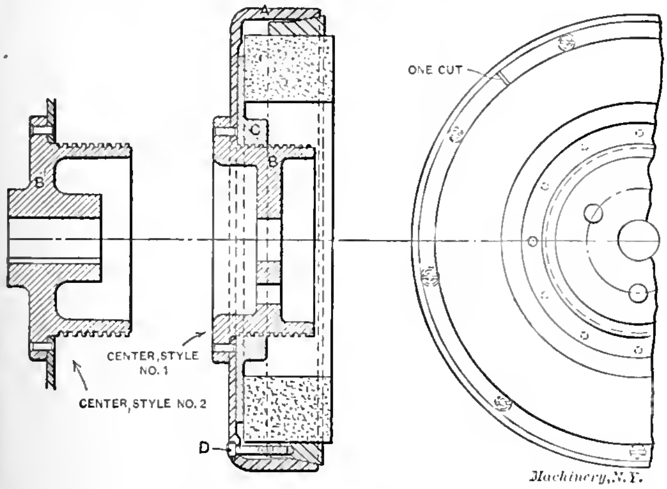


Fig. 2. Sectional View of the Graham Pressed Steel Grinding Chuck

This body is fastened by small rivets to the cast-iron center *B*, which is made to suit any style of spindle. Two examples of varying styles of center are shown, one at *B* and the other at *B'*. The first would be used for disk grinders, and the second for all kinds of face grinding machines, such as used for work on knives, safe plates, guide bars and special work. This center *B*, which is threaded on its periphery, serves also as a screw for the setting-out nut *C*. This nut is turned by a straddle wrench provided with pins to engage holes drilled for the purpose, which show quite plainly in Fig. 1.

The clamping device consists of a split ring drawn into a tapered conical bearing in the body *A*, by numerous screws *D* at the back. This ring has but one cut in it, which has been found by experience to be sufficient. This gives a very powerful and satisfactory grip. Provision is also made, when necessary, for the use of sectional blocks of emery, in place of solid rings, though this is not illustrated in either of the engravings.

Chucks of this kind are called for principally by users of disk grinders, whose work requires something less expensive and more durable than emery cloth. These chucks are known in size by the outer diameter of the grinding ring rather than the over-all dimension. In this particular design this outside diameter has been reduced greatly in comparison to that of the wheel, owing to the use of the pressed steel body. These chucks are made to take rings from 9 inches to 30 inches in diameter and weighing from 40 to 330 pounds for the different sizes. On the very largest of them the outside diameter of the body is not more than 2 inches larger than the diameter of the ring.

WRIGHT QUICK-ADJUSTING WRENCH

The Wright Wrench Co., of Canton, Ohio, and Tacoma, Wash., has designed the simple and quickly-adjusted wrench shown herewith. Fig. 1 shows the tool in the workman's hand, while Fig. 2 shows its construction. Its simplicity is evident.

It is composed, as may be seen, of two main members—the outer jaw and handle *A*, of one piece, and the sliding jaw *B*. The latter carries in a recess a toothed gripping block *C*, which engages the corresponding teeth of a ratchet strip *D* Spring *E* tends to hold the teeth of the block in contact with those of the strip and thus lock the wrench. By pressing down on the outer end of the jaw with the thumb, however, as shown in Fig. 1, these teeth are disengaged, and the thumb is free to slide the jaw to any adjustment throughout its range. Releasing the hand of the operator again sets the adjustment in the new position.


Fig. 1. The Wright Quick-adjusting Wrench

The handle and outer jaw are made of 20-point carbon, open-hearth, drop-forged steel, carbonized, mottled and hardened. The sliding jaw is made of carbonized semi-steel, also mottled and hardened. The rack and pawl are of carbon tool steel. All these parts are hardened. The spring steel wire is of oil tempered steel. The parts are milled, ground and polished before putting on the mottled finish, which resists rust and is far superior to a bright finish in durability. The carbonizing is done from the makers' special formula.

The American Locomotive Co., recently made a comparative test to destruction of a series of 12-inch wrenches, using many forms and shapes. These failed at a leverage of 7 inches from the center of the nut at pressures varying from 1,700 to 4,000 pounds. All the other wrenches fractured in such ways as to make the jaw useless. The Wright wrench became inoperative at 2,600 pounds, owing to the giving out of the ratchet mechanism. Since this can be repaired at a cost not to exceed 10 cents, it will be seen that the tool is easily made as good as new, and ready for service even at this high pressure.

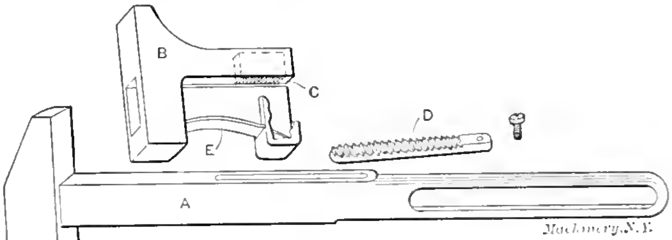


Fig. 2. The Construction of the Wright Wrench

The tool is made in various sizes from 6 inches up to 18 inches. It will take small hexagon nuts or finished screw

heads and leave them in as good condition as the ordinary screw adjustment wrench, since provision is made to avoid back lash, and the wrench will not lock on the nut or lose its adjustment while in operation.

WALTHAM CLUTCH CUTTING MACHINE

The Waltham Machine Wks., Newton St., Waltham, Mass., makes the automatic clutch cutting machines shown herewith. They are designed for cutting the ratchet-shaped teeth on the clutches used in the stem-wind mechanism of watches, or for cutting teeth of any shape on small parts, in which the direction of the cut is at right angles to the axis of the work. They are made in two styles, shown in Figs. 1 and 2 respectively. In Fig. 1 the machine is arranged to stop after the completion of the last cut so that the work may be removed and a new piece put in by hand. With the machine in Fig. 2 the mechanism runs continuously, the blanks being fed from a magazine and removed automatically from the machine.

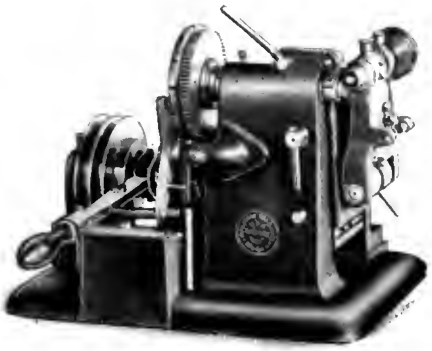


Fig. 1. Automatic Face Clutch Cutting Machine for Small Work

The blank is held by a spring chuck in an indexing spindle at the front of the machine. The cutter spindle is carried in bearings attached to a swinging arm. These bearings are normally at right angles to the axis of the work spindle but may be swiveled somewhat so that a slight undercut may be made. The swinging arm in turn is carried by a vertical slide operated by a cam. The support for this slide can be swiveled 5 degrees to either side of the vertical position, so that angular cuts can be made. Screw adjustments are provided for centering the cutter and setting it to the depth of cut. The adjustment for the location of the cut is made by an eccentric on the swing shaft.

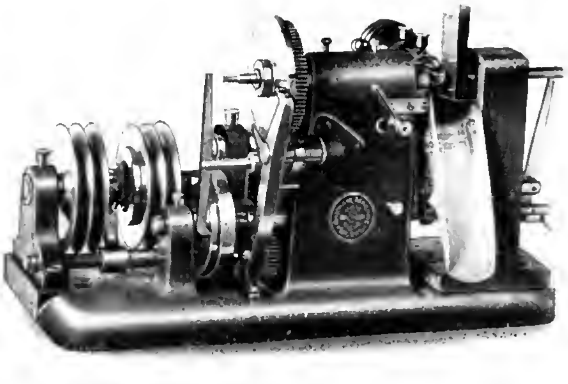


Fig. 2. Clutch Cutting Machine, with Magazine and Automatic Feed

The pitch of the feed cam is made to suit the particular work on which the machine is to be used. The cut is made from the top downwards and the cutter is swung away from the work during the return to allow for indexing. A friction indexing mechanism is used. An important provision in the machine is that for cutting the work around twice for the purpose of removing the burr on the tops of the teeth made by the first cut. This second cut is made at a considerably increased speed.

The machine shown in Fig. 2 is practically identical with that shown in Fig. 1 except for the addition of the mechanism necessary for the automatic handling of the work in placing it in the chuck and removing it after completion. The magazine in which the blanks are placed is shown extending upward at the right. The use of this automatic attachment adds from 20 to 25 per cent to the production of each machine and permits one operator to care for a large number of them. The machine illustrated here will cut teeth of 64-pitch or finer.

NORKA TWO-GROOVED HIGH-SPEED TWIST DRILL AND CHUCK

In the department of New Machinery and Tools in the April, 1908, issue of MACHINERY, we illustrated two designs of high-speed drills, made by the Whitman & Barnes Mfg. Co., of Akron, O., and Chicago, Ill. One of these was a flat drill, and the other a twist drill made of high-speed steel, twisted while hot so that the grain of the steel was not disturbed. This method of making gives these tools great strength and durability in the most refractory materials. The construction has since been improved, as shown in the accompanying illustrations, giving apparently a drill of somewhat simpler form and a more compact chuck.

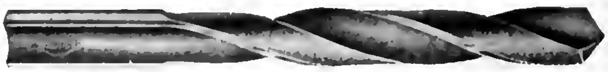


Fig. 1. The Norka High-speed Twisted Drill

The drill, it will be seen, has no tang, the driving being done on the whole length of the shank. In twisting the drill, a section of the stock is left untwisted and this part, being grooved, forms the shank. The jaws of the chuck are carefully machined to fit this groove, so that the drill is not only held securely, but centrally as well. The whole drill is ground to size, and may be used for work of the highest accuracy. It is made of "W. & B." high-speed steel, mixed to the manufacturer's special analysis, which gives the drills the necessary hardness to secure the maximum amount of work, and at the same time retains the toughness required to reduce splitting and breakage to a minimum.


Fig. 2. Special Chuck for Norka Drill

The chuck, as stated, is accurately made. The jaws are locked on the drill by a heavy clamping nut. Figs. 2 and 3 show the chuck alone, and with the drill in place, respectively. The thrust of the drill is taken (it will be seen) by a loose key inserted between the jaws at the bottom of the slot. There are thus but three pieces in this tool.

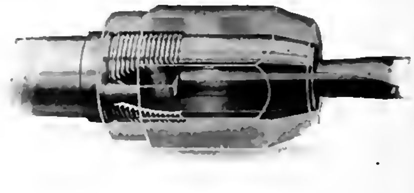


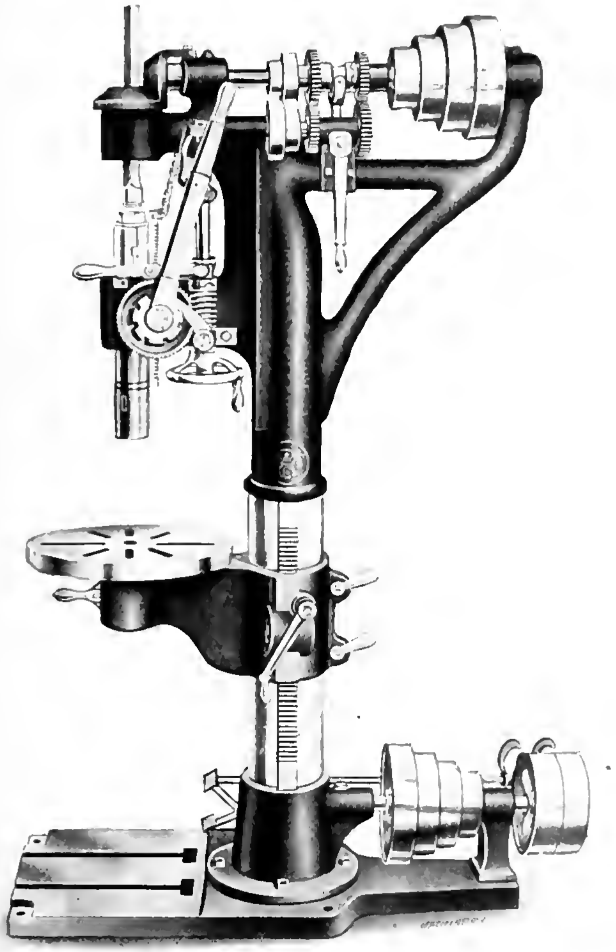
Fig. 3. Drill in Chuck, showing Long Grip in the Grooves

ROBERTSON 21-INCH UPRIGHT DRILL

The Robertson Drill & Tool Co., 1848 Niagara St., Buffalo, N. Y., is completing the drilling machine illustrated herewith, which combines a number of new features while retaining standard constructions which have proved their value by long use. Special attention is called to the spindle drive and to the back gearing. Instead of keying the spindle to the driving gear as usual, the spindle is made of square section, accurately fitting a corresponding hole in the gear. This obviates all danger of cramping, met with in the older construction. Its efficacy is especially noticeable in tapping. It is common, for instance, in drilling even the heaviest work, to have it raised from the table by the action of the tap, this being made possible by the side thrust or cramping

of the keyed spindle in the gear. With the square spindle drive the same piece requires no clamping, thus showing that less power is required and that friction has been eliminated to a large degree.

The back gears can be thrown in or out, or the spindle stopped, by the back gear handle shown. This can be done while the machine is running at full speed without danger of excessive shock. While the drive in general follows the lines of the standard drill press, this machine has been built throughout from original patterns and designs. No attempt has been made to meet competition by furnishing a tool which is too light and weak for the size of work it is intended to perform. A 5½-inch diameter column is provided with this 21-inch drill, and the diameter of the spindle through the quill is 1 9/16 inch. The table is raised by a crank operated through a self-locking worm gear and pinion. All clamps are provided with attached handles, making the use of wrenches unnecessary.



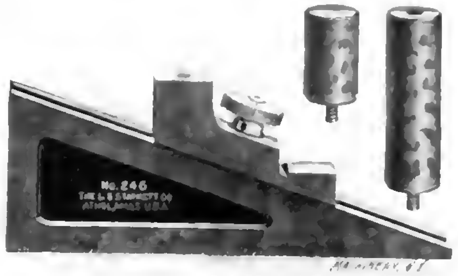
Heavy Duty Drill, with Power Feed and Automatic Stop

The following dimensions will give an idea of the capacity and rigidity of the machine: Diameter of the column, 5½ inches; total height of the machine, 60 inches, and net weight, 650 pounds. The counter-shaft runs 250 revolutions and has tight and loose pulleys 8 inches in diameter for a 2½-inch belt. The largest step of the cone pulley is 9 inches, and the smallest 4½ for the 2½-inch belt. The machine will drill to the center of a 21¼-inch circle. The table is 15¼ inches in diameter, and has a vertical travel of 40 inches. The vertical travel of the spindle is 10 inches; it has a No. 3 Morse taper hole. All parts are well ribbed and of good workmanship. The gears are cut from the solid, the racks and small pinions being cut from steel. The plain wheel and lever are power-fed, and automatic stop and quick return are provided.

STARRETT PLANER AND SHAPER GAGE

The L. S. Starrett Co., of Athol, Mass., has added to its line of machinists' tools, the convenient planer and shaper gage shown herewith. This gage is of the adjustable wedge type; it is made of drop-forged steel and is so constructed as to give a wide range of measurements. It can be set to any dimension from ½ to 5½ inches. As may be seen, gage surfaces of two different heights are provided, and the upper one is arranged to be extended by the use of the screw blocks shown, either or both of which may be used.

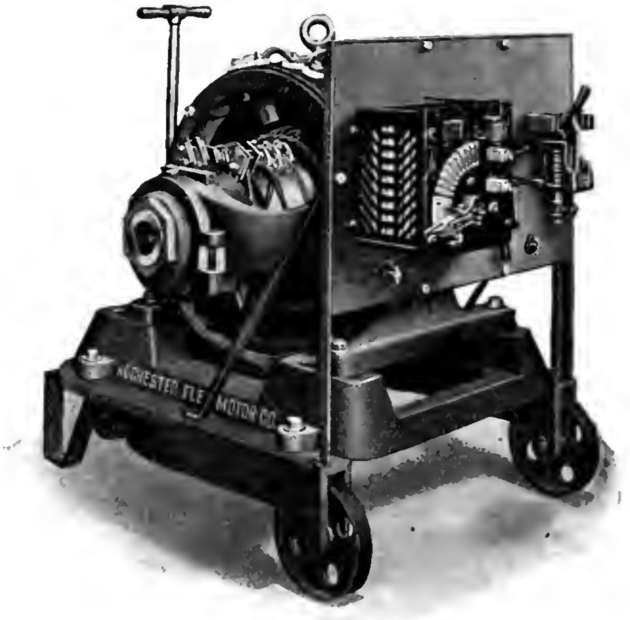
It will be found convenient on other work besides planing. It is very useful, for instance, on the miller, where slots are to be machined. The gage can be inserted in the slot and the blocks adjusted until a perfect fit is obtained. Then the tool may be removed and the exact measurement taken by the use of a micrometer. Where a close measurement is required, the tool can first be set by the micrometer and then used as a standard gage. It is case-hardened and carefully finished.



An Adjustable Gage for Setting Planer and Shaper Tools, etc.

ROCHESTER PORTABLE MOTOR

In shops where the individual drive has not yet been adopted, there are times when the shafting of a whole building or, at least, a whole department, has to be kept running in order to furnish power to a single tool on which overtime work has to be done. To meet the demands of one of its customers who was often in this predicament, the Rochester Electric Motor Co., Rochester, N. Y., designed the portable outfit illustrated herewith. It was so successful that a second was made for the same customer, and since then several have been made for others.



A Portable Motor for General Emergency Work in Machine Tool Driving

These outfits (see the accompanying engraving) comprise slow-speed motors mounted upon iron trucks, with permanent connections between motor, rheostat, switch and circuit breaker. Heavy clamping terminals permit the motor to be connected up to the service wires very quickly. The design of the truck is such that with the handle in a vertical position, the weight of motor is thrown upon the forward wheels, effectually blocking them. The wheels are mounted on an eccentric axle, so that lowering the handle for moving the outfit raises the weight from the wheels. The forward wheels

are located close together, making it possible to manoeuver the truck in cramped quarters.

The builders also furnish portable trucks with variable speed motors, to be used in case of breakdown of the motors on individually driven machines. One customer has a variable speed motor equipped with a back geared shaft, making it possible to connect quickly with almost any drive in the shop.

MORROW QUICK-RELEASING BALL BEARING CHUCK

As mentioned in a note in the New Tools department of the November, 1908, issue of MACHINERY, the Morrow Mfg. Co., of Elmira, N. Y., makes a ball-bearing drill chuck, so constructed that the knurled sleeve gives positive control to the jaws in all positions, and holds them square with the drill. The provision of the ball bearing makes it possible to get a very firm grip with the jaws with comparatively little effort on the part of the operator. The construction also is such that the driving force exerted on the drill tends to tighten it in place. This tool has recently been improved by the incorporation of a quick-releasing device which permits the loosening of the chuck jaws with a very light twist of the hand, even though the turning force applied to the drill may have tightened the jaws up very strongly. Fig. 1 shows a chuck made on this plan, while Fig. 2 is a sectional drawing illustrating the details of the design.

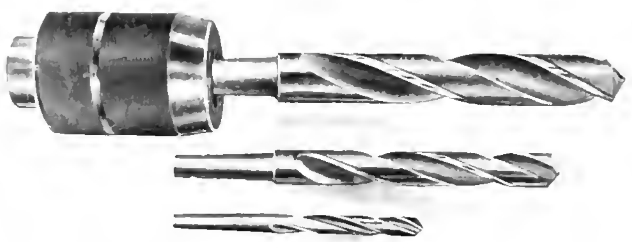


Fig 1. The Morrow Quick-releasing Ball-bearing Chuck

Referring to Fig. 2, which shows the construction most plainly, *A* is the body of the chuck, by which it is held in the spindle of the machine. On the nose of *A* is fitted a revolving sleeve *B*, held in place by the threaded collar *C*. A ball bearing and shoulder on *A* are shown, which serve to retain *B* and *C* in place and permit them to be turned easily in tightening the drill, as will be explained later. *B* is slotted radially to hold three jaws *D*. An outer sleeve *E* with an inner taper seat, threaded solidly onto *B*, furnishes the abutment surface by means of which jaws *D* are pressed down onto the drill. These jaws have dove-tailed slides machined on their inner faces, which fit radial dove-tailed slots in plate *F*. This latter has a shank with a short square thread fitting the bore of sleeve *G*. This sleeve is provided with a fine pitch square thread on the outside diameter, fitting a corresponding seat in body *A*. A slot milled across the face of sleeve *G* permits the insertion of a pin *H* in the shank of *F*, which is thus allowed a limited rotary movement with reference to *G*.

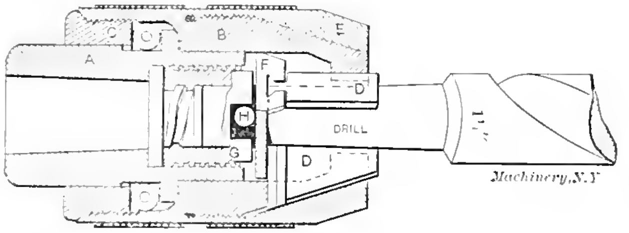


Fig 2. The Construction of the Morrow Chuck

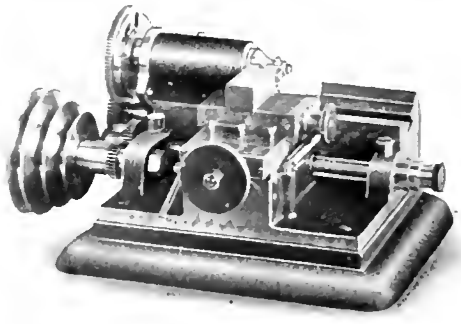
The action of the chuck will now be understood. The drill being inserted in place, the hand of the operator grasps the knurled periphery of sleeves *B* and *E*, which revolve together, turning jaws *D* and with them the plate *F* to which they are dove-tailed. This, in turn, by the action of the pin *H* in the slot in *G*, revolves the latter and screws it out to the right from its threaded seat in body *A*. This, in turn, forces *F* and jaws *D* outward to the right; forcing all the jaws against the inner conical seat of sleeve *E* simultaneously, thus strongly gripping the shank of the drill. The thrust of the outward pressure of jaws *D* is taken on the ball bearing between the sleeve *C* and the shoulder on body *A*.

In loosening the drill, the workman grasps the periphery of the chuck and turns it in the opposite direction. Parts *B*, *C*, *E*, *D*, *F*, *H* and the drill all revolve together. *G* remains stationary for the moment, however, since the slot in its face permits a slight free rotation of the pin *H*. This slight rotation screws inward the coarse threaded shank of *F* in the sleeve *G*, withdrawing it rapidly to the left, and loosening the chuck jaws. The lead of the coarse thread on the shank of *F* is so great that the hand readily screws *F* back and loosens the drill no matter how tightly the latter may have been held. In tightening the drill in place again, *G* remains stationary as before until pin *H* strikes the other side of the slot, when conditions are again as shown in Fig. 2.

This construction gives the greatest facility in handling a chuck of this type without the aid of a spanner or wrench even on sizes running over ½ inch capacity. The particular chuck illustrated (which is known as the makers' No. 5½) was designed to use up drills from which the tangs have been twisted. The body of the chuck is 3 inches in diameter by 4 inches long and will hold Nos. 1, 2, and 3 taper shanks, thus giving a range of drills from ¼ inch to 1¼ inch which may be rescued from the scrap heap. The chuck will safely hold a 1¼-inch drill to its full capacity without slipping, or straining the hand of the operator. The No. 4 chuck for straight drills takes from ¼ to ¾ inch, and No. 5 from ½ to 1 inch. All parts are hardened and ground accurately to size.

WALTHAM CUTTER TURNING AND BACKING-OFF MACHINE

The machine illustrated herewith is built by the Waltham Machine Works, Newton St., Waltham, Mass., and is intended for the work of turning and backing off minute precision formed cutters.



Lathe for Turning and Relieving Minute Formed Cutters

The machine consists, as may be seen, of a head-stock of the lathe, mounted on a base provided with a cross-slide for the forming tool. The backing off or relieving of the cutter teeth is obtained by a cam on the driving shaft connected to the lower cross-slide by means of a reducing lever. The driving shaft is connected with the work spindle by a train of gears. For the change gears regularly furnished, any number of teeth from 4 to 16 may be backed off. By the use of special gears it is feasible to back off cutters having as many as 20 teeth.

The depth of cut is gaged by a hand-wheel graduated to one-half of a thousandth of an inch, on the feed-screw on the upper cross-slide. The side adjustment of the tool is obtained through the longitudinal slide adjusted by a screw having a hand-wheel graduated to one-thousandth of an inch. Either circular or rectangular tools may be used.

An important feature of the machine is the provision for reversing the head-stock on the bed—that is to say, placing it either to the right or the left of the tool-slide. This permits the cutting of both sides of a cutter with a single tool, thus giving assurance of absolute symmetry in the finished shape of the cutter. As the profile of the bed to which the head-stock is clamped is an arc, having its center identical with that of the work spindle, the reversing of the position of the head-stock has no effect on the distance of the work from the tool. The second setting thus gives the proper

position and the proper diameter of cut to match with the first.

The machine can be used for turning cutter blanks or circular form tools, as well as for backing off teeth. By turning the lever at the left of the cross-slide, the cam becomes inoperative, and when the lower side is clamped by the lever on the right, the two remaining slides can be used the same as a compound rest on the lathe. The machine will hold rectangular forming tools up to ⅜ inch square and circular tools from 1 to 1¼ inch in diameter. Although of small size, the machine is very stiff. The base measures 11 by 14 inches and the net weight is about 100 pounds. The work spindle, cam-shaft bearings, etc., are made of hardened steel, and the finish and workmanship are intended to meet the highest requirements of watch machine construction.

GERSTNER PORTABLE TOOL CASES

H. Gerstner & Sons, 871 Germantown Ave., Dayton, O., are manufacturers of a line of tool-chests and cabinets particularly adapted to the needs of skilled mechanics. They have recently perfected a line of portable tool-cases made in a number of styles and sizes, of which one is here illustrated. Particular features of these tool-cases are their neatness and careful finish, and their compactness. Every inch of available space has been utilized in them, and the tools may be placed in separate drawers where they can be kept in good condition and easily picked out when needed. This gives a much more orderly and systematic arrangement than is afforded by the older style of chests. A convenient feature of style No. 31, shown herewith, is a patent self-hinging lid with a felt-lined tray, which will slide in under the bottom drawer and out of the way if desired, leaving the case in the form of a chest of drawers. When, however, the drawers are closed and the lid is brought up and fastened, the case is safely locked, permitting it to be carried from one job to another with a full kit of tools.

A Leather-covered Portable Tool Case for Machinists' and Toolmakers' Use

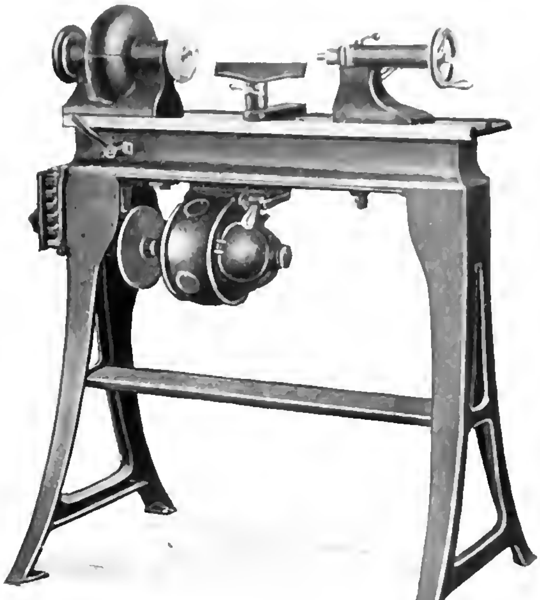
These cases are substantially constructed, of seasoned lumber, and are either lock-cornered or dove-tailed, with all parts that are liable to warp well paneled. They are finished in quartered oak, or are covered with the genuine or the best quality of imitation black seal leather. When covered, these cases are also finished in cherry or mahogany if desired. Drawers are lock-cornered and glued, with sheet metal bottoms covered with the best quality of heavy green felt. They are finished with shellac throughout. The trimmings are in harmony with the design, and of sensible construction. They are of highly polished brass, either lacquered or nickeled.

Besides cases and chests for tool-makers and mechanics, this firm makes a line of cases for draftsmen, electricians, and metal-pattern makers. Orders are solicited for special tool-cases, which will be built as desired by the customer in matters of style, size, price, etc.

MOTOR-DRIVEN SPEED LATHE

In the department of New Machinery and Tools in the April and May, 1908, issues of MACHINERY, we described two friction-driven sensitive drill presses manufactured by the Washburn Shops of the Worcester Polytechnic Institute. The satisfactory operation of these tools has led to the adaptation of the same principle to a speed lathe, intended for service on both wood and metals. This lathe is illustrated in the accompanying engraving. The advantages of this particular type of friction drive are the instant control of the speed variation, the starting and stopping of the lathe independent of the motive power, the automatic control of the power transmitted from the driving shaft, whereby the power consumed varies directly as the work requires, and the use of a constant speed motor so that the full efficiency of the motor is available for the slower speeds.

The illustration shows the motor-driven type. The motor is hung from the lathe bed at such an angle that it does not project in front of the bed, and is never in the way of the operator. The power is transmitted from the motor to the main spindle by means of a double roll and disk friction The pressure of the disks on the rolls is controlled automatically by means of a cam clutch. This cam clutch acts as a positive drive or tightener, and increases or decreases the pull of the disk on the roll directly as the work requires, the pressure between the disks and rolls being very slight except when turning. This construction is the same as used for the drill presses previously described.



Variable Friction Drive Speed Lathe, built by Washburn Shops of Worcester Polytechnic Institute

The variation of spindle speeds is obtained by throwing the lever near the head-stock. This lever is attached to a segment gear which meshes into a rack cut in the roll carrier, the extreme movement of the rack being only 2 inches to obtain a range of speeds of over 4 to 1. This sliding of the rolls across the disk is easily accomplished, as there is slight normal pressure on the rolls except when the machine is working. The motor is run at 1,800 R. P. M. and the drive is so designed that a speed variation of the spindle is obtained ranging from 600 to 2,650 R. P. M. The spindle is stopped, without stopping the motor, by throwing the speed lever to its extreme position. When in this position, the driver disk is out of contact with the rolls, the disk being recessed for this purpose. This also permits starting the motor without load. The disk on the spindle is wholly enclosed by the head-stock and a moveable cap, and a hand wheel is provided on the end of the spindle for use as a brake and for placing the work. A noticeable feature is the smoothness of operation due to the entire elimination of belts.

The lathe is fitted with either a direct current or induction motor, or a special single-phase motor may be used whereby the lathe can be run from the ordinary lighting circuits. This makes the lathe of special value for house or garage use. The

lathe may also be fitted to run at slower speeds for metal work and in this case is provided with draw-in chucks and a side rest.

INGERSOLL COMBINED HORIZONTAL AND VERTICAL SPINDLE MILLING MACHINE

Our readers will remember that we published, as a leading article of the New Tools department in the June, 1908, issue of MACHINERY, a description of a combined horizontal and vertical spindle milling machine built by the Ingersoll Milling Machine Co., of Rockford, Ill. Since putting out this first design, the makers have added certain improvements in mechanism and structure which materially increase the stiffness and convenience of the machine. It is now also furnished in two sizes, thus covering a wider range of usefulness. Figs. 1 and 2 illustrate the two sizes of these machines, while Fig. 3 shows quite plainly the mechanism of the larger of the two.

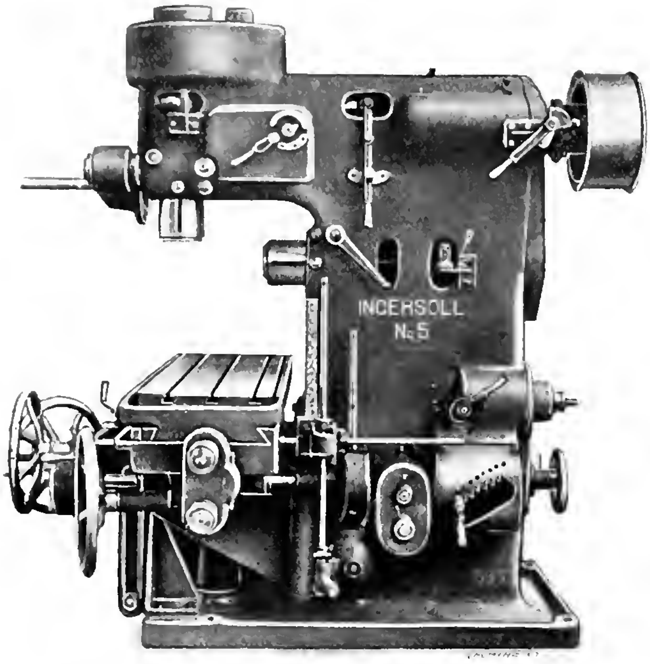


Fig 1 The Largest Size of the Ingersoll Combined Vertical and Horizontal Column Type Miller

General Construction

A brief general description of the tool will not be out of place before calling attention to the particular points of improvement in the new design. Below the horizontal spindle the machine is similar in appearance to the ordinary column-and-knee type milling machine. Above the horizontal spindle, the column has been brought forward to furnish a housing for the vertical spindle, which is as solidly supported as in any approved type of regular vertical milling machine. This spindle is well out from the face of the column, and a long knee is provided, thus giving a large cross-feed movement. To prevent this from weakening the machine, heavy knee supports are provided on the No. 5 size.

The machine is gear driven throughout, both as to speeds and feeds, the latter being taken (as required by modern practice) from a constant speed driving shaft. Longitudinal, cross and vertical power feeds are provided, all reversible and all controlled by automatic stops.

Changes in the Drives

Perhaps the most radical change in the new design is in the spindle driving mechanism. This, as may be seen in Fig. 3, provides for 16 changes of speed, applicable alike to the vertical and horizontal spindles, the final or "back-gear" change for the two spindles being independent. Fig. 3 shows a motor-driven machine. In the belt-driven machines, such as shown in Figs. 1 and 2, the driving gear *A* is replaced by a constant speed pulley. The inner surface of the flange of this gear or pulley (as the case may be) forms a seat for the conical clutch member *B*, which is pressed into engagement by a spring as shown, and is thrown out of engagement by lever *C*. This clutch and spring furnish a safety device to limit the driving power to a point which the machine will safely stand. Four gears *D* on the constant speed driving shaft mesh with four mating gears *E* on the variable speed shaft *F*. This latter is shifted axially by a lever having four positions, as shown just at the right of the vertical spindle in Fig. 1. It carries clutch teeth engaging corresponding internal clutch teeth on extensions of gears *D*, so that each of its four positions gives the corresponding one of four changes of speed.

On shaft *F* are also keyed the double gears *G*, which engage corresponding gears *H* on shaft *J*. Shifting gears *G* by the lever shown entering an opening at the top of the column in Fig. 1, doubles the four speeds previously obtained. Shaft *J* is connected by bevel gears as shown with the back-gearing *K* on the vertical spindle, where the eight speeds previously obtained are doubled to 16 by the shifting of the clutch sleeve *L*, to engage either upper or lower gear *K* with the vertical spindle. In a similar way shaft *J* is connected by a train of spur gears with similar back-gears *K* and sliding sleeve *L* on the horizontal spindle. The handles for throwing the back-gears are plainly shown in Fig. 1, and this back-gear mechanism is the same as described for the earlier machine; as is, also, the axial adjustment provided for each of the two spindles and the form of spindle bearings used.

The older machine gave four changes of speed only from the driving shaft instead of the 16 here provided. The new design thus obviates the necessity of speed changes in the counter-shaft, and permits the use of a constant speed motor drive.

The Feed Mechanism

Instead of being driven by a chain, the feed mechanism is connected with the constant speed shaft by a vertical shaft *M* and bevel gears. The same frictional spring driving device *N* is used to prevent breakage of the feed mechanism. The gear box, which is inclosed within the column of the machine, is of the familiar tumbler gear type, with added changes by means of shifting gears and clutches giving 16 variations for the No. 3 machine and 32 for the No. 5 machine.

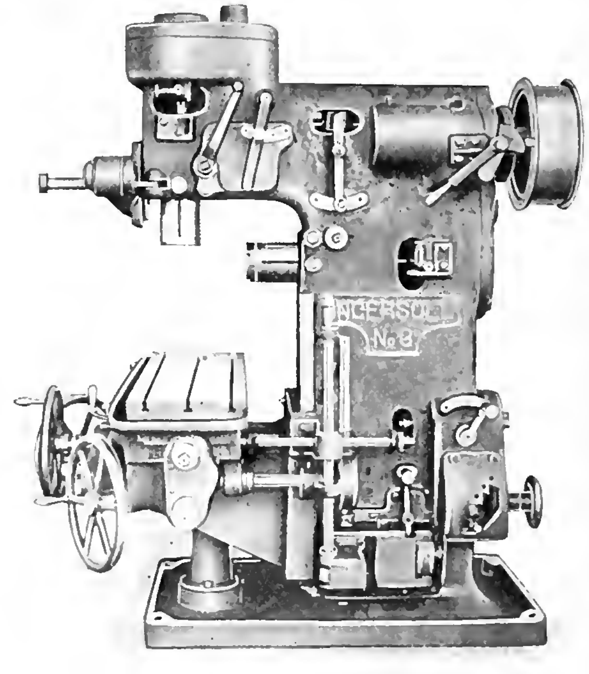


Fig. 2. The Smaller, or No. 3, Size

All the feeds are reversed from the bevel gear reversing mechanism at *O*. The reversing clutch at this point is operated by the vertical rock shaft *P* which is geared with the horizontal rock shaft *Q*, and connected by a reach rod with the reversing lever *R* at the front of the knee. The regular stop dogs on the front of the table operate this reversing lever for stopping the longitudinal feed in either direction. The stops for the automatic cross-feed are shown at *S* and *S*. They are adjustable on rock shaft *Q*, and by means of in-

clined cam faces acting on similar engaging faces on stationary support *T*, shaft *Q* is rocked at the extremes of the desired movement; this, through the connections described, throws the reversing clutch to the central or off position. Similar adjustable dogs *U* on the vertical rod *P*, engage corresponding cam faces on *T*, and furnish the automatic stop for the vertical travel of the knee. Slip clutches are provided at the various feed screws for connecting each of the feeds in the three directions, and hand-wheels are conveniently placed for operating them manually without interference with each other.

Minor improvements in construction that will be noticed are the more rigid design of the overhanging arm, the more compact arrangement for the machine as a whole in spite of the stockier design, and the convenient provision for motor driving when desired, as shown in Fig. 3. It should also be mentioned that a spring counterweight is provided for the knee of the No. 5 machine.

Dimensions and Range of Feeds

The following dimensions will give an idea of the capacity of the two sizes of this machine. The No. 3 machine has a table whose working surface is 14 inches wide by 48 inches long. The longitudinal feed is 39 inches, the cross-feed 11, and the vertical feed 15 inches. Sixteen changes of feed are provided ranging from ½ to 20 inches per minute. The spindle is of open-hearth crucible steel, running in phosphor bronze bearings, and has a No. 12 Brown & Sharpe taper hole. The 16 spindle speeds range from 13 to 350 revolutions per minute. The table will take in 23 inches under the vertical spindle, as a maximum, and 2 inches as a minimum. The distance from the center of the horizontal spindle to the top of the table ranges from 15 inches to 0. The distance from the center of the vertical spindle to the face of the column is 16 inches. The shipping weight of the machine is about 7,500 pounds.

The corresponding dimensions for a No. 5 machine are as follows: The working surface of the table is 20 by 60 inches, and the longitudinal, cross and vertical feeds are 59, 15 and 16 inches respectively. Thirty-two changes of feed, varying from ⅝ inch to 24 inches per minute, are provided. The spindle has a No. 16 Brown & Sharpe taper hole. The spindle speeds are the same as for the smaller machine. The capacity of the table under the vertical spindle ranges from 26 inches maximum to 4 inches minimum. The distance from the top of the table to the center of the horizontal spindle ranges from 16 inches maximum to 0 minimum. The center of the vertical spindle is 20 inches from the face of the column. The shipping weight is about 15,400 pounds. A circular table with automatic feed will be provided for either of these machines at an extra cost.

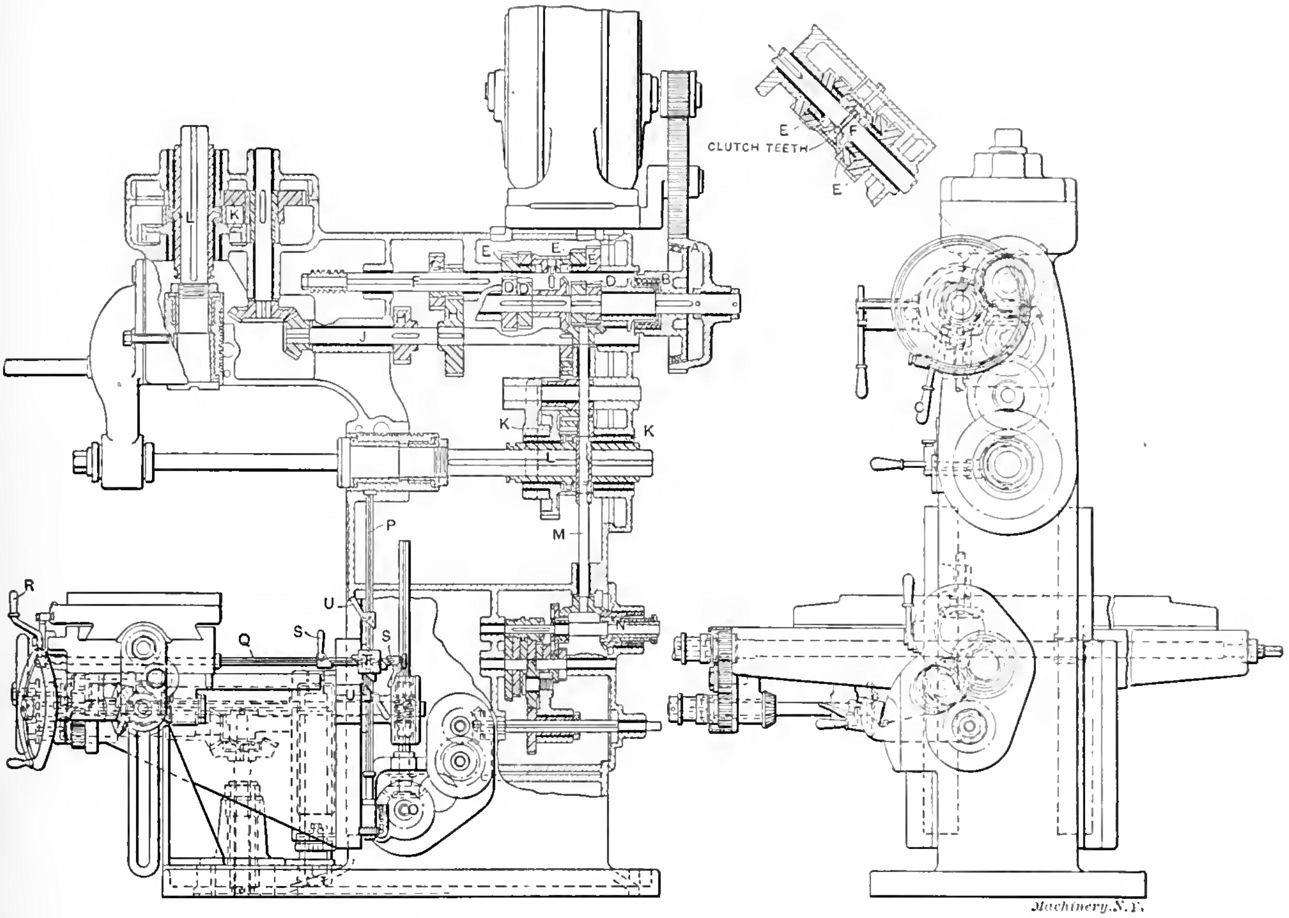


Fig. 3. The Feed and Drive Mechanism of the No. 5 Machine

OBERMAYER BLUE LEATHER BELLOWS

The ordinary bellows used by foundry men gives a great deal of trouble from the cracking of the leather which, being the most vulnerable part of the tool, shortens its period of usefulness. The Obermayer Co., of Cincinnati, O., has succeeded in producing a bellows with a specially prepared leather, which is unusually soft and pliable, thus doing away with most of the danger of cracking. The treatment which the leather receives gives it a deep blue color and this, in combination with a careful oil-soaking process, produces the required flexibility. The bellows is strongly made in all respects. It is fitted with a short steel spout which will not be crushed, broken or rusted, in the treatment ordinarily received around the foundry.

FRANKLIN MOORE CO.'S IMPERIAL HOIST

The Franklin Moore Co., of Winsted, Conn., has designed and placed on the market a chain hoist with a number of innovations which tend to increase its strength, efficiency and general handiness. Among other improvements is a new method of supporting the load sprocket from the hook, and an improved brake mechanism. The construction also permits a very compact design, requiring small head room, and gives a total weight for the apparatus which is considerably less than for older designs of the same capacity.

The general appearance of the Imperial hoist is shown in Fig. 1, while the details of its construction will be plain from the line engraving, Fig. 2. The hand chain wheel *A* is connected (through the brake mechanism) with shaft *B*, which has formed on it a pinion *C*, meshing with similar gears *DD* on a pair of similar intermediate shafts *E*. Shafts *E*, in turn,

carry pinions *F*, which mesh with the large gear *G* on the load sprocket shaft. This latter is supported on roller bearings in hangers *H*, to the upper end of which the hook *J* is pivoted. It will thus be seen that the load is supported from sprocket *K* through hangers *H* to the hook, without putting any strain whatever on the cast iron casing of the hoist. These hangers or yokes are made of steel. This avoids the possibility of an accident due to imperfect castings—a risk which is always taken where the top hook is fastened to the housing. The method of gearing employed effects a considerable reduction in friction loss as well, since the housing or casing is free from strain, permitting all the other shafts and gears to run freely. This, in combination with the ball bearing support of the load shaft, gives a high hoisting speed with comparatively little force exerted by the operator. The fact that the load is supported so directly also, without requiring a heavy, strong casing, explains the reason why the hoist can be made compact and of light weight.

Fig. 1. The Imperial 2-ton Chain Hoist

The operation of the brake will be easily understood from Fig. 2. In hoisting a load the direction of rotation of the sprocket wheel *A* is such that it is screwed on threaded shaft *B* toward the right, tightly clamping leather washer *M* between friction members *N* and *O*, so that *A*, *M*, *N*, *O* and shaft *B* revolve together as one member. If now the operator releases the hand chain, the tendency of the mechanism would be to run back, if the load is heavy enough. This is prevented, however, by the fact that friction plate *N* is provided with a ratchet mechanism (not shown in the engraving) which prevents it from rotating backward, and as *A*, *M*, *N*, *O* and *B* are all clamped together, the load is held stationary. If sprocket wheel *A* is rotated backward by hand chain

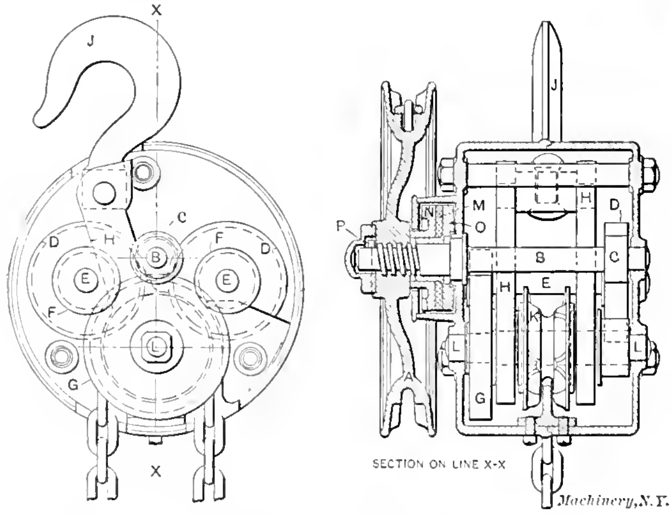


Fig. 2. Mechanism of the Imperial Hoist, showing Improved Brake and Suspension

to lower the load, it is first unscrewed to the left on the threaded shank of shaft *B*, thus releasing friction surfaces *M*, *N* and *O*, and permitting the work to descend in spite of the stationary disk *N*, as long as hand wheel *A* is revolved. When this is again left stationary the rotation of *B* under the influence of the load, screws it into the hub of *A*, thus again drawing the surfaces on *M*, *N* and *O* into tight contact, and stopping the rotation against the stationary disk *N*. Pin *P* prevents *A* and *B* from unscrewing more than is necessary to give a free but easily controlled descent. The load thus descends rapidly and smoothly and with perfect safety.

Great pains have been taken in the construction of this line of hoists in the matter of selecting suitable materials which would give satisfactory wear under the continued abuse to which chain blocks are subjected. The working parts are accurately made on high-class machinery, and are all thoroughly protected by the enclosed two-piece housing provided. The Imperial hoist is made in a number of sizes, ranging from ½ to 20 tons capacity.

BLEVNEY AUTOMATIC POLISHING MACHINE FOR FINISHING PUNCHINGS

John C. Blevney, 216 High St., Newark, N. J., has built for some years a form of polishing machine, which has come into extensive use for finishing metal surfaces of all kinds. The distinctive feature of this polishing machine is its use of two belts. The inner belt is usually made of leather, perforated and ribbed, as described later, to give a better grinding action. This inner belt does the driving. The outer belt is composed of emery cloth and rides over the lower belt, passing around one of the two pulleys on which the latter is carried, and then over an idler of its own, by means of which the proper tension is maintained on it irrespective of the heavier tension given to the driving leather belt. This construction, originally applied in the regular vertical machine of the builder, can easily be followed in the horizontal arrangement of the automatic machine illustrated in Figs. 1 and 2.

Arrangement of Driving Belts

In arranging this machine for the automatic finishing of punchings and other flat steel parts, the belts were arranged to run horizontally in order to design the feeding mechanism to the best advantage. The structure of the machine is of a light but rigid design, and carries stiff cylindrical bars on which the various idler and driving pulleys and other operating mechanisms are adjustably mounted. The driving belt from the main line-shaft is led to tight and loose pulleys at the right of the base of Fig. 1. The counter-shaft on which these pulleys are mounted is adjustable on the bar by which it is supported to give the proper tension to the driving belt; this latter extends diagonally upwards in Fig. 2 to the driving shaft of the polishing belts. The driving shaft is mounted on a fixed support clamped to the upper bar as shown, and it carries on its other end a pulley for driving the inner or leather belt of the double belt system. This passes over an idler at the right of Fig. 2. This idler pulley is mounted in adjustable bearings and the proper tension on the belt is maintained by the lever and weight shown, acting through the chain connection with the sliding journal support. The grinding belt proper, of emery cloth, lies over the leather belt and extends back to the idler at the left of Fig. 2. This idler is also mounted on a sliding journal in the upper bar, and is provided with a lever and weight arrangement for giving it the proper tension. This tension is less, of course, for the emery cloth than for the leather belt.

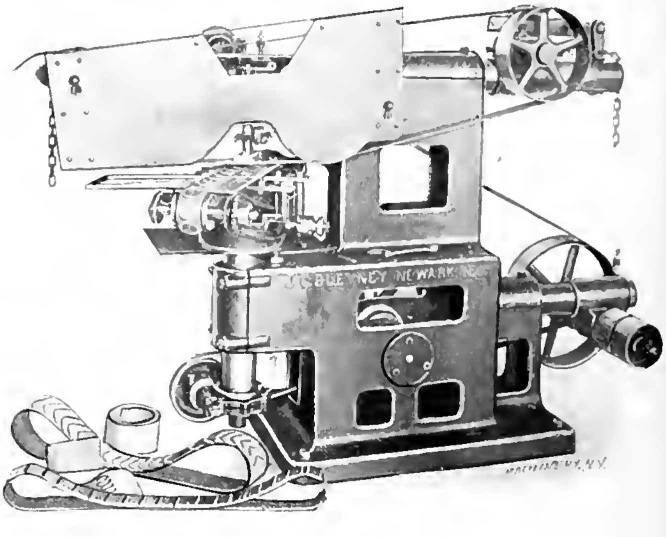


Fig. 1. Blevney Horizontal Grinding and Polishing Machine, with Automatic Belt Feed

Feed Mechanism

So far the general arrangement of the machine is identical with that for the original vertical design. The improvement consists in the addition of the automatic feeding mechanism shown. This consists of a holder provided with driving and idler pulleys so mounted as to rotate a leather feeding belt across the under surface of the grinding belt. The frame in which these feed belt pulleys are mounted can be adjusted so that the belts cross each other at any desired angle, thus giving an opportunity to cross the grinding marks when roughing and finishing cuts are taken. On the feeding belt are riveted suitable metal strips or pins for confining the punchings or other parts which are to be finished. The movement of the feeding belt is continuous, being driven by the chain and sprockets shown in Fig. 1, operated by bevel and spur gearing from a vertical shaft through the center of the column on which the mechanism is mounted. Connection with the counter-shaft at the rear of the machine is made, as shown in Fig. 2, by a pair of three-step cone pulleys, which provide means for varying the rate of feed.

The operator sits at the front of the machine (Fig. 1) and places the punchings in the holders on the constantly moving feed belt. The mechanism is carefully guarded on the operator's side, by the removable sheet iron guard shown. The machine has a capacity for finishing punchings of 1 square inch surface at the rate of 4,000 per hour.

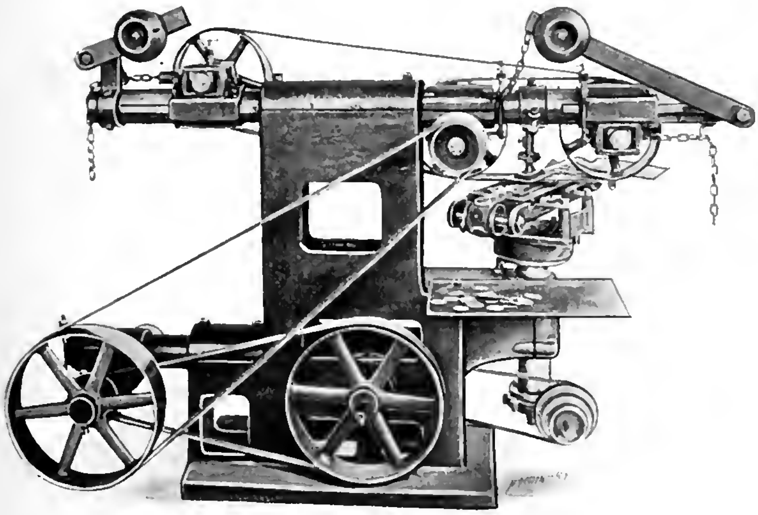


Fig. 2. Rear View of Machine, showing Drive and Tension Mechanism

Pressure for polishing is produced by the spring and weight controlled presser-plate, shown immediately above the belt in Figs. 1 and 2. A latch is provided for raising this plate off the belt when no work is beneath it and a stop is also furnished to limit the thickness to which the work is ground, and to prevent, as well, the grinding of the feed belt and its holders when no work is passing through the machine. The feed belt itself runs on a metal plate. The surfaces finished are thus true with each other, the belts being held between two flat metal surfaces.

Construction of Belts

The construction of the belts is interesting in a number of respects. The inner or driving belt is usually made of leather, ribbed as shown in the sample on the floor at the base of the machine in Fig. 1. This ribbing raises corresponding ribs in the thin emery cloth belt which runs over it, giving alternate grinding and relieving surfaces to the belt; this gives provision for taking care of the dust produced by the grinding, and prevents clogging with grains of emery, as would be the case if its surface were smooth and unbroken. In this respect the action of the ribbed belt is similar to that of the grooved surface so largely used for disk grinders, though it has the advantage over the latter that the ribs constantly change position, as the emery belt is constantly changing its position with relation to the leather belt by which it is driven. The dust which collects in the recesses between the ribs is easily thrown off on the revolving pulleys, and the belt is kept cool as well by its rapid motion.

For accurate flat grinding the inner leather driving belt may be replaced by an endless steel belt. This, however, does not give so good a cushion for polishing as leather. An improved form of joint is used in forming the light emery belts. This joint is shown in the section of belt on the floor in Fig. 1. It consists of a series of interlocking fingers cut from each other in the belt, inserted in each other, and then glued and dried under pressure. This results in a joint as strong as the original belt, and at the same time of the same thickness, if properly pressed. It is made without waste of stock. The belt in the foreground is a feed belt for plain washers of a considerable range of diameter; these are inserted between the tapering steel plates provided.


A Friction Roller Attachment for Making Fine Adjustments on the Beam Caliper

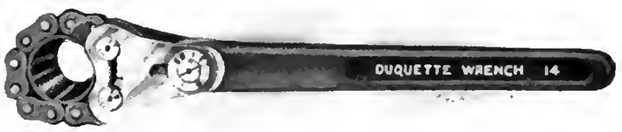
Besides the automatic features in this particular machine, this system of grinding offers evident advantages in the way of rapidity of action, simple use of the emery cloth, and provision for the rapid change of grinding material. The bearings are dust-proof and the machine is strongly driven. The maker is prepared to furnish machines of the same principle constructed for the hand or automatic finishing of almost any work for which polishing by emery cloth is adapted.

IMPROVED ADJUSTMENT FOR COLUMBIA CALIPERS

The E. G. Smith Co., 134 No. 3rd St., Columbia, Pa., maker of the well-known "Columbia" line of machinists' tools, has recently improved the standard beam caliper, as shown in the accompanying engraving, by the addition of an ingenious attachment for making fine adjustments. This new attachment, which the makers call the "fine roll," is exceedingly simple. It consists of a roller straddling the scale, and pulling the sliding head along forward or backward as required. It does this very smoothly, and delicate adjustments can be made with much greater rapidity and ease than with the old style adjusting screw. This attachment is furnished with any of the maker's calipers.

"DUQUETTE" TWO-WAY PIPE WRENCH

The chain pipe wrench shown herewith is made by the Toledo Wrench Co., 1507 Nicholas Building, Toledo, O., and is known as the "Duquette" two way pipe wrench. Three important improvements are offered in its design. First, it has a positive two way action. It works like a ratchet in either direction, grips the work instantly, and can be reversed immediately. The annoyance arising from a crossed thread in starting a jointed pipe is quickly overcome; no re-adjustment of the chain is necessary. The second advantage is that this



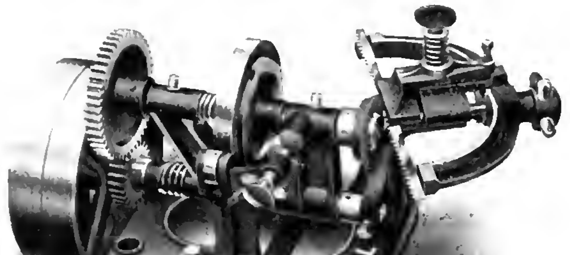
A Chain Pipe Wrench whose Action is Reversible

wrench has no teeth, yet it will take a tight grip on an oil covered nickel pipe without crushing or marring the surface. In the third place, being of the type in which pressure is applied practically throughout the whole circumference of the pipe, there is no tendency to crush rusty spots in old pipes, or to open new pipes at a seam, as sometimes happens. The head portion of the handle, in connection with the inner surface of the chain links, gives practically a true circular pressure about the work, exerting a uniform pressure. The wrench releases immediately when the pressure is removed, but will bite again and not slip so long as force is exerted. All parts of this tool are well made and are interchangeable. Being suited to a wide range of work, it should find ready appreciation with mechanics in general.

ROTARY FILE AUTOMATIC BAND SAW SHARPENER

The accompanying illustration shows a band saw filing machine made by the Rotary File & Machine Co., 589 Kent Ave., Brooklyn, N. Y. It is a new design of filing machine which has been built for some years, and which has met with a high degree of appreciation among users of band saws. The tool is chiefly remarkable for the simplicity with which it performs a somewhat complicated operation. The file itself is circular and revolves continuously. It has file teeth cut for about three-quarters of its periphery, the remaining part being smooth. The file teeth are cut at such an angle as to give very efficient action. The smooth portion of the file is used in feeding the saw, as will be described.

The machine is driven from the tight and loose pulleys at the left. The driving-shaft is connected by gearing with the cam-shaft above it, which is mounted in bearings on arms swinging about the driving-shaft as a pivot. The cam has acting surfaces on its periphery and on its face. The surface on its periphery bears against a roll on the stationary stand bolted to the base, so that the cam-shaft is thus rocked in toward and out away from the saw. The cam surface on the face bears against a similar roll pivoted on the stand, and gives the cam-shaft an axial movement. These axial and rocking movements are, of course, imparted to the file itself, which is mounted on the cam-shaft.



A Band Saw Sharpener of Noticeable Simplicity

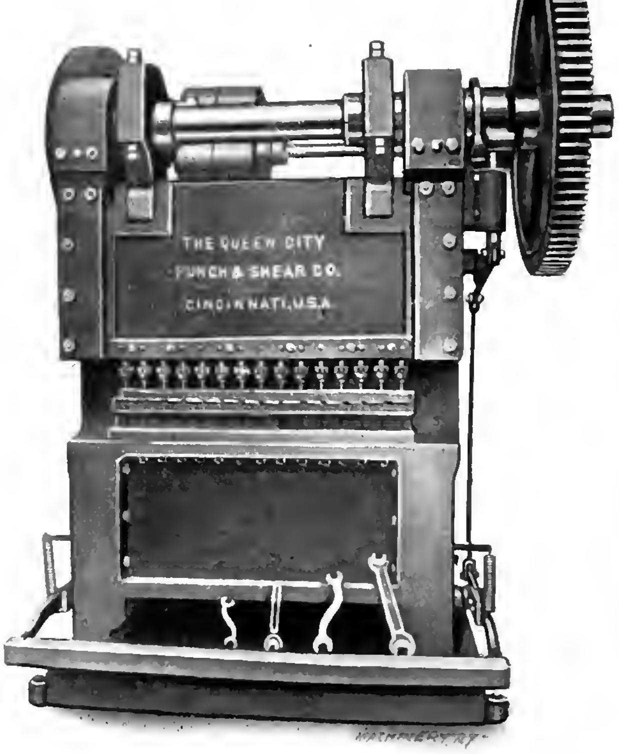
The saw is held in the frame shown, being guided by the ledges on which it rests. It passes through the adjustable friction clamp in the center of the frame, which gives the proper tension for holding the saw during the filing, and still permits it to be fed forward without binding. The holding frame may be swung about its pivot to change the angle of the tooth, and may be adjusted in and out to agree with the width of the saw blade.

The operation of the machine is as follows: Considering that the blade is in proper position, the file, as it revolves, is forced into the tooth, cutting the worn metal away and sharpening it to give a new cutting edge. The face and periphery cams then swing the file out and back, dropping it into the next tooth of the blade; by the continued action of the cams, the rotating file is properly placed in this tooth and the blade is pushed forward by the file until the position occupied by the preceding tooth is reached. This pushing of the blade is done on the smooth portion of the periphery of the file. The cutting does not commence again until the blade is fed forward as described. Suitable adjusting screws regulate the movements of the cams, which may be varied to suit saws of different width and pitches.

The concave face given to the tooth by the file is said to be much superior to the convex surface given by the hand operation, even when the latter is skillfully done. It is claimed, also, that the cost of files is reduced by the use of this machine.

QUEEN CITY MULTIPLE PUNCH

The accompanying illustration shows a multiple punching machine recently built by the Queen City Punch & Shear Co., of Cincinnati, O. It is well adapted to general work, owing to its large capacity and convenience of arrangement. The punches and dies are interchangeable, and can be spaced in any position required by the work to be done. The capacity of the tool permits the punching of fifteen ¼-inch holes in ¼-inch material, in one operation.



A Multiple Punching Machine with Adjustable Punches and Dies

The machine is built with any depth of throat, and any depth between the housings required. The engraving shows the machine with 48 inches between the housings, and a 3-inch throat. It can be either belt or motor-driven. Machine cut gearing is used, insuring smooth and noiseless operation; and the machine is equipped with a newly designed automatic speed stop clutch, which the builders have found to give unusually good service. This machine can also be used as a gap shear by removing the punching tools and attaching suitable blades for such work. The tool thus appears to be well adapted to general or special machine shop use.

TWENTY-ONE INCH SNYDER UPRIGHT DRILL

J. E. Snyder & Son of Worcester, Mass., have placed on the market the 21-inch drill shown in the accompanying engraving. As may be seen, it is a rugged and business-like appearing tool, and is capable of doing heavy work for a machine of its size. It has sufficient driving power to drill 1¾-inch holes in cast iron, or 1⅜-inch holes in solid machinery steel. It has a wheel and lever feed combined, and a power feed with automatic stop. The whole driving mechanism, including the bevel gearing and the belt area, has been designed for heavy service.

The following dimensions will give an idea of its size and capacity. The height from the floor to the upper cone pulley is 21 inches. The machine will take 26 inches between the

table and the end of the spindle, or 43½ inches on the base. The table is 17 inches in diameter, and the main column 6 inches. The driving pulleys are 11 inches in diameter for 2½-inch belt, and the cone pulleys range from 4¾ to 10 inches for the same width of belt. The spindle, in the sleeve, is 1½ inch in diameter. It has an automatic feed of 8 inches, and has a No. 3 Morse taper hole. The weight of the machine is about 900 pounds. It is shown here arranged for motor-drive, using a 1-H.P., 220-volt, General Electric direct-current motor. It is regularly furnished for tight and loose pulley drive.

A 21-inch Drill of Rugged Design

At the Mechanical and Electrical Exhibition recently held in Worcester, this tool attracted considerable attention. It was tested by drilling seven ⅝-inch holes in 1⅛-inch solid cast iron, doing this in 30 seconds with the lever feed. The operator was unable to stall the machine, though using his whole weight on the lever.

"VIXEN" HAND MILLING TOOL

In the department of New Machinery and Tools in the September, 1908, issue of Machinery, we described the "Vixen" patent milling file. The maker of this file, the National File & Tool Co., 110 Allegheny Ave., Philadelphia, Pa., has recently adapted this style of file to be used as a hand planing or surfacing milling tool for metal.

The "Vixen" Milling File adapted for use as a Hand Planing or Surfacing Tool

As may been seen in the engraving, the construction is very simple. A strip of hard wood is provided with a convenient metal handle, and a small projecting front hook to assist in guiding the stroke. Attached to the lower side of this wooden strip, by bolts as shown, is a "Vixen" milling tool or file blade. When so held, this blade is in convenient form to use on all sorts of surfacing operations on all sorts of materials, such as steel, iron, copper, tin, babbitt, aluminum, bronze, marble, etc. The peculiar shape and cutting actions of the teeth have been explained before. Suffice it to say that they are machined instead of being struck by a chisel, and that carefully shaped and very efficient cutting teeth are thus obtained. This surface milling tool is furnished in 8, 10, 14, 16 and 18-inch lengths.

TAYLOR & FENN TYPE C MANUFACTURERS' DRILL

The manufacturers' sensitive drill made by the Taylor & Fenn Co., of Hartford, Conn., is now furnished with a simple and effective design of power feed when so desired. The drill press provided with power feed is called by the makers the "Type C." It is illustrated in Figs. 1 and 2.

The general features of the Taylor & Fenn sensitive drill are well known. In the multi-spindle style shown in Fig. 1 the separate columns are adjustable on the top of the base to any desired center distance within the limits of adjustment required for the machine. Each separate column carries a complete driving mechanism, with a geared variable speed drive, operated by the lever seen projecting from the gear box at the rear in Fig. 2. A vertical variable speed shaft passes up through the center of the column, and is connected with the drill spindle by a chain and sprocket wheels at the top. This chain is shown provided with a guard.

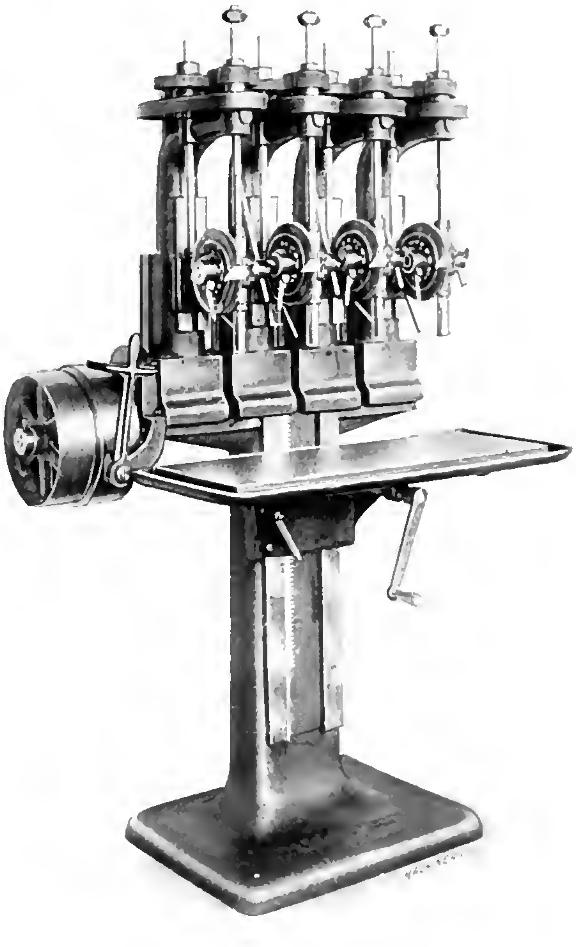


Fig. 1. Taylor & Fenn Multiple Spindle Sensitive Drill with Power Feed

The details of the automatic feed are best seen in Fig. 2. A vertical worm-shaft is geared with the spindle at the top of the column. Two rates of feed, one of 0.0071 and the other 0.0096 inch per revolution of the spindle, are provided by loosening the nut on the intermediate gear stud and reversing the compound connecting gear. The worm on the vertical shaft engages a worm-gear with a bronze rim and a hardened steel center, in which notches are cut to form a clutch ring for receiving the driving lever. The worm-wheel runs free on a bronze bushing when the driving lever is disengaged. It always remains in mesh with the worm, so that the wear is evenly distributed over all the teeth. The driv-

ing lever is fastened to a clamp collar that fits on the end of the feed pinion shaft, which is octagon in shape, permitting of eight settings of the feed lever. If it is desired to shorten or lengthen the range of feed, it may be quickly accomplished by loosening the binder screw on the clamp collar, slipping it off and replacing it into position so that the lever shall have minimum travel to the knock-off. The lever is disengaged from the clutch ring by means of a hardened knock-off, which has an adjustment greater than the distance between the notches on the clutch ring, and may then be set to drill holes of a given depth with great accuracy.

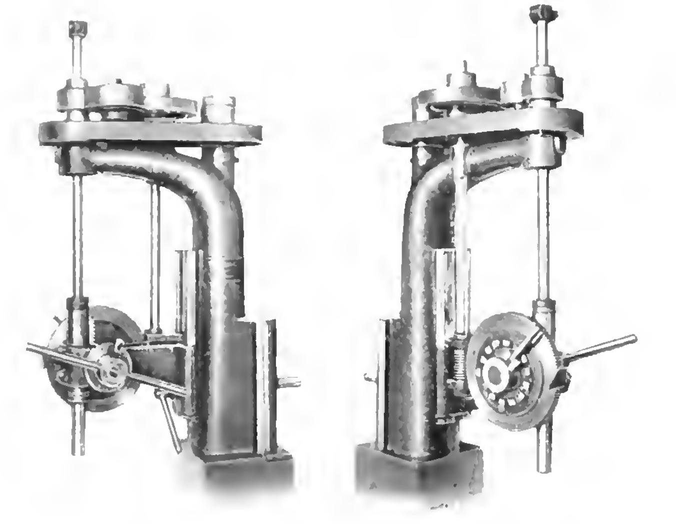
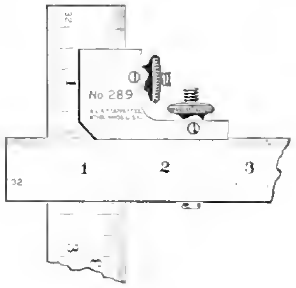


Fig. 2. The Mechanism of the Power Feed

The "Type C" drill press illustrated herewith is the same as the regular "Type A" machine, with the addition of the automatic power feed. The separate spindle columns are interchangeable with all the other types, and may be used in combination with any of them on the same base. This same power feed may also be applied to one spindle of the "Type B" machine which was illustrated in the New Tools department of the January, 1909, issue of MACHINERY. By this means all the spindles are fed simultaneously. The power feed may at any time be disengaged and the same lever feed used as in the ordinary "Type A" machine.

AUXILIARY SCALE ATTACHMENT FOR STARRETT SQUARES

The attachment shown herewith is furnished by the L. S. Starrett Co., Athol, Mass., for use with the 12-, 18- and 24-inch blades of the No. 11, 23 and 33 squares. It can be used with any of the makers' regular rules up to 1 inch in width, or with the No. 21 flat steel square as well.



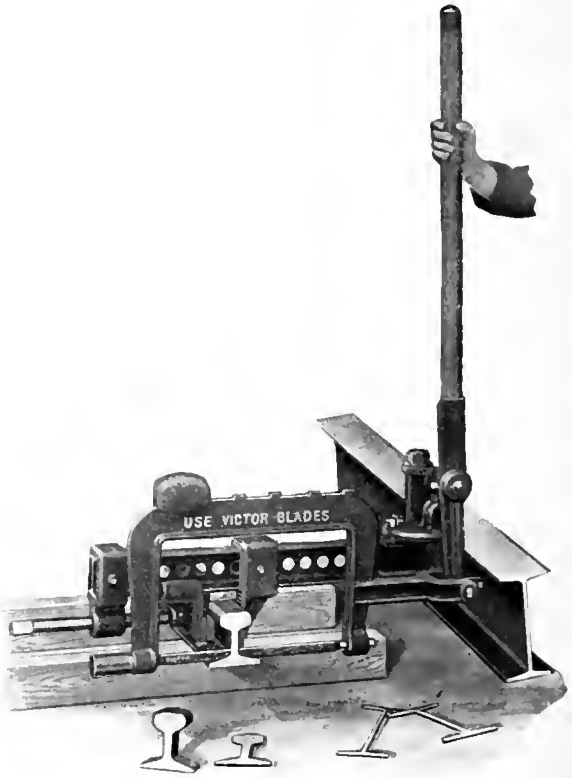
A Device for Clamping together Scales and the Blades of Squares

The ways in which it may be used will readily be appreciated. It is shown in the engraving holding two rules or blades together at right angles. Either of these may be adjusted in relation to the other for any dimension within their range. The blades are held squarely at right angles to each other. This device increases the usefulness of the combination square in laying out centers, or in scribing lines at right angles to each other, but at a given angle with a reference surface. They also convert the combination square into a height gage or beam caliper, and extend its usefulness in many other directions which will readily be appreciated by the mechanic who uses it.

M. S. W. PORTABLE HACK-SAW MACHINE

The Massachusetts Saw Works of Chicopee, Mass., has designed a portable hack-saw machine for use in cutting rails, I-beams and other steel shapes, in place. Such work hitherto has either been done by a portable circular saw machine, or by the ordinary hand hack-saw, generally operated by two men. The ordinary portable saw has the disadvantage of requiring two or three men to set it up and operate it, and it is troublesome as well in the matter of keeping the saws in the proper condition. The hand hack-saw is a slow and tedious device. It takes experienced men to cut through an ordinary rail or I-beam without breaking several blades, and it takes conscientious men to work on such a job without doing more or less loafing.

The attachment shown in the accompanying engraving uses the hack-saw under the best conditions. The clamp is universal, and may be easily adjusted to any steel shape, or to almost any kind of miscellaneous work it may be desired to saw. The saw is operated by a long handle, so that the workman stands or sits in the position most convenient for protracted exertion. This handle is mounted on a pivoted base, so that cuts may be taken at any desired angle. The frame itself is solid and substantial, and is provided with an adjustable weight for giving a suitable and even rate of feed.

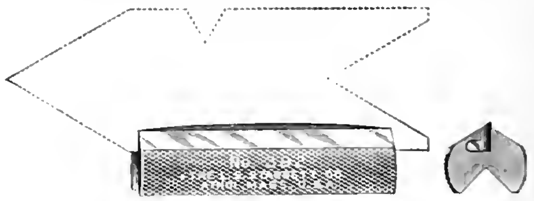


A Portable Hand-operated Hack-saw Machine

The whole apparatus, set to run, weighs about 90 pounds. One man can easily cut through a 9-inch I-beam in from twenty-five to thirty minutes, without resting. Saws in this machine make clean straight cuts, and the danger of breakage is reduced to a minimum. Fourteen-inch blades are used. The makers sell a grade of blade which they call the "Victor Special P" blade which has been found to give unusual satisfaction on I-beam and rail work.

STARRETT CENTER GAGE ATTACHMENT

The center gage attachment shown herewith is made by the L. S. Starrett Co., Athol, Mass. It consists of a V-block, with a slot containing a flat spring to hold the center gage, by friction, parallel with the V-surface. By placing the block against the lathe spindle or face-plate, a threading tool can



A V-block Holder for the Center Gage

be adjusted in proper alignment to cut both sides of a thread to the exact angle, for either external or internal work. The V-block will be found convenient for lining the attachment on arbors or other cylindrical pieces. The attachment is adapted to holding the gage either by the side or end, in any position required for the work in hand.

FOSDICK MOTOR-DRIVEN HORIZONTAL BORING, DRILLING AND MILLING MACHINE

In the October, 1908, issue of MACHINERY, in the department of New Machinery and Tools, we illustrated the No. 0 horizontal boring, drilling and milling machine made by the Fosdick Machine Tool Co., of Cincinnati, O. Provision has recently been made for equipping this boring machine with constant speed motor drive, as shown in Fig. 1. The speed box used is of the tumbler gear type, and is equipped with steel gears throughout. There are four changes made through the tumbler gears, and two changes made through the back gears in the speed box, making a total of eight changes of speed. The slow speed change is made through a pair of tool steel clutches, 4 inches in diameter, and the high speed change through a powerful friction clutch, 5½ inches in diameter. These changes are controlled by a lever shown running to the front of the machine, which can also be used for starting and stopping. A 5 H.P. constant speed motor, 1,000 R.P.M., is used, geared direct to the drive shaft through a pair of spur gears, the pinion of which is of rawhide, brass mounted.

In using a variable speed motor, the equipment is similar to that shown, with the exception of the speed box and the controller. A drum type of controller is used on the variable speed motor drive, mounted on the head, where the speeds can be easily controlled from the front of the machine. The lever for starting, stopping or making the back gear changes, is in the same position as shown for the constant speed drive.

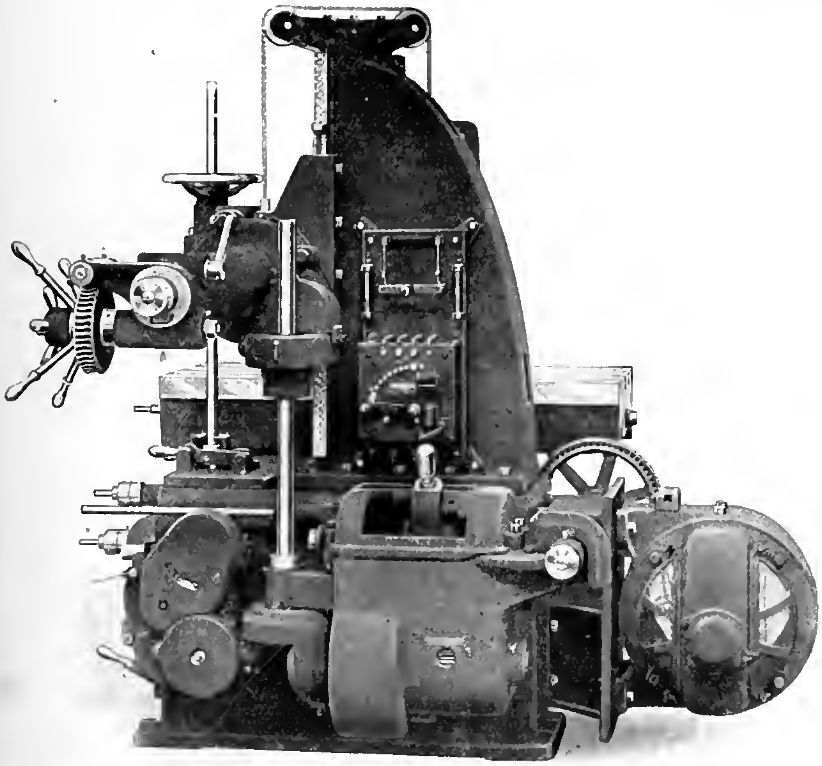


Fig. 1. Arrangement of Drive on Fosdick Boring Machine, for Use with Constant Speed Motor

Fig. 2 illustrates three recent attachments provided for this machine. The star feed facing attachment can be bolted directly to the spindle sleeve, or clamped in any desired position on the spindle itself. It will face work up to 18 inches in diameter. The auxiliary table is used for overhanging parts of any kind, which may be bolted to it, or allowed to slide on it with the adjustment of the main table. It is 8 inches wide and 48 inches long, and is provided with a T-slot for its full length. The swiveling table shown may be revolved by hand or by worm-wheel movement as desired; the worm and its hand-wheel may be withdrawn, leaving the table free. Four tightener bolts are provided for securely fastening the rotary platen to the base-plate when the adjustment has been made. The base-plate in turn is tongued and bolted to the cross-table of the machine. This table is graduated to ½ degree. It is 24 inches in diameter and 6 inches high, with an accurately bored center hole for arbors and plugs. Four cored T-slots are provided in the top surface.

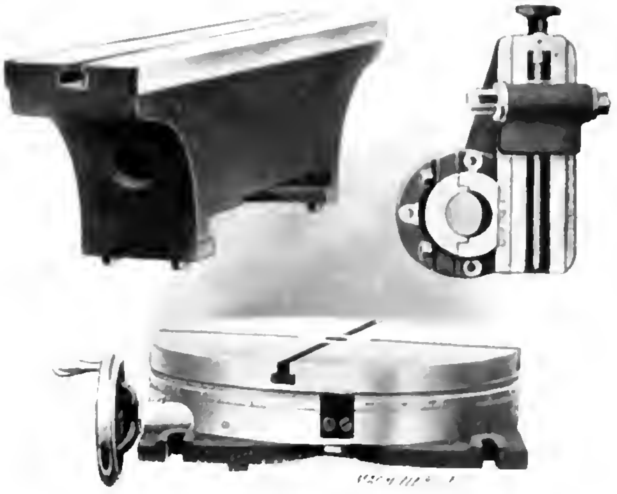


Fig. 2. Auxiliary Table, Facing Attachment, and Revolving Table for Boring Machine

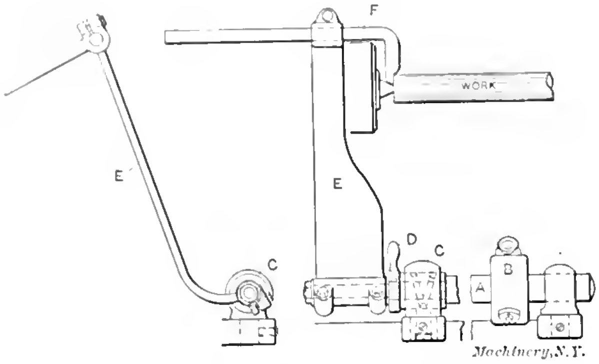
COMPENSATING AUTOMATIC STOP FOR "LO-SWING" LATHE

The well-known "Lo-Swing" lathe built by the Fitchburg Machine Works, Fitchburg, Mass. (see description in the November, 1905, and September, 1907, issues of MACHINERY, has recently been equipped with the improved stop motion illustrated herewith.* The particular point of advantage in the construction of this stop motion is its provision of means for stopping all the cuts taken on the machine at a desired distance from the head-stock end of the stock, no matter what the depth of the centering may have been; or the desired shoulder distances may all be cut to dimensions measured from the deepest point of a rough or irregular end; furthermore, the mechanisms makes provision for stopping the cuts automatically at desired distances from shoulders turned in previous operations, on cuts taken from the opposite end of the stock.

In the illustration, *A* is a stop rod, mounted on fixed brackets on the base of the machine, and carrying stops *B*, which may be adjusted to any desired position to throw out the feed mechanism in the carriage of the lathe. The left-hand support *C*, of this bar *A*, contains a sleeve in which the bar is journaled. This sleeve has cut in its periphery a coarse thread, as indicated by the dotted lines, and is provided with a handle by which it may be rocked. A cone pointed screw, fast in support *C*, enters this groove. It will be seen that the rocking of handle *D* will thus move the sleeve axially, and will likewise shift the axial position of bar *A* and the stops *B*, which are mounted on it. To the left end of bar *A* is clamped arm *E*, carrying index finger *F*.

The operation of this device is as follows: The first piece of work of a lot having been placed on the centers, ready for turning, arm *E* is swung up to the work, and handle *D* is rocked until the end of finger *F* just touches the end of the work. *E* is then swung back again with *D* remaining in place. Bar *A* has now been set to a position depending upon the position of the end of the stock being turned; stops *B* next are set to give the required shoulder distances as meas-

ured from that end. If the next piece put in the machine is centered too deeply, *F* is swung up again opposite the end of the work, and *D* is rocked until the end of the finger again matches. This shifts *A* to the right as may be required to give the same dimensions as before, measured from the end of the new bar of stock. In the same way, for very rough work, the end of finger *F* is placed a trifle inside the position where the end of the stock will just clean off in machining. In second operation work, finger *F* is similarly set to agree with the position of the shoulder from which it is desired to take measurements.

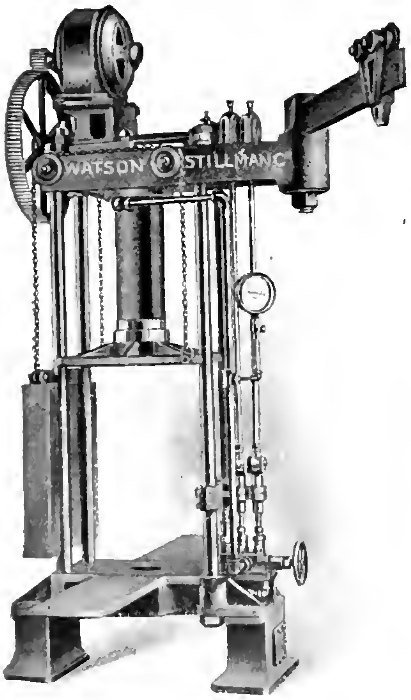


Compensating Automatic Feed Stop for Lathe

The operation of this stop is practically instantaneous, and adds greatly to the accuracy and convenience of the machine.

WATSON-STILLMAN REVERSED CYLINDER PRESS

A recent addition to the line of presses made by the Watson-Stillman Co., 50 Church St., New York City, is shown in the accompanying engraving. This is a reversed cylinder forcing press especially adapted for pressing on bearings and for miscellaneous shop work. As will be seen from the illustration, a crane bracket and beam, extending from one end, enables the operator to swing a heavy piece of work onto bracket shelves extending out from each side of the bottom platen. These shelves, 30 inches long by 12 inches wide, are detachable, can be lifted off, on jobs where they would be in the way, and are sufficiently strong to support any work that will go into the machine. They will be appreciated by those who have had to push castings or parts into place on the ordinary small platen.



A Press for General Shop Use in Pressing on Bearings, etc.

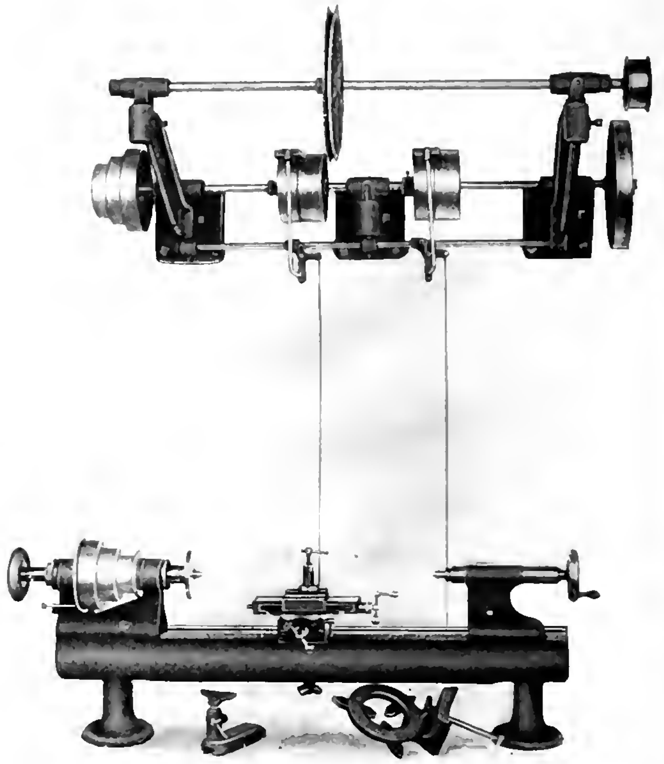
The motor, mounted upon pedestals on top of the press, drives the pump shaft through single gearing. A hand or belted drive is furnished if desired instead of the motor. On the other end of the pump shaft are two eccentrics, each driving one of the pistons of a ¾-inch by 2-inch twin pump, for which the pedestal legs act as reservoirs.

The operating valve is of the single screw stem type, and connected to release the pressure from the work when opened, and start the ram down when closed. It will not retain the pressure unless the motor is stopped or the liquid driven through the safety valve. Other types of valves may be substituted to meet special conditions. A gage is furnished to read in tons or pounds per square inch, as desired.

ROCKFORD MACHINE & SHUTTLE CO.'S PRECISION BENCH LATHE

We illustrate herewith a precision bench lathe made by the Rockford Machine & Shuttle Co., of Rockford, Ill. It is designed for small tool work, jigs, etc., or wherever accurate lathe operations are required, though it is well adapted for the finer grades of manufacturing purposes as well.

The collet has capacity for stock up to ½ inch in diameter. The lathe swings 7 inches over the bed and 4½ inches over the slide rest, and takes 16 inches between the centers.



Rockford Precision Lathe, with Wall Countershaft

A carefully designed thrust bearing is provided. The head and tail centers are ground to No. 1 Morse taper, and the rear end of the spindle is fitted to the standard size for indexing plates. The cone pulley flange is provided with two rows of index holes. The counter-shaft shown is intended to be screwed to the wall. It is provided, as may be seen, with a second shaft for driving grinding and other attachments.

STANDARD DESIGN FOR NEWTON HORIZONTAL MILLING MACHINE

The Newton Machine Tool Works, Inc., of Philadelphia, Pa., has persistently re-designed its line of horizontal milling machines, to keep pace with the capabilities of modern, inserted tooth, high-speed cutters. The changes that have been made have related mostly to the general stiffness of the machine, and to the power of the driving mechanism. It has been found that the rate of removal of metal is about 1¼ cubic inch per minute per H.P., the volume removed being proportionate to the size of the machine. This high rate of removal results in cuts so rapid, that the time of setting the work and adjusting the cutters has become the important factor on most work, rather than the time required on the cut itself. For this reason the builders have found it advisable to redesign the mechanism of their horizontal milling machines from the standpoint of convenience and rapidity of handling.

The machine shown in Figs. 1 and 2 has the controlling levers all mounted within convenient range of the operator, so that any movement except the clamping of the rail can be

obtained instantly. This latter adjustment offers no difficulties, however, since the use of roller thrust bearings at the top and bottom of the elevating screws permits the rail gibs to be tightened to a stiff running fit, and be so used for heavy cuts. Lever *A*, shown attached to the rock-shaft at the bottom of the bed in Fig. 1, passes through to the opposite side as shown in Fig. 2, and is there connected with a bevel gear reversing clutch by means of which all the feeds and fast traverse movements are stopped, started and reversed. Lever *B* operates the table locking mechanism. Lever *C* operates the clutch engaging the rapid power adjustment for the cross-rail. Lever *D* engages a clutch which throws in either the fast travel or feed for the table, as desired. The levers on the feed-box operate change gears, which give nine changes of feed through the different combinations. The hand-wheel may be slipped forward or back on its shaft to give l and vertical adjustment to the rail or to the table as required

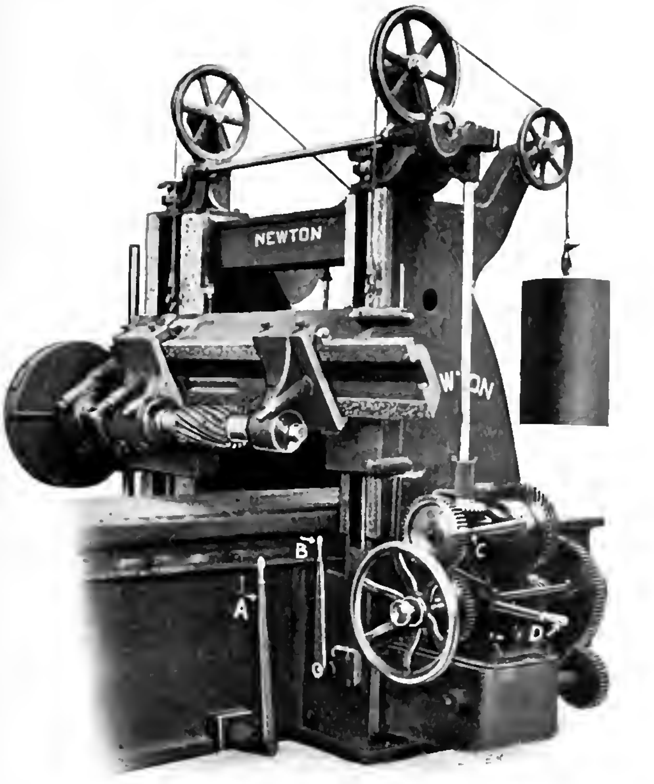


Fig. 1. The Operating Side of the Newton Standard Horizontal Miller

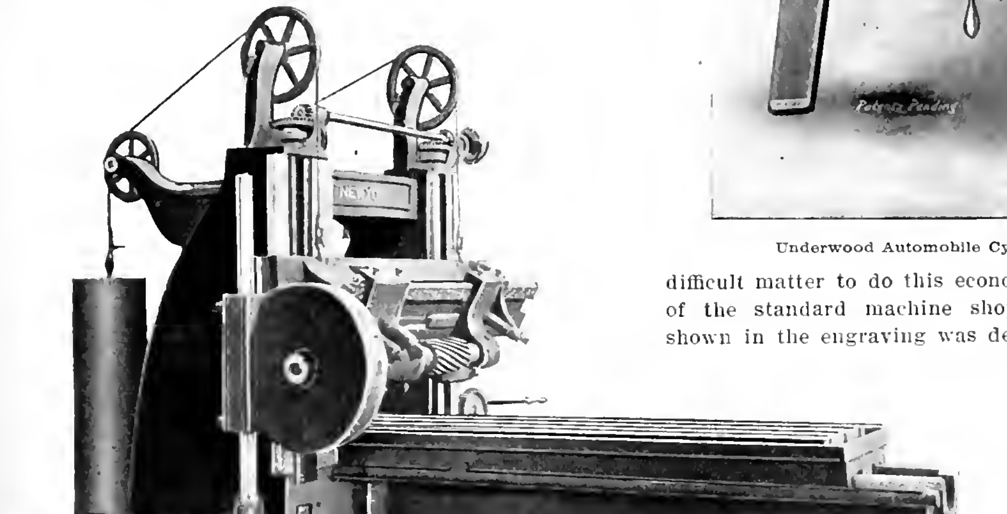


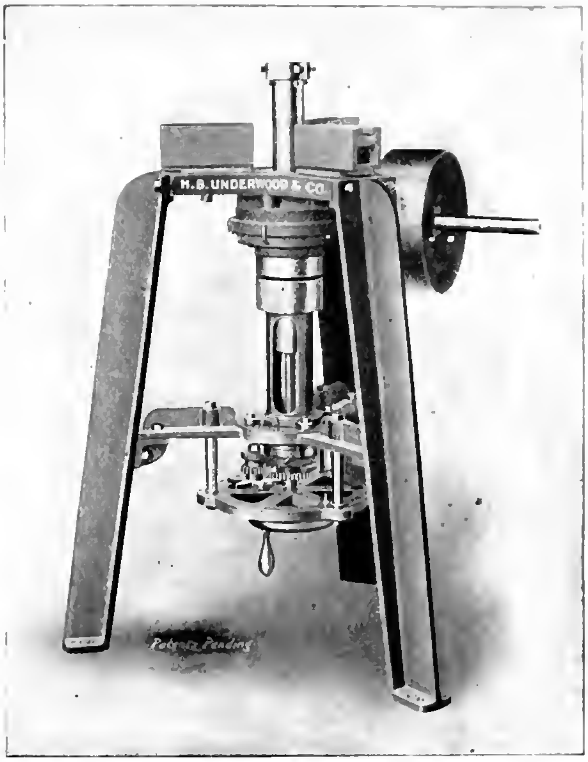
Fig. 2. Arrangement of the Drive and the Controlling Mechanism of the Newton Miller

It will be seen that the operator has all the required controlling levers within easy reach of his working position

This line of machines is complete in all sizes from the smallest (having a table 11 inches wide with 20 inches between the uprights) to the largest, having a table 60 inches wide and 70 inches between the uprights. On the machine illustrated, the makers have been able, in their own shop, on cast iron brackets, to take cuts 9 inches wide, 5/16 inch deep and 15 inches long, in one and one-half minute. Another cut which was taken was 11¼ inches wide and 3/16 inch deep with a table feed of 11½ inches per minute. The machine here shown will be supplied with either a 15 or a 20-horse-power motor, according to the work to be done. The average removal of metal is 1¼ cubic inch per minute.

UNDERWOOD AUTOMOBILE CYLINDER RE-BORING MACHINE

H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., in the regular run of shop work has been frequently called upon to re-bore automobile cylinders. Finding it a difficult matter to do this economically and efficiently on any of the standard machine shop tools, the special machine shown in the engraving was designed. This tool follows the general mechanism of the regular portable cylinder boring machine made by the builders. It is provided, in addition, with such changes in mechanism and such arrangements for mounting and holding the work, as suit the special operation of re-boring automobile cylinders.



Underwood Automobile Cylinder Re-boring Machine

The tool operates in a vertical position, and thus requires but little space. The boring mechanism is supported on a stout tripod as shown. The cylinder to be re-bored rests on three adjustable sliding blocks, planed true and at right angles to the spindle. Suitable clamps hold the cylinder in place after it has been centered; since it rests on the face by which it is bolted to the engine base, accurate alignment is insured. This method of holding applies equally well to

single and multi-cylinder castings, either of which styles are held without distortion. As the work is done in a vertical position, the chips fall out without clogging the cutters or interfering with the work.

The driving pulley shaft is connected with the cutter spindle by worm-gearing. The spindle or boring bar has about 15 inches travel, with a variable automatic feed operated by a star wheel engaging one or more knockers, as required. A special adjustable head is mounted on the spindle for centering the cylinder. After centering, this is removed, and the cutting tool substituted. The cutter head carries four tools which may be adjusted simultaneously to the depth of the cut by screwing down a taper seat in the center of the head. A 1-horse-power motor is sufficient to drive the machine.

This tool is also capable of boring as well as re-boring, and several of them may be set to work in a space which one large machine tool would occupy. The tool is easy to operate and does good work. Only one cut is required, and this may be taken in a remarkably short time.

HYATT HIGH-DUTY ROLLER BEARING

The roller bearing made by the Hyatt Roller Bearing Co., of Newark, N. J., is well-known to mechanics and engineers. It employs a flexible roller, which is formed of helical coils of steel, having a rectangular section. These rollers are confined in a cage which locates them properly between an inner and outer hardened shell, of which the former is made fast to the shaft and the latter to the bearing. For hardened shafts the inner bushing is omitted. In the high duty bearings here described, this inner bushing is omitted only for hardened, heat-treated shafts and rolls or coils.


Hyatt High-duty Roller Bearing

This high duty type of the Hyatt roller bearing has been designed to meet conditions of service which can not be met with the commercial type. To make this increase in capacity, the carbon steel parts of the commercial type have been replaced with alloy steel, properly heat treated; also as explained above, hardened and ground inner and outer surfaces have been provided for the bearing of the rollers. The increase of capacity of the bearing thus obtained may be employed either in getting the same capacity in a smaller space than in the original form, or in getting an increased capacity in the same space. This bearing is particularly adaptable for automobile transmissions, rear axles, and other applications where the duty required of the bushing is great, while the space available for it is limited.

Two designs are made, one of them narrower than the standard to meet the first conditions mentioned, and the other considerably wider for the heaviest service. The light series is made for shafts from ¾ to 2¾ inches in diameter, and for safe loads of from 460 to 3,030 pounds; the corresponding sizes for the heavy series have a capacity of from 1,200 to 6,890 pounds. The length of the smallest size is 2 inches over the bearing, while that of the largest is 3½. These loads give the amount of radial load that a bearing can be subjected to under a maximum speed of 1,000 revolutions per minute. The flexible nature of the roller permits the safe absorption of a reasonable amount of shock. The loads given are the results of actual tests by the mechanical inspection department of the makers, who stand always ready to assist customers in every way in the proper choice of bearings and in their proper installation.

* * *

Switzerland imports machinery to the value of about $10,000,000 yearly. Seventy-six per cent of the machinery imported is of German manufacture.

NEW MACHINERY AND TOOLS NOTES

Brazing Compound: Universal Fluxine Co., Urbana, O. This compound may be used for fusing together cast iron and other metals. It is adapted also to the brazing of high-speed steel cutters to soft steel bodies.

Name Plate Machine: Roovers Mfg. Co., Brooklyn, N. Y. This instrument is adapted to the making of embossed letters for use on patterns, machine tools, in stock rooms, etc., and for general use in numbering and classification about manufacturing plants.

Roller Thrust Bearing: Reeves Pulley Co., Columbus, O. This bearing was developed by the makers to fill the requirements for their variable speed transmission. It is carefully machined, and provided with thrust rollers of large diameter, held in the position required for proper action.

Water-Cooled Rolling Mill: Atlas Machine Co., Waterbury, Conn. This is a rolling mill for small, accurate work; it is provided with a water circulation through the rolls for carrying off the heat generated by the work performed on the metal. The rolls are 6 inches in diameter by 2½ inches face.

192-Inch Plate Shear: United Engineering & Foundry Co., Pittsburg, Pa. A heavy plate shear of the guillotine type, with a capacity for shearing ⅜-inch plate 192 inches wide. The crank-shaft is supported by four bearings on a heavy truss connecting the tops of the housings. A cam-operated plate holder is provided.

Combination Square: W. F. Dissell, 9700 Gibson Ave., Cincinnati, O. This combination square consists of two steel rules, provided with suitable surfaces and clamps for engaging each other firmly in the various positions required for a tool of this kind. It may be set up for use as a depth gage, try square, hook rule, T square, vernier caliper, etc.

Geared-Drive 20-Inch Shaper: Mark Flather Planer Co., Nashua, N. H. This firm has recently added to its line a 20-inch gear-driven shaper made on practically the same lines as the 16-inch shaper described in the November, 1907, issue of Machinery. The design avoids the use of the cone pulley, and is particularly adapted to direct connection with a constant-speed motor.

Portable Drill: Coates Clipper Mfg. Co., Worcester, Mass. This portable drill is intended to be driven by the Coates flexible shaft from any convenient motor power, preferably from a portable motor. It is in the form of the ordinary breast drill. The breast-plate, however, may be removed, and the tool used with the regulation "old man."

"Cito" Cut Meter. Schuchardt & Schutte, 90 West St., New York City. This is a development of the makers tachometer, arranged for giving direct readings in linear velocity. A friction wheel is provided which is placed against the surface whose speed is to be measured. The readings are made from a dial graduated in meters per minute, or feet per minute, as required.

Combined Punch and Shear: Jannell Machine Co., Rumford, Me. This is a small tool, standing a little over 3 feet high. It will punch ⅝-inch holes in ⅜-inch iron, and has sufficient gap capacity and driving power to shear ⅝-inch stock 6 inches wide. The tool has a distinctive appearance, being mounted on a heavy base with all the gearing and other mechanism below the dies.

Heavy Five-Spindle Milling Machine: Niles-Bement-Pond Co., 111 Broadway, New York City. This is a heavy milling machine provided with two facing heads on the cross-rail, a side facing head on the front of each housing and a horizontal slab milling spindle. The vertical spindles are both counterweighted. The table has a working surface 14 feet long, and the clear width between the uprights is 38½ inches.

Shop Transit: H. W. Brown, 63 Canal St., Waterbury, Conn. This tool is a modification of the engineer's transit, omitting every adjustment and piece of mechanism that is not required for shop use. It will be found useful in connection with the modern practice of laying out large work by sighting through the telescope, as well as for running line shafts, setting foundations, etc.

Automobile Cylinder Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This is a double-head boring machine with spindles driven by worm-gearing, so arranged that the center distances may be adjusted without disturbing the drive. The machine is arranged for either open or closed cylinders, as may be required. Four changes of feed are provided.

Portable Boring Machine: Beaman & Smith Co., Providence, R. I. This machine has unusual capacity for a portable tool. It is of the type in which the column, carrying a vertical traveling spindle head, is adjustably mounted on ways on a horizontal base. It is provided with all the movements and conveniences of the ordinary stationary machine, though intended for portable use. It weighs about 15 tons.

Steam Hammer Having Anvil Solid with the Frame: Niles-Bement-Pond Co., 111 Broadway, New York City. The anvil is mounted directly on the base. The side housings are lipped over bearings on the top of the base, and are held to it by bolts provided with heavy springs to allow a slight vertical movement from the rebound of the blow. This is an 8,000-pound hammer of the double housing type.

Special Lathe for Billet Turning: Pacific Iron Works, Bridgeport, Conn. This is a lathe designed especially for turning billets of copper, brass or other alloys for the purpose of cleaning off the scale and other imperfections before putting them through the rolls. This operation also serves to reveal flaws which might otherwise remain hidden. Special holding devices for supporting the billets are provided. The machine weighs about 7,000 pounds.

Angle Drive: Max Ams Machine Co., Mt. Vernon, N. Y. This drive is adapted to the transmission of power through shafting set at right angles. It consists of two short pulley shafts connected by sprockets and a special chain running over sprocket idlers. The chain is so constructed that it will bend and run over sprockets in all four directions. This device is built to transmit various amounts of power as required.

Double-End Lathe Tool: Taylor Mfg. Co., Hartford, Conn. This tool-holder has a provision for clamping a round shank blade at either end, one of the blades being held horizontally and the other at an angle. The blades may be easily ground as turning tools, parting tools, threading tools, etc. The round shank arrangement gives the edge an adjustable cutting angle, and permits tipping the threading tool to agree with the angle of the thread.

Press for Shallow Drawing and Forming in Heavy Plate: Ferracute Machine Co., Bridgeton, N. J. This press, being designed for large work in heavy metal, has been given the form of the coining press made by the same builders. The lower bed or "ram" is operated by a toggle joint mechanism. The blank holder in the upper member is supported by heavy springs, grouped in a casing at the top of the frame. The ram is capable of exerting a maximum pressure of 450 tons.

Motor-Driven Vertical Spindle Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. This vertical spindle milling machine is of large capacity and heavily built. Work 10 inches in height can be taken between the table and the end of the spindle. The distance from the center of the spindle to the face of the column is 33 inches. The length of the in-and-out feed and the length of the cross-feed are also of the same dimension.

High-Speed Steam-Hydraulic Flanging Press: United Engineering & Foundry Co., Pittsburg, Pa. This is a form of rapid action, horizontal press, built on Davy patents, whose principles were discussed in an article entitled "Rapid Action Hydraulic Forging Press," in the May, 1907, issue of Machinery. The makers have acquired the right to this important machine for the United States. This press is intended to take the place of the steam hammer in ordinary machine forging, doing the work as quickly and more effectively.

Slab Miller with Auxiliary Vertical and Horizontal Spindle: Ingersoll Milling Machine Co., Rockford, Ill. This tool is one of the builders' regular slab or horizontal spindle milling machines, provided with an auxiliary head, carrying two spindles at right angles to each other, on either of which milling cutters may be mounted. The attachment is particularly adapted to face milling in either the horizontal or vertical plane, simultaneously with the use of a regular milling cutter for the main arbor.

Independent Chuck with Differential Screw Mechanism: Carter Chuck Co., St. Louis, Mo. This is an independent chuck, with a neatly designed differential screw mechanism for setting down the jaws on the work. This gives, of course a much greater gripping power than can be obtained with an ordinary screw. The construction is such that most of the wear comes on an easily renewed member, making repairs simple and inexpensive. The matter of durability, however, has been carefully considered in the design of the tool.

Crank-Shaft Grinding Machine: Tindel-Morris Co., Eddystone, Pa. This is a grinding machine specially designed for multiple throw crank-shafts. These shafts are driven from each end by geared head-stocks, provided with face plates which hold the work without requiring special fixtures of any kind. Counter-balances are provided on each face-plate to insure steady running. Suitable back-rests, truing stands, etc., are furnished, so that the grinding is effected as conveniently as for ordinary cylindrical work.

Armington Electric Hoist: Armington Electric Hoist Co., Wickliffe, O. These hoists are made in various styles, either for single point suspension, with plain or geared trolley, or in the trolley form with both power hoist and travel. They are made in sizes from 1 to 10 ton capacity, with a standard hoisting speed of from 1 to 12 feet per minute. An improved brake mechanism is employed; it is of the coil type, and of practically one-piece construction. The mechanism is very compact, though accessible. Careful attention has been given to lubrication.

Nelson Combined Ratchet Wrench and Drill: L. H. Brown Mfg. Co., Carlinville, Ill. This reversible ratchet drill is provided with adjustable chuck jaws, which may be used for holding nuts, bolt heads, etc., as well as for holding drills. By removing the feed-screw, a free hole is left through the center of the tool, so that it may be slipped over a long threaded bolt. The ratchet mechanism is entirely enclosed, making the tool more durable than with the ordinary open construction. The head room is unusually short, adapting it to use in confined places.

Draftsmen's Protractor: L. S. Starrett Co., Athol, Mass. This is a protractor intended especially for use in the drafting-room. It is made of sheet steel, nickel-plated and is graduated in degrees to read from either left or right. The vernier provided gives accurate readings to within 5 minutes. The straight edges of the protractor are graduated in inches and 16ths, the adjustable edge being graduated to 6 inches in length. Angles can be reversed without resetting by simply turning the instrument 90 degrees around on the T square or straight edge.

Tool-Holder for Turning and Threading: G. R. Lang Co., Meadville, Pa. The idea incorporated in the locomotive and car wheel tire turning tool made by this firm, and mentioned in a note in the December, 1908, issue of Machinery, has been applied to a general tool-holder for turning, threading, etc. The threading blades and the smaller turning blades are made from triangular drawn stock. Larger tools are milled from stock to fit the dovetail in the holder. The lock-bolt in the latter supports the blade against a solid abutment, and at the same time clamps it tightly in place by frictional means.

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In a paper read before the *Société de Ingenieurs Civils de France*, it was stated that in the Messina earthquake, reinforced concrete proved itself to be the safest building material for regions thus afflicted. One typical example is cited of a house now standing in the center of a section where all the other buildings were reduced to fragments. This house sheltered a family the members of which are now the sole survivors within a large adjacent area. The one million-gallon reinforced concrete reservoir supplying the city with water suffered no damage.

PRESENTATION OF THE JOHN FRITZ MEDAL TO CHARLES T. PORTER

The National Engineering Societies, comprising the American Society of Civil Engineers, The American Institute of Mining Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, conferred the John Fritz medal for 1908 on Mr. Charles T. Porter for his work in advancing steam engineering and his improvements in engine construction. The medal was presented in the presence of a distinguished company on the evening of April 13th, in the auditorium of the Engineering Societies' building at 29 West 39th St., New York.

The John Fritz medal was established by the professional associates and friends of John Fritz, of Bethlehem, Pa., on August 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress. (See MACHINERY, September, 1902.) The awards are made annually by a board of sixteen, appointed or chosen in equal numbers from the membership of the four societies named. The awards up to date have been as follows:

First award, January 20, 1905, to Lord Kelvin for his work in cable telegraphy and other scientific attainments.

Second award, January 19, 1906, to George Westinghouse for the invention and development of the air brake.

Third award, January 18, 1907, to Alexander Graham Bell for the invention and introduction of the telephone.

Fourth award, January 17, 1908, to Thomas Alva Edison for the invention of the duplex and quadruplex telegraph, the phonograph, the incandescent lamp system of electric lighting, etc.

Fifth award, January 16, 1909, to Charles T. Porter for his work in advancing the knowledge of steam engineering and in improvements in engine construction.

Mr. Henry R. Towne, chairman of the board of award, presided at the meeting, and Dean W. F. M. Goss, of the University of Illinois, read a paper entitled "The Debt of Modern Industrial Civilization to the Steam Engine as a Source of Power." After the presentation of the medal to Mr. Porter letters of salutation were read from societies and prominent engineers in the United States and Europe, and then followed a paper by Prof. F. R. Hutton, of Columbia University and honorary secretary of the A. S. M. E., "The Debt of the Modern Steam Engine to Charles T. Porter." Robert W. Hunt followed with "The Debt of the Era of Steel to the High-Speed Steam Engine," and Frank J. Sprague concluded with "The Debt of the Era of Electricity to the High-Speed Steam Engine."

Professor Hutton spoke in detail of the pioneer work of Mr. Porter, and gave him credit for first seeing the great possibilities of the high-speed engine. In analyzing the debt we owe to the work of Mr. Porter, stress was laid on the following:

"First, the reciprocating engine owes to him the first vision of the advantages that come from making the crank-shaft turn at a high number of revolutions whereby the weight of the motor per horse-power is reduced; and second, for raising the standard of mechanical construction because of the necessity of such in the high-speed engine. We owe to Mr. Porter many engineering details which are commonplaces of modern practice. He created a condenser air pump that was directly connected to the engine and capable of running at high speed, and a highly sensitive governor in two forms."

Among those present on the rostrum were: James C. Brooks, Charles L. Clarke, W. F. M. Goss, C. W. Hunt, F. R. Hutton, George W. Melville, Alfred Noble, C. A. Parsons (England), W. H. Pegram, Charles T. Porter, Charles B. Richards, Henry R. Towne, Jesse M. Smith, E. G. Spilsbury, Frank J. Sprague, Ambrose Swasey, John E. Sweet, E. Swenson, G. G. Ward, S. S. Wheeler.

* * *

A record in long-distance telegraphy has been achieved by the Indo-European Telegraph Co., which has succeeded in transmitting messages direct from London to Calcutta, a distance of 7,000 miles, with no intermediate re-transmissions. A speed of forty words a minute was maintained.

NEW STEAM-ENGINE VALVE MECHANISM

On April 6 the Rothchild Engine Company, 102 Center Street, New York, gave a public demonstration of a new and novel form of valve mechanism which the company expects to apply to both stationary engines and locomotives. The engine which has been built for the purpose of trying out the new valve has four cylinders which are cast integrally in pairs. The steam chest for each set of cylinders is located at the top and contains a single valve which is in the form of a cylindrical bushing. These valves are connected by a shaft which is rotated from the main shaft below, by a chain, and sprockets so proportioned that the crank-shaft makes three revolutions while the valves are making one. Three steam ports, 120 degrees apart, are cut into the valve for each cylinder. Each set of three ports is in line with a larger main port opening into the cylinder, and as the valve turns one-third of a revolution, while the crank-shaft makes a complete turn, obviously, one port will be at the point of admission at the beginning of each stroke. The live steam which is within the cylindrical valve would be admitted to the cylinder while the port in the valve was passing the larger main port were it not for a half-round cut-off valve which fits inside of the cylindrical valve. This cut-off valve closes the port and cuts off the steam at a point depending upon its angular position which is varied by the movement of a lever. The point of release occurs when the port through which steam was admitted opens into the exhaust port which is located in the lower side of the cut-off valve. By changing the position of this valve so that its opposite edge controls the point of cut-off, the reversal of the engine is effected.

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The Queensboro, or Blackwells Island bridge, joining Manhattan Island and Queens County, New York, was opened to traffic March 30. This bridge is of the cantilever type and is one of the three great cantilever structures in the world, completed or in construction, the other two being the Firth of Forth bridge and the Quebec bridge, one section of which fell in process of construction last year. The Queensboro bridge is 8,600 feet long, including the approaches. The bridge proper is 3,746 feet long, made up as follows: Anchor span, 460 feet; channel span, 1,182 feet; island span across Blackwells Island, 632 feet; span over the east channel of the river, 984 feet; and anchor span on the Long Island shore, 459 feet. The approaches are 4,854 feet. The roadway is 135 feet above mean high water mark and the towers are 185 feet above the bottom chord. The height of the trusses of the island span is 118 feet. This is the heaviest part of the bridge, weighing 10,400 tons or 16½ tons to the linear foot. The steel superstructure was furnished by the Pennsylvania Steel Co. and weighs 52,000 tons. The width between the railings of the lower floor is 86 feet and of the upper floor 67. The total cost of the bridge is about $20,000,000. Ground was broken for the bridge in 1893, but active work was not begun until January, 1901. Following the fall of the Quebec bridge, an investigation was made of the plans for the Queensboro structure, and it was deemed unadvisable to subject it to the load for which it was originally designed. It was designed to carry four elevated railway tracks, but only two will be laid. Provision is made for four trolley tracks and one 34-foot roadway on the lower deck and two rapid transit tracks and two 14-foot walks on the upper deck.

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PERSONAL

Percy Reston has been promoted to the position of chief draftsman in the office of the Cincinnati Planer Co.

John W. Freeman has been appointed manager of the Sprague Electric Co.'s Pittsburg office to succeed Mr. F. W. Parry, who recently resigned.

James Hartness, president of the Jones & Lamson Machine Tool Co., Springfield, Vt., sailed for Europe April 14 on the steamer *Mauretania*.

E. E. Brosius, Alliance, Ohio, has been made sales manager of the Pawling-Harnischfeger Co., Milwaukee, Wis., builders of traveling cranes.

H. W. Bridge is now president of the Buckeye Equipment Co., Cincinnati, O., having succeeded J. S. Nowotny, who retired from the company some time ago.

At the last meeting of the directors of the firm of John Steptoe Shaper Co., Cincinnati, Ohio, G. K. Atkinson, superintendent, was elected secretary-treasurer.

H. M. Wood, formerly with the Niles-Bement-Pond Co., has joined the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, to act as publicity and advertising manager.

J. B. Baker of the Safety Emery Wheel Co., Springfield, Ohio, sailed April 1 for a two months' business trip to England, Germany, Holland, Norway and Sweden.

H. L. Clark, formerly superintendent of the Dominion Coal Co., Glace, Cape Breton, has recently been appointed superintendent of the Chester Park shops of the Cincinnati Traction Co.

M. E. Dewstoe, First National Bank Building, Birmingham, Ala., has been appointed selling agent of the Bullard Machine Tool Co., Bridgeport, Conn., in the Alabama and Tennessee territory.

W. Robertson has severed his connection with the Robertson Mfg. Co., Buffalo, N. Y., and is now with the Robertson Drill & Tool Co., manufacturers of a line of power hack saws and drill presses.

H. W. Kreuzburg, president of the Champion Tool Works Co., Cincinnati, O., recently returned from a business trip which included San Francisco, Denver, Salt Lake City and other large cities in the West.

Philip Fosdick, president, and R. K. Le Blond, vice-president of the Cincinnati Chuck Co. Cincinnati, Ohio, are in Europe on a business-pleasure trip. They expect to return to this country about May 1.

John R. Kempf, secretary and treasurer of the Star Corundum Wheel Co., Detroit, Mich., sailed for Europe April 16 on the steamer *St. Paul*, to make an extensive business tour of England and the Continent.

C. G. Hafley, formerly advertising manager for the Buffalo Forge Co., Buffalo, N. Y., and later with the Keuffel & Esser Co., is now with the Vechten-Waring Co., 92 John St., New York, acting as assistant in the advertising service department.

W. H. Smead, mechanical engineer, has moved his office from Greenboro, N. C., to 207 Prudential Building, Atlanta, Georgia. Mr. Smead will continue his general engineering business, making a specialty of designing power and heating plants.

Frank Wells Hall has been appointed manager of the Philadelphia office of the Sprague Electric Co., New York. Mr. Hall formerly was connected with Sprague Electric Co. both in the New York and Chicago offices in an engineering and sales capacity.

F. O. Hoagland, who for twelve years past has been connected with the Pratt & Whitney Co., Hartford, Conn., the last eight years of which as department foreman, has been made chief mechanical engineer with the Remington Arms Co., Ilion, N. Y.

W. S. Rogers, president of the Bantam Anti-Friction Company, Bantam, Conn., sailed for Germany April 29, on the invitation of several German makers of balls and ball bearings, to make close connections for the handling of their goods in this country.

D. B. Clark, master mechanic of the Chester Park Shops of the Cincinnati Traction Co., has been appointed master mechanic of the Columbus shops of the Ohio Electric Railway Co. Mr. Clark will continue to hold his position as master mechanic of the Chester Park shops.

Hermann Hill, 437 Columbus Ave., Boston, Mass., has invented machinery for the manufacture of expanded metals and will organize a company called the Steel Fire Proofing Co., for the manufacture of expanded metals for all classes of service. The factory will be located in Pittsburgh, Pa. His temporary shop is at 82 Purchase St., Boston, Mass.

George Taylor, for the past three years connected with the testing and construction department of the General Electric Co., of Schenectady, N. Y., lately resigned to become a partner in the Taylor Machinery Co., 8 Oliver St., Boston, Mass., a concern recently organized by Thomas I. Taylor, as noted in the March number of MACHINERY.

P. V. Vernon, chief designer of Alfred Herbert, Ltd., machine tool builder, Coventry, England, has sent a communication to the American Society of Mechanical Engineers, of which he is a member, proposing that the British Institution of Mechanical Engineers and the American Society of Mechanical Engineers cooperate to secure the adoption of a standard for involute gearing.

P. E. Montanus, president of the Springfield Machine Tool Co., Springfield, Ohio, returned from a two months' business trip in Europe, March 27. Mr. Montanus reports that the outlook for the sale of standard American machine tools in foreign markets is not promising and that foreign manufacturers are rapidly developing imitations of American machines, which are sold at lower prices than the American tools.

Frank P. Peters has been promoted from the position of general foreman of the Sodemann Heat & Power Co., St. Louis, Mo., to that of superintendent of the entire factory. Mr. Peters went from the United States Heater Co., Detroit, Mich., in January, 1908, to take charge of the machine department, and was soon promoted to general foreman. He has had about ten years' experience in the manufacture of radiators and heating apparatus, and is a practical machinist.

Edwin C. Thurston, who has been with the Gould & Eberhardt Co. for the past four years, in their machine designing department, and who was formerly with the Brown & Sharpe Mfg. Co. for a period of over ten years, having had experience and charge of work in the various machine tool and sewing machine departments, has associated himself with Mr. J. C. Blair, expert tool maker, machine builder and manufacturer of metal specialties. Messrs. Thurston and Blair will take up special small machinery and tool designing and building, metal specialties, model and experimental work, pattern making, drawings, tracings, blue-printing, etc., and also developing and perfecting ideas for inventors. They are located at 78 Clinton St., Newark, N. J.

James R. Anderson, sales manager of the Lunkenheimer Co., Cincinnati, Ohio, recently returned from a business trip through South America. In an interview he laid much stress on the bad results on American commerce caused by poor packing of goods. He said that American manufacturers, including those in all lines, do not pack their goods strong enough for rough handling. As a consequence, packages are frequently broken and goods of all kinds are lost or damaged in transit. Another serious fault is that American manufacturers do not cater to the size, kind, quality and weights of packages that South Americans want. It appears that it will be necessary for American manufacturers who desire to develop a South American trade, to send a trustworthy representative who will spend some time in making the acquaintance and learning the peculiarities of the inhabitants. There are many prejudices to overcome and ideas to be conformed to. The custom house regulations of various countries are complex and a great deal of attention must be given to meeting these regulations to avoid loss and trouble.

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OBITUARIES

G. Charles Connor died March 27 of blood poisoning following an operation for intestinal abscess. Mr. Connor was manager of the Philadelphia office of the Sprague Electric Co., which position he had held since February, 1903. He leaves a widow and son.

Nathan P. Towne, chief engineer of the Cramp Ship Building Co., Philadelphia, Pa., and formerly an engineer of the United States Navy, died at his home in Philadelphia, April 23. Since 1893 Mr. Towne designed and superintended the construction of the engines of nearly all the battleships, cruisers and vessels built at Cramp's.

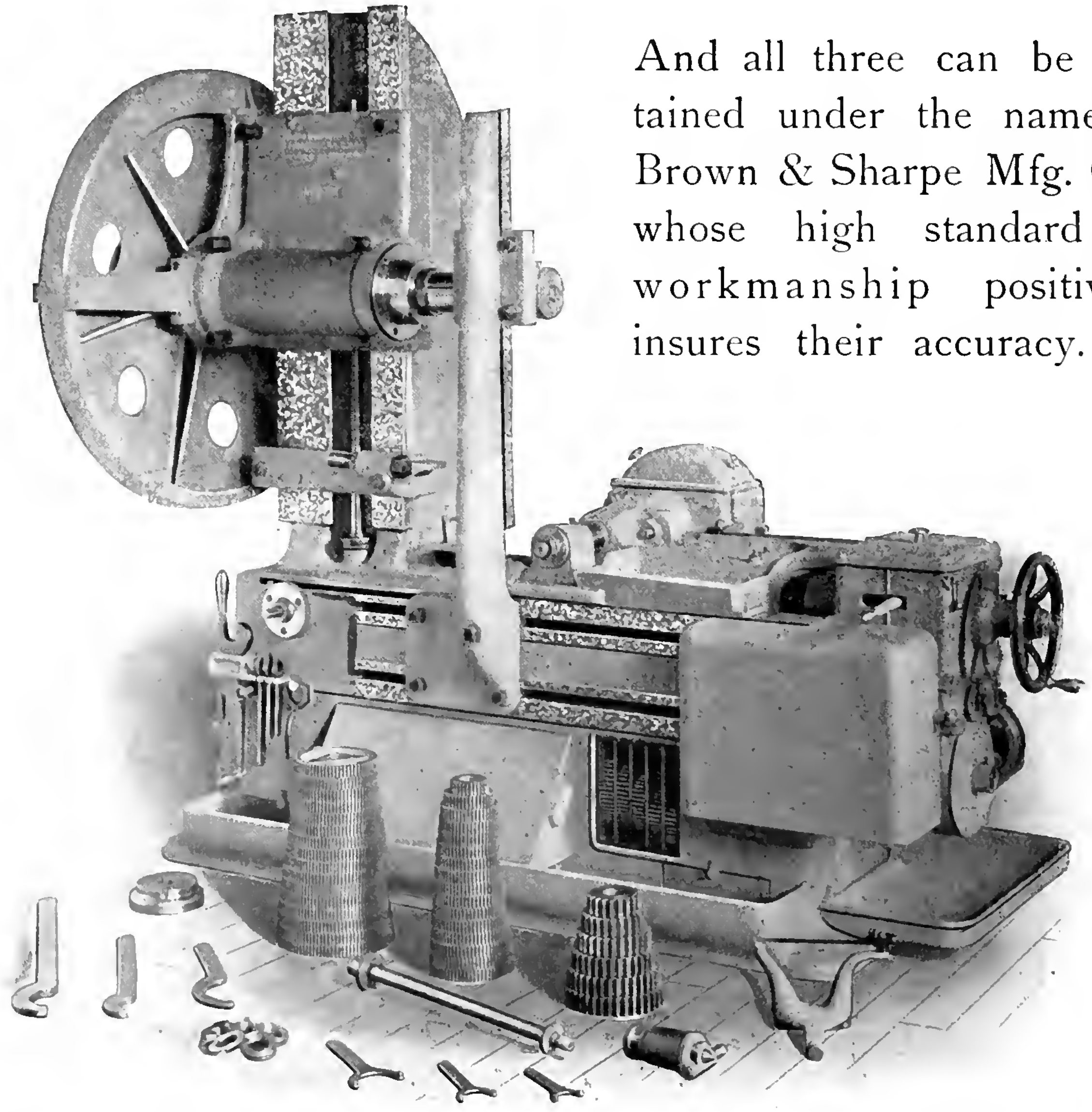
John Hall, a prolific inventor, died of pneumonia at St. Luke's Hospital, New York, April 20, aged eighty years. He was the inventor of the Hall car coupler, and while chief engineer of the A. Coburn Co., Philadelphia, Pa., manufacturers of thermometers, he made many improvements which greatly reduced the cost of thermometers, and made possible the cheap thermometers now in common use.

MATTHEW MORTON

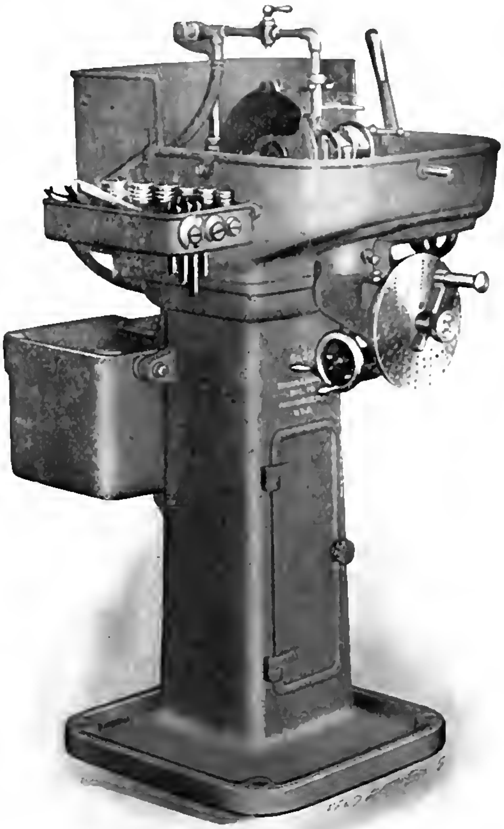
Matthew Morton, president and founder of the Morton Mfg. Co., Muskegon Heights, Mich., died at his home in that city, March 10, from an attack of pneumonia, in the seventy-third year of his age. A passion for mechanics and development of new ideas and improvements in machinery characterized Mr. Morton's life, and he was actually engaged in his business pursuits up to the Saturday noon preceding his illness.

Mr. Morton was a native of Scotland. He was born in Ayrshire, May 5, 1836. His father and mother, James and Margaret Morton, moved their family to America in 1844, and settled on a farm in Armada Township, Macomb Co., Michigan. Mr. Morton lived on the farm until he attained his majority. He frequently would go to Romeo, a distance of seven miles, to market and generally spent a little time at a machine shop there in making parts for a foot lathe. These parts he took home and stored in the woodshed, and one rainy day, when they were all ready, he assembled the lathe, quite to the displeasure of his parents, who did not take kindly to mechanical pursuits, but the lathe served its purpose and helped do the repair work in the community to general satisfaction. This incident clearly shows the trend of Mr. Morton's mind in early years.

After becoming of age, Mr. Morton moved to Armada village and with his foot lathe started in business, and a year later moved to Lapeer, Mich., at that time a frontier lumber town, and engaged in the steam engine business under the name of the Lapeer Engine Works. In 1861 he constructed his first steam engine, making the patterns and molding them and melting the iron in a home-made cupola. He machined the parts and assembled the engine unassisted, and did the entire work himself. He made a reputation for building engines of



Providence, Rhode Island, U. S. A.



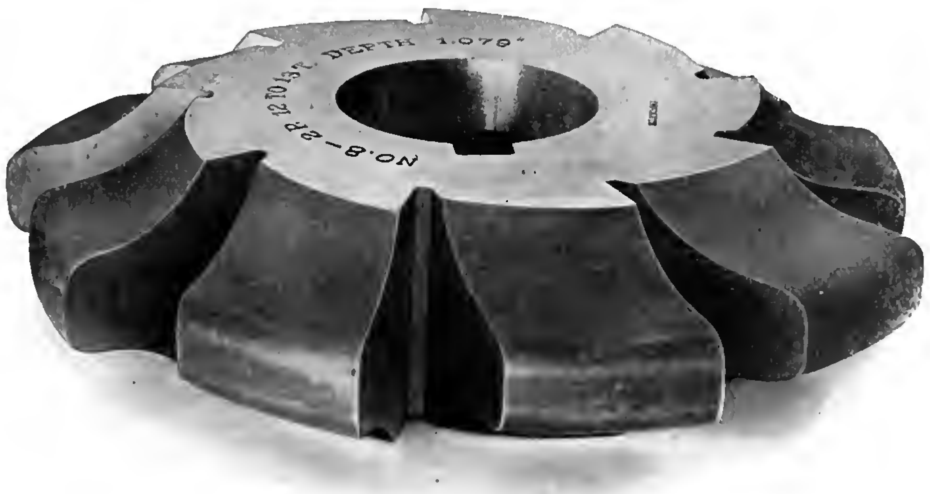
ACCURACY is a part of the machines because of their rigid construction, large index wheels, accurate indexing mechanisms, and long and wide bearing surfaces.

ACCURACY is established in the cutters because their forms are carefully laid out from original curves which are the standards of modern gearing practice.

ACCURACY in the grinding is made possible because the machines grind every cutter radially and equidistant, which is the only way the original forms of the cutters can be maintained.

By means of such a combination of B. & S. Machines and Cutters, accurately cut gears are obtained.

Write for circulars of the machines and cutter list.



Matthew Morton

very low steam consumption, and a prosperous business was established.

In 1866 he formed a co-partnership with the late William McDonald, which lasted for about five years. In 1871 he disposed of his interest in Lapeer to Mr. McDonald and moved to Romeo, where he again started the business of building engines. While in Romeo he built his first marine engine which operated with such economy and was so satisfactory that the user made him a present of $100. He also built a portable machine for boring cylinders and with it by hand bored out four locomotive cylinders in twenty hours.

From 1875 to 1878 he was engaged in building and repairing marine and stationary engines with Mr. A. H. Hamblin in St. Clair, Mich. The partners returned to Romeo where they began manufacturing agricultural machinery, but depression in business and financial reverses overtook them and Mr. Morton again started at the foot of the ladder with his foot-power lathe, and then founded the present business. He built the first successful key-seater that cut with a single tool, which proved to be constructed on the best principle for cutting key-ways. The developments of this line were such that machines were required to be built to cut key-ways up to six feet long and six inches wide.

In 1887 Mr. Morton developed the Morton portable slotter and planer, which was the first machine used in the Pittsburg district for planing the feet and windows of roll housings. The machine proved to be a valuable tool for heavy work and has since been largely sold to builders of heavy machinery in America and foreign countries. In 1891 Mr. Morton and the other members of his company moved to Muskegon Heights, a suburb of Muskegon, where in the same year the Morton Mfg. Co. was incorporated with Matthew Morton, president; A. T. Morton, vice-president; and William Rowan, secretary and treasurer, who have since been officially connected with the company. From this time on the draw-cut shaper was developed for general machine shop work, railroad work, steel foundry work, etc. The first machine built was of 26-inch stroke, from which start machines have been developed up to the traveling head planer and shaper, the largest in the world, having a stroke of seven feet. The machine stands 22 feet high and weighs 35 tons complete.

Mr. Morton was original in his ideas and constructive methods. He never looked at the catalogues of other machine tool builders to see what he should make. During his life he took out over forty patents, which nearly all have proved to be useful and valuable. He is survived by his wife, a daughter and two sons.

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SOCIETIES AND COLLEGES

Beloit College, Beloit, Wis. Sixty-second annual announcement and catalogue for 1909-10. 159 pages, 5¼ x 7⅝ inches.

University of New Mexico, Albuquerque, N. M. Bulletin of the university containing catalogue for 1908-09 and announcements. 126 pages, 5⅝ x 7½ inches.

The Massachusetts Institute of Technology, Boston, Mass., has made fuller provision for advanced study relating to the higher degrees of Master of Science, Doctor of Philosophy, and Doctor of Engineering. During the present year, graduate students were awarded $5,100 for scholarships and graduate scholarships. The library received accessions aggregating 5,163 items for the year of 1908.

The executive committee of the Museum of Safety and Sanitation, of 29 W. 39th Street, N. Y., has detailed Dr. Wm. H. Tolman, the director, for field work, and he will start May 1 on a lecturing tour. Chambers of commerce, manufacturers' associations, engineering, insurance and architectural societies, railway and other clubs, may avail themselves of this illustrated exposition of devices and methods for reducing damage suits and preserving efficiency for the cost of the lantern operator ($10) if not too far removed from the itinerary.

The National Metal Trades Association held its eleventh annual convention in the Hotel Astor, New York, April 14 and 15. Nearly 200 were registered in attendance, and the association was welcomed by Hon. Patrick H. McGowan, president of the New York Board of Aldermen. A number of valuable papers were presented and discussed. Among them was, "Profit Sharing," by R. T. Crane, Crane Co., Chicago, Ill., and N. O. Nelson, N. O. Nelson Mfg. Co., St. Louis; "The Premium System of Paying for Labor," by F. C. Blanchard, works manager, The Ashcroft Mfg. Co., Bridgeport, Conn.; "Industrial Peace," by Hon. C. P. Neill, United States Commissioner of Labor; "What the Workingman Wants from the Employer," by James Wilson, president Pattern Makers' League of North America; "Employers' Liability Insurance," the Hon. Epaphroditus Peek, of Yale University; "Industrial Training Through Apprenticeship Systems," by E. P. Bullard, Jr., of the Bullard Machine Tool Co., Bridgeport, Conn., "The Labor Question," by David Gibson, editor "Common Sense," Cleveland, Ohio. The officers elected for the coming year are: H. P. Eells, president; J. H. Schwacke, first vice-president; H. W. Hoyt, second vice-president, and William Lodge, treasurer.

The charter members of the Museum of Safety and Sanitation met on Tuesday evening, March 30 and elected the following officers: Acting president, Philip T. Dodge; vice-presidents, Charles Kirchhoff, T. C. Martin, Prof. F. R. Hutton, and R. W. Gilder; treasurer, Robert A. Franks; plan and scope committee, Prof. F. R. Hutton, William J. Moran, Dr. Thomas Darlington, B. D. Whitfield, and P. T. Dodge; director, Wm. H. Tolman. The Museum of Safety and Sanitation has its office at the United Engineering Societies' Building, 29 West 39th Street. The objects of the museum are to study and promote means and methods of safety and sanitation and the application thereof to any and all public or private occupations whatsoever, and of advancing knowledge of kindred subjects; and to that end to establish and maintain expositions, libraries and laboratories and their branches, wherein all matters, methods and means for improving the general condition of the people as to their safety and health, may be studied, tested and promoted, with a view to lessening the number of casualties and avoiding the causes of physical suffering and of premature death; and to disseminate the results of such study, researches and tests, by lectures, exhibitions and other publication.

COMING EVENTS

May 4-7.—Spring meeting at Washington, D. C., of the American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City, secretary.

May 5-7.—Joint convention of the Southern Supply and Machinery Dealers' Association and American Supply and Machinery Manufacturers' Association, Chattanooga, Tenn. Alvin M. Smith, Richmond, Va., secretary and treasurer of the Southern Supply and Machinery Dealers' Association, and F. D. Mitchell, secretary and treasurer, American Supply and Machinery Manufacturers' Association, 309 Broadway, New York.

May 12-14.—Annual meeting of the National Supply and Machinery Dealers' Association, at the Fort Pitt Hotel, Pittsburg, Pa. Secretary-Treasurer, A. T. Anderson, 41 Wade Building, Cleveland, Ohio.

May 18-20.—American Foundrymen's Association convention, Cincinnati, Ohio, Hotel Sinton, headquarters. Richard Moldenke, secretary, Watchung, N. J.

May 25-26—Spring convention of the National Machine Tool Builders' Association at Milwaukee, Wis. Plankington House, headquarters. P. E. Montanus, president of the Springfield Machine Tool Co., Springfield, Ohio, secretary.

May to November, 1910.—International Exhibition of Railway and Land Transport, Buenos Ayres, Argentine Republic, commemorating the first centennial of the Argentine Independence. The officers of the exhibition are, Alberto Schneidweind, general director of Argentine Railways, president; H. H. Loveday, general manager of Argentine Railways, and Dr. H. H. Trays, local director of Central Argentine Railways, vice-presidents; Juan Pelleschi, commissioner general; Eduardo Schlatter, secretary.

June 1.—Opening of the Alaska-Yukon-Pacific Exposition in Seattle, Washington, which is designed to call the attention of the world to the importance of Seattle as the western gate-way to the United States, and to its rapidly growing commercial importance. The exposition will include many working exhibits, among which are meat packing, watch making, jewelry, silk-making, rope-making, telephoning, printing, etc.

June 1-5.—Annual meeting of the International Railway General Foremen's Association at Chicago, Ill. E. C. Cook, Royal Insurance Building, Chicago, Ill., secretary.

June 7-19.—Cleveland Industrial Exposition, under the auspices of the Cleveland Chamber of Commerce, Cleveland, Ohio. It is estimated that 125,000 different articles are manufactured in Cleveland's 3,500 shops, and it is proposed to display to the world at this exposition the wonderful industrial facilities of the city. The products comprise steel ships, heavy machinery, hardware, twist drills, reamers, milling cutters, wire nails, bolts, nuts, vapor stoves, malleable castings, automobiles, paints and oils, etc. William G. Rose, Cleveland, Ohio, secretary.

June 9-11.—Joint convention of the Southern Hardware Jobbers' Association and the American Hardware Manufacturers' Association at Hotel Shenley, Pittsburg, Pa. F. D. Mitchell, 309 Broadway, New York, secretary and treasurer.

June 16-18.—Annual convention of Railway Master Mechanics' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 21-23.—Annual convention of the Master Car Builders' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 22-24.—National Gas and Gasoline Engine Trades Association convention, South Bend, Ind. Headquarters, Oliver Hotel. Albert Stritmatter, Cincinnati, Ohio, secretary.

September 25-October 2.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the Tribune Building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

NEW BOOKS AND PAMPHLETS

New Method of Gas Manufacture, by Henry I. Lea. Pamphlet of 16 pages, 6 x 9 inches. Paper read before the Illinois Gas Association, Chicago, Ill., March 17, 1909. Henry I. Lea, The Rookery, Chicago, Ill.

Social Engineering. By W. H. Tolman, with introduction by Andrew Carnegie. 364 pages. Published by the McGraw Publishing Co., New York. Price $2, instead of $5 as given in the review in the April number.

Annual Report (49th) of the Superintendent of Insurance of the State of New York, Part 4. Assessment or Cooperative and Fraternal Insurance. 271 pages, 6 x 9 inches. Published by the State of New York, Albany, N. Y.

A Study of Roof Trusses, by N. C. Ricker, and Lighting Country Homes by Private Electric Plants, by T. H. Amrine, published by the University of Illinois, Urbana, Ill., have been issued in a new edition in response to the demand. These are known as Bulletins Nos. 16 and 25 respectively.

Supplement to MACHINERY, June, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Twist Drill Grinding"

SHOP OPERATION SHEET NO. 100.

Franklin D. Jones. MACHINERY, June, 1909

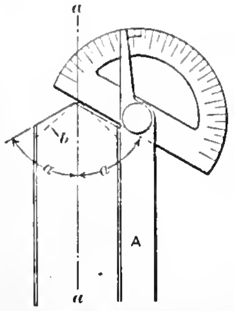


Fig. 1

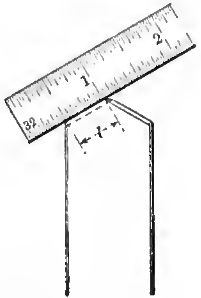


Fig. 2

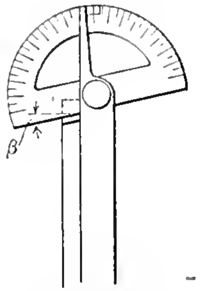


Fig. 3

Machinery, N.Y.

Grinding a Flat Drill.

NOTE.—A drill should be ground so that the two cutting edges make the same angle, *a*, with the axis *a-a*. When these angles are not equal, one side will have more work to do than the other. The angle of clearance β should also be equal for both cutting edges. For general work this angle should be about 12 degrees, but if the material to be drilled is soft and the feed is to be heavy, it may be increased to 15 degrees. The length *l* of each cutting edge should also be the same, as otherwise the hole drilled will be larger than the drill diameter.

1. Set a protractor *A* (a tool used for measuring angles) to an angle of 59 degrees, and test the angularity of the cutting edges of the drill to be ground. If these edges should, for example, be as indicated by the dotted lines *b*, when grinding, more metal would, of course, be removed from the point of the drill. Thus it will be seen that this preliminary test saves time.

2. When grinding, support the drill on the tool rest, and move it slowly back and forth in order that any unevenness in the wheel face will not affect the straightness of the cutting edge. Use, preferably, the face of the emery wheel in order to derive benefit from the cooling water, and grind slowly so that the temper of the tool will not be affected. The position of the tool in relation to the face of the emery wheel should be such that the angle *a* which the cutting edges make with the axis *a a*, and the angle of clearance β will be ground as nearly correct as can be judged.

3. Test the angularity of each cutting edge with the protractor, as shown in Fig. 1, and continue grinding until each edge is at an angle of 59 degrees with the axis of the drill.

4. With a scale measure the length *l* of each cutting edge as shown in Fig. 2; if they are unequal correct by grinding, being careful not to change the angle of the cutting edge.

5. Set the protractor to an angle of 12 degrees; test the clearance angle β and, if necessary, regrind until the clearance is approximately 12 degrees on each side.

NOTE.—When grinding a drill by hand it should, of course, as far as possible, be made correct with the first grinding. The operation has been somewhat separated in the foregoing in order to make the requirements more clear.

SHOP OPERATION SHEET NO. 101.

Franklin D. Jones. MACHINERY, June, 1909.

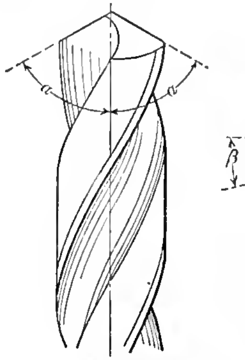


Fig. 1

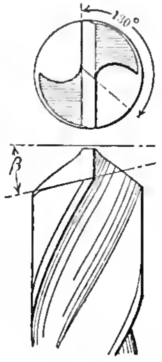


Fig. 2

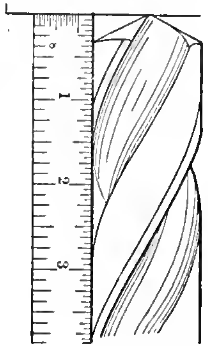


Fig. 3

Machinery, N.Y.

Grinding a Twist Drill.

NOTE.—The cutting edges of a twist drill should, as with the flat drill, be equiangular, of the same length, and have the same clearance. When both the cutting edges of the drill are ground to the same angles *a*, one cutting edge supports or counteracts the tendency of the other to spring from the cut (providing the clearance is also correct), but when the angles *a* are different, one edge will do more work than the other, thus subjecting the drill to an unbalanced twisting or torsional strain.

1. Grind each cutting edge to an angle *a* of 59 degrees (see Fig. 1), using the face of a wet emery wheel, and proceeding the same as if a flat drill were being ground, as described in paragraph 2 of the preceding sheet. The end of the drill will then appear as shown in Fig. 2. The clearance angle will be approximately correct when the line joining the cutting edges is at an angle of 130 degrees as shown.

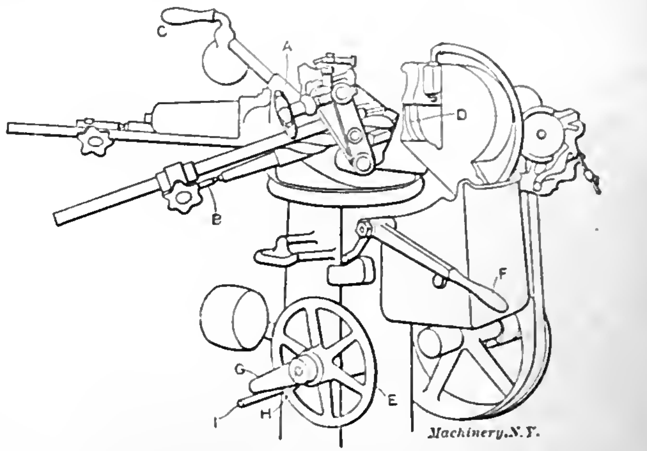
NOTE.—There is a difference of opinion as to the best angle *a* of the cutting edge. As this angle is decreased the pressure required to force the drill through the metal becomes less, but the length of each cutting edge is increased with the result that more power is required to turn the drill. An included angle of 118 degrees is thought by some to equalize the thrust and torsion to the best advantage, while others advocate much more acute angles.

2. Grind away the metal back of each cutting edge, indicated by the shaded portion (Fig. 2), by moving the outer end of the drill, which is fulcrumed on the tool-rest, up and down with the right hand. Continue grinding until a surface, which should be approximately conical in form, is blended into the flat part previously ground. The backing or clearance of the cutting edges should be of such a form and angle as to allow the drill to cut freely and without binding as it is fed into the metal.

3. The clearance for each cutting edge may be tested by placing the drill point against a flat surface, and then slowly revolving it close to a scale held in the position shown in Fig. 3. If the clearances are not approximately alike, this will be shown by their relative positions to the graduation marks upon the scale, as the drill is turned.

SHOP OPERATION SHEET NO. 102.

Franklin D. Jones. MACHINERY, June, 1909



Grinding a Twist Drill in a Sellers Grinder.

NOTE.—As it is impossible to grind drills theoretically correct by hand, at least in a reasonable length of time, special grinders are used for this purpose in which the movement of the drill in relation with the wheel is automatically guided so that its end is correctly formed. The way in which a Sellers grinder is operated is explained in the following:

1. Open the jaws of the chuck by operating the hand-wheel *A* and insert the drill from the back, letting the end rest on the lower jaw with the cutting edge just touching the end-stop. Close the jaws and bring up back-center *B* and clamp it; then release the jaws, hold the drill against center *B* with the left hand and, at the same time, rotate it against the two side-stops on the jaws. Then clamp the drill tightly by hand-wheel *A*, using the right hand.

2. Turn handle *C* part way back and feed up the emery wheel *D*, by hand-wheel *E*, until it just touches the drill. Turn handle *C* forward, feed in the wheel and pass it back and forth over the face of the drill by lever *F*, moving handle *C* back a little every other cut. When the entire end has been ground, hold lever *F* stationary and rotate the drill, taking a finishing cut over the surface just ground.

3. When one side of the drill is finished, loosen the jaws of the chuck, and turn the drill half way around. Press its lips, as before, against the side-stops on the jaws and at the same time hold the drill firmly against the back-center *B*; then tighten the chuck and grind the second lip without adjusting the stone.

NOTE.—When considerable metal has to be removed, and it is necessary to adjust the emery wheel for two or more cuts, mark its final position by clamping the lever *G*, by the nut *H*, against the stop-pin *I*. When the second half of the drill is being ground, feed the emery wheel forward until lever *G* strikes the stop-pin, thus bringing the wheel to the position it occupied when grinding the first half. When this side is finished, turn the drill again, and re-grind the first half to insure having both sides alike.

I.—FORMULAS FOR STRENGTH OF FLAT PLATES

Square Flat Plates, Supported at all Four Edges. Load Uniformly Distributed Over Unsupported Surface of Plate.

Author and Reference	Formulas as given by Author	Total Load W = PL^2	Unit Fiber Stress in Pounds per Square Inch f =	t^2 =	Thickness Plate in Inches t =	L^2 =	Clear Span Between Supported Edges L =	Uniform Load per Unit of Surface P =
Grashof, Troutwines C. E. Pocket Book 1906, Page 493–494	$f = \frac{CL^2P}{4t^2}$ $P = \frac{4ft^2}{CL^2}$ $C = 1.125$	$3.56\,ft^2$	$0.28\,\frac{W}{t^2}$	$0.28\,\frac{W}{f}$	$0.53\sqrt{\frac{W}{f}}$			
			$0.28\,\frac{PL^2}{t^2}$	$0.28\,\frac{PL^2}{f}$	$0.53L\sqrt{\frac{P}{f}}$	$3.56\,\frac{ft^2}{P}$	$1.89t\sqrt{\frac{f}{P}}$	$3.56\,\frac{ft^2}{L^2}$
J. B. Johnson, The Materials of Construction 1897, Page 93	$t = 0.61L\sqrt{\frac{P}{f}}$	$2.67\,ft^2$	$0.375\,\frac{W}{t^2}$	$0.375\,\frac{W}{f}$	$0.61\sqrt{\frac{W}{f}}$			
			$0.375\,\frac{PL^2}{t^2}$	$0.375\,\frac{PL^2}{f}$	$0.61L\sqrt{\frac{P}{f}}$	$2.67\,\frac{ft^2}{P}$	$1.634t\sqrt{\frac{f}{P}}$	$2.67\,\frac{ft^2}{L^2}$
Rankine, Civil Engineering, Page 543	Bending Moment $M = \frac{WL}{16}$	$2.67\,ft^2$	$0.375\,\frac{W}{t^2}$	$0.375\,\frac{W}{f}$	$0.61\sqrt{\frac{W}{f}}$			
			$0.375\,\frac{PL^2}{t^2}$	$0.375\,\frac{PL^2}{f}$	$0.61L\sqrt{\frac{P}{f}}$	$2.67\,\frac{ft^2}{P}$	$1.634t\sqrt{\frac{f}{P}}$	$2.67\,\frac{ft^2}{L^2}$
Wm. F. Fischer	$\frac{WL}{24} = \frac{fLt^2}{6}$ or $M = M_1$	$4\,ft^2$	$0.25\,\frac{W}{t^2}$	$0.25\,\frac{W}{f}$	$0.5\sqrt{\frac{W}{f}}$			
			$0.25\,\frac{PL^2}{t^2}$	$0.25\,\frac{PL^2}{f}$	$0.5L\sqrt{\frac{P}{f}}$	$4\,\frac{ft^2}{P}$	$2t\sqrt{\frac{f}{P}}$	$4\,\frac{ft^2}{L^2}$

Compiled by William F. Fischer

II.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Square Flat Plates Firmly Secured Along All Four Edges, Load Uniformly Distributed Over Unsupported Surface of Plate.

Author and Reference	Formulas as Given by Author	Total Load PL^2 = W =	Unit Fiber Stress Pounds per sq. in. f =	t^2 =	Thickness of Plate Inches t =	L^2 =	Clear Span Between Supported Edges L =	Uniform Load per Unit of Surface P =
Grashof, Troutwines C. E. Pocket Book 1906, Page 494	$f = \frac{CL^2P}{4t^2}$ $P = \frac{4ft^2}{CL^2}$ $C = 0.75$	$5.33\,ft^2$	$0.1875\,\frac{W}{t^2}$	$0.1875\,\frac{W}{f}$	$0.433\sqrt{\frac{W}{f}}$			
			$0.1875\,\frac{PL^2}{t^2}$	$0.1875\,\frac{PL^2}{f}$	$0.433L\sqrt{\frac{P}{f}}$	$5.33\,\frac{ft^2}{P}$	$2.31t\sqrt{\frac{f}{P}}$	$5.33\,\frac{ft^2}{L^2}$
J. B. Johnson, The Materials of Construction 1897 Page 73	$f = \frac{9PL^2}{32t^2}$ $t = 0.53L\sqrt{\frac{P}{f}}$	$3.6\,ft^2$	$0.28\,\frac{W}{t^2}$	$0.28\,\frac{W}{f}$	$0.53\sqrt{\frac{W}{f}}$			
			$0.28\,\frac{PL^2}{t^2}$	$0.28\,\frac{PL^2}{f}$	$0.53L\sqrt{\frac{P}{f}}$	$3.6\,\frac{ft^2}{P}$	$1.89t\sqrt{\frac{f}{P}}$	$3.6\,\frac{ft^2}{L^2}$
Unwin, Elements of Machine Design Page 73	$f = \frac{L^2P}{4t^2}$	$4\,ft^2$	$0.25\,\frac{W}{t^2}$	$0.25\,\frac{W}{f}$	$0.5\sqrt{\frac{W}{f}}$			
			$0.25\,\frac{PL^2}{t^2}$	$0.25\,\frac{PL^2}{f}$	$0.5L\sqrt{\frac{P}{f}}$	$4\,\frac{ft^2}{P}$	$2t\sqrt{\frac{f}{P}}$	$4\,\frac{ft^2}{L^2}$

Square Flat Plate, Supported At All Four Edges, Loaded at Center With a Concentrated Load W.

Author and Reference	Formulas as Given by Author	Central Load W =	Unit Stress in Extreme Fiber. Pounds per sq. Inch f =	t^2 =	Thickness Plate in Inches t =
Rankine, Civil Engineering, Page 543	Bending Moment $M = \frac{3WL}{16}$	$0.9\,ft^2$	$1.125\,\frac{W}{t^2}$	$1.125\,\frac{W}{f}$	$1.06\sqrt{\frac{W}{f}}$
Grashof, Trautwines C. E. Pocket Book, Page 493	$f = \frac{3CW}{4t^2}$ $W = \frac{4ft^2}{3C}$ $C = 2$	$0.667\,ft^2$	$1.5\,\frac{W}{t^2}$	$1.5\,\frac{W}{f}$	$1.23\sqrt{\frac{W}{f}}$

Square Flat Plate, Firmly Secured at all Four Edges, Loaded at Center with a Concentrated Load W.

Grashof, Trautwines C. E. Pocket Book, Page 493	$f = \frac{3CW}{4t^2}$ $W = \frac{4ft^2}{3C}$ $C = 1.75$	$0.762\,ft^2$	$1.31\,\frac{W}{t^2}$	$1.31\,\frac{W}{f}$	$1.144\sqrt{\frac{W}{f}}$

Compiled by William F. Fischer

III.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Flat Rectangular Plates, Supported at all Four Edges and Loaded with a Uniformly Distributed Load $W = PLl$.

Author and Reference	Formulas as Given by Author	Total Load W on Plate =	Pressure on Plate per Unit of Area P =	Unit Stress in Extreme Fiber of Material f =	Thickness of Plate, Inches t =
Johnson, Materials of Construction, $L = 2l$ or greater	$f = \frac{3Pl^2}{4t^2}$	$1.34\frac{fLt^2}{l}$		$0.75\frac{Wl}{Lt^2}$	$0.866\sqrt{\frac{Wl}{fL}}$
	$t = \frac{l}{2}\sqrt{\frac{3P}{f}}$		$1.34\frac{ft^2}{l^2}$	$0.75\frac{Pl^2}{t^2}$	$0.866\,l\sqrt{\frac{P}{f}}$
Johnson, Where $L = 1\frac{1}{2}l$ about	$f = \frac{3}{4}\cdot\frac{3Pl^2}{4t^2}$	$1.8\frac{fLt^2}{l}$		$0.56\frac{Wl}{Lt^2}$	$0.75\sqrt{\frac{Wl}{fL}}$
	$t = \frac{3}{4}l\sqrt{\frac{P}{f}}$		$1.78\frac{ft^2}{l^2}$	$0.56\frac{Pl^2}{t^2}$	$0.75\,l\sqrt{\frac{P}{f}}$
Rankine, Civil Engineering Page 543	$M = \frac{WL^4l}{8(L^4+l^4)}$	$1.34\frac{ft^2(L^4+l^4)}{L^3l}$		$0.75\frac{WL^3l}{t^2(L^4+l^4)}$	$0.866\sqrt{\frac{WL^3l}{f(L^4+l^4)}}$
			$1.34\frac{ft^2(L^4+l^4)}{L^4l^2}$	$0.75\frac{Pl^2L^4}{t^2(L^4+l^4)}$	$0.866\,L^2l\sqrt{\frac{P}{f(L^4+l^4)}}$
Grashof, Trautwines Pocket Book Page 493	$f = \frac{CPL^2l^2}{2t^2(L^2+l^2)}$	$1.77\frac{ft^2(L^2+l^2)}{Ll}$		$0.56\frac{WLl}{t^2(L^2+l^2)}$	$0.75\sqrt{\frac{WLl}{f(L^2+l^2)}}$
	$C = 1.125$		$1.77\frac{ft^2(L^2+l^2)}{L^2l^2}$	$0.56\frac{PL^2l^2}{t^2(L^2+l^2)}$	$0.75\,Ll\sqrt{\frac{P}{f(L^2+l^2)}}$
Fischer	$\frac{Pl^2(2N+L)}{24} = \frac{fLt^2}{6}$				
			$\frac{4fLt^2}{l^2(2N+L)}$	$\frac{Pl^2(2N+L)}{4Lt^2}$	$0.5\,l\sqrt{\frac{P(2N+L)}{fL}}$

M = Maximum Bending Moment, Inch Pounds
L - Longest Span, and l - Shortest Span Between Edge of Supports
$N = L - l$ W, P, f, and t as given above.

Note:- If L and l are given in feet P = Pounds per sq. foot. If L and l are in inches, P = Pounds per sq. inch. $W = PlL$.

Compiled by William F. Fischer

IV.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Flat Rectangular Plates, Firmly Secured at all Four Edges Loaded with a Uniformly Distributed Load $W = PLl$.

Author and Reference	Formulas as Given by Author	Total Load W on Plate =	Pressure on Plate per Unit of Area P =	Unit Stress in Extreme Fiber of Material f =	Thickness of Plate in Inches t =
Grashof, Trautwines C.E. Pocket Book, Page 493	$f = \frac{CPL^2l^2}{2t^2(L^2+l^2)}$	$2.67\frac{ft^2(L^2+l^2)}{Ll}$		$0.375\frac{WLl}{t^2(L^2+l^2)}$	$0.62\sqrt{\frac{WLl}{f(L^2+l^2)}}$
	$C = 0.75$		$2.67\frac{ft^2(L^2+l^2)}{L^2l^2}$	$0.375\frac{PL^2l^2}{t^2(L^2+l^2)}$	$0.62\,Ll\sqrt{\frac{P}{f(L^2+l^2)}}$
Unwin, Elements of Machine Design, Page 93	$f = \frac{PL^4l^2}{2t^2(L^4+l^4)}$	$2.\frac{ft^2(L^4+l^4)}{L^3l}$		$0.5\frac{WL^3l}{t^2(L^4+l^4)}$	$0.7\sqrt{\frac{WL^3l}{f(L^4+l^4)}}$
			$2.\frac{ft^2(L^4+l^4)}{L^4l^2}$	$0.5\frac{PL^4l^2}{t^2(L^4+l^4)}$	$0.7\,L^2l\sqrt{\frac{P}{f(L^4+l^4)}}$
Neglecting End Bearings Entirely where $L = 2l$ or Greater, and Treating as a Simple Beam, Uniformly Loaded — See Below.					
Bending Moment $M = \frac{Wl}{12}$	Resisting Moment $M_1 = \frac{fLt^2}{6}$	$2.\frac{fLt^2}{l}$		$0.5\frac{Wl}{Lt^2}$	$0.7\sqrt{\frac{Wl}{fl}}$
or $M = \frac{PLl^2}{12}$	$\frac{Wl}{12} = \frac{fLt^2}{6}$		$2.\frac{ft^2}{l^2}$	$0.5\frac{Pl^2}{l^2}$	$0.7\,l\sqrt{\frac{P}{f}}$
Assuming $\frac{3}{4}$ of Load to be Carried at the Sides and $\frac{1}{4}$ Carried at the Ends, Where $L = 1\frac{1}{2}l$ about, (Treated as a Simple Beam) — See Below.					
$M = \frac{3}{4}\cdot\frac{Wl}{12}$	$M_1 = \frac{fLt^2}{6}$	$2.67\frac{fLt^2}{l}$		$0.375\frac{Wl}{Lt^2}$	$0.62\sqrt{\frac{Wl}{fL}}$
or $M = \frac{3}{4}\cdot\frac{PLl^2}{12}$	$\frac{3Wl}{48} = \frac{fLt^2}{6}$		$2.67\frac{ft^2}{l^2}$	$0.375\frac{Pl^2}{t^2}$	$0.62\,l\sqrt{\frac{P}{f}}$

M = Maximum Bending Moment, Inch Pounds
L - Longest Span, Between Supports
l - Shortest Span, Between Supports

W, P, f, and t as given above
Note:- If L and l are given in inches, P = pounds per sq. inch. If L and l are given in feet, P = pounds per sq. foot.

Compiled by William F. Fischer

MACHINERY
June, 1909

KNURLS AND KNURLING OPERATIONS—1

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

DOUGLAS T. HAMILTON[*]

Douglas T. Hamilton[†]

In designing a set of cams for knurling operations on the Brown & Sharpe automatic screw machines, it is desirable that as little experimental work as possible be required. The following formulas and data have been derived and collected by the writer for use in work of this kind, and are here presented with the hope that they will prove of value to others. Before taking up the data and formulas, the different tools and appliances necessary for knurling will be briefly reviewed.

Rear Cross-slide Knurl-holder

A very solid and rigid rear cross-slide knurl-holder is shown in Fig. 1. It is held by means of the cap screw *B* on the outside face *A* of the cross-slide tool-holder. This screw also holds the circular cut-off tool in position. The holder allows the knurl to pass over the work, and returns it after the piece has been cut off. The holder is simple and cheap, and covers a wide range of work, as the distance *C* to the circular cut-off tool can be changed so that the work will be cut off closer or further away from the knurl, as desired. The set-screw *D* supports the knurl-holder rigidly, and also provides means for adjusting. The oil hole *E* permits a good supply of oil to reach the knurl for removing all chips. This holder, however, can be used only on the tool-holder which carries the cut-off tool, because the finished piece must be severed from the bar before the knurl can return.

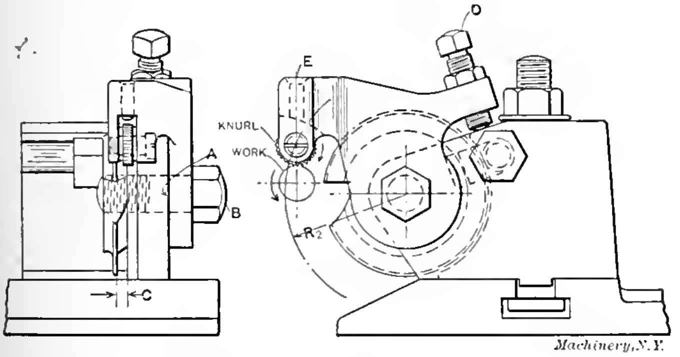
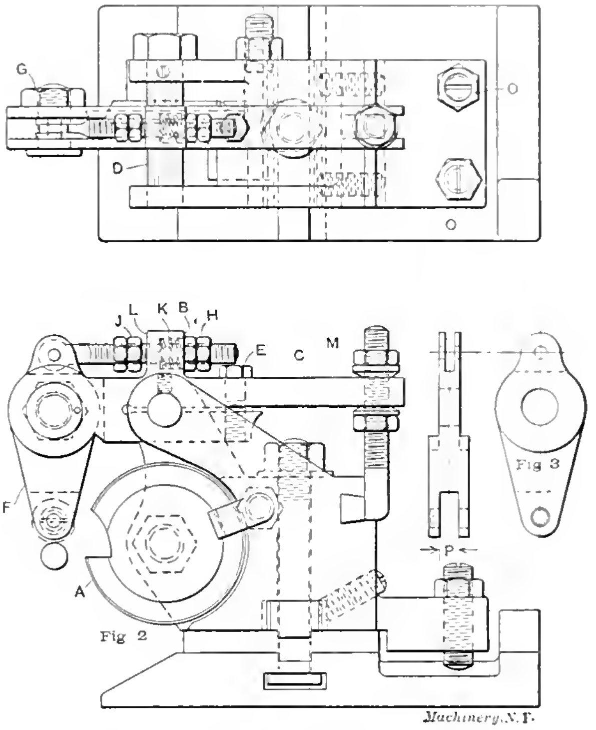


Fig. 1. Rear Cross-slide Knurl-holder

Universal Cross-slide Knurl-holder

The knurl-holder shown in Fig. 1 is limited in its range, but the one shown in Fig. 2, while more expensive and complicated, is also more efficient and universal. This holder eliminates the cross-slide tool-post, and carries the circular cut-off tool *A* in the same way as it would be held in the ordinary tool-post. It can also be used in conjunction with either circular form or cut-off tools on the front cross-slide. The knurl can operate at any desired position on the work by moving the arm *C* along the bar *D* and then clamping it by means of the cap screw *E*. The holder *F* which carries the knurl can be moved in or out to any position to suit the different diameters of stock being knurled, and is adjusted by means of adjusting nuts *H* and *J*. The nut *G* is adjusted to insure a good working fit of the holder, and also prevents side movements. When the knurl passes over the stock the nut *H* is brought up against the face *B* of the arm *C*, and also puts a tension on spring *K*, so that when the knurl has passed over the work and the pressure on the spring is released, the spring forces the nut *J* up against the face *L* and permits the knurl to clear the work when passing back over the stock. The nuts *M* permit the arm *C* to be raised or lowered for different diameters of stock. The washers are convex as shown so that the arm is held firmly even when at an angle to the face of the nuts *M*. Screws *O* tend to steady the holder.



Figs. 2 and 3. Universal Cross-slide Knurl-holder

In Fig. 3 the knurl-holder proper is shown in detail. It will be seen that knurls of different widths may be used by making the distance *P* to suit.

Straight Knurls

Straight knurls, as shown in Fig. 4, are generally cut in the milling machine with a cutter of the desired angle. The greatest difficulty is met with in selecting a suitable angle for the teeth for knurling different materials. A blunt knurl will work better on soft materials than one with a more acute angle. The writer has found by experiments that the following angles are satisfactory for the materials specified:

Materials	Angle
Brass and hard copper	90 degrees.
Gun screw iron	80 degrees.
Norway iron and machine steel	70 degrees.
Drill rod and tool steel	60 degrees.

When laying out a set of cams for knurling operations, it is necessary to know the depth of the tooth in the knurl.

If $d =$ depth of tooth in knurl,

$p =$ circular pitch of knurl,

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P = "pitch of knurl" = number of teeth in one inch of the circumference $= \frac{1}{p}$,

a = included tooth angle of knurl,

then, for all practical purposes, the depth may be calculated as follows: When

$$a = 90 \text{ degrees, } d = \frac{p}{2},$$

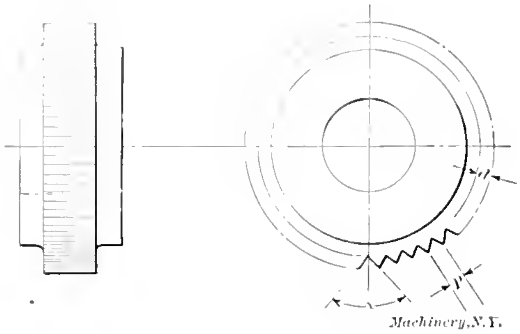


Fig. 4. Straight Knurl

$$a = 80 \text{ degrees, } d = \frac{p}{2} \times \tan 50 \text{ degrees,}$$

$$a = 70 \text{ degrees, } d = \frac{p}{2} \times \tan 55 \text{ degrees,}$$

$$a = 60 \text{ degrees, } d = \frac{p}{2} \times \tan 60 \text{ degrees.}$$

The values of d for different pitches ranging from 16 to 62 teeth per inch of circumference have been calculated from these formulas and are given in Table I.

Concave Knurls

The designing of a concave knurl which will work satisfactorily is, in most cases, a difficult problem, as the radius of the knurl cannot have the same radius as the piece to be knurled. It will be seen in Fig. 5 that if the knurl and the work are of the same radius, the material compressed by the knurl will be forced down on the shoulder A and will consequently make a poor looking job. The writer, having met with this difficulty, finally devised an empirical formula which gives satisfactory results.

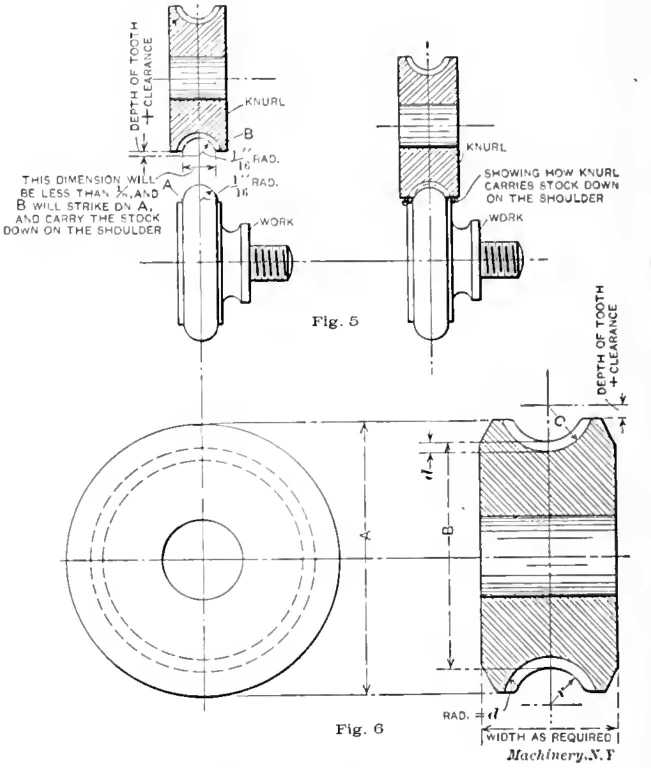
TABLE I. DEPTH OF TEETH IN KNURLS

P = number of teeth in one inch of circumference
p = circular pitch
a = included angle of tooth
d = depth of tooth

P	p	$a = 90°$	$a = 80°$	$a = 70°$	$a = 60°$
		d	d	d	d
16	0.0625	0.0312	0.0371	0.0445	0.0540
18	0.0555	0.0277	0.0330	0.0395	0.0480
20	0.0500	0.0250	0.0297	0.0357	0.0433
22	0.0454	0.0227	0.0260	0.0324	0.0393
24	0.0416	0.0208	0.0247	0.0297	0.0360
26	0.0384	0.0192	0.0228	0.0274	0.0332
28	0.0357	0.0178	0.0212	0.0254	0.0308
30	0.0333	0.0166	0.0199	0.0237	0.0287
32	0.0312	0.0156	0.0185	0.0222	0.0270
34	0.0294	0.0147	0.0175	0.0209	0.0254
36	0.0277	0.0138	0.0164	0.0197	0.0239
38	0.0263	0.0131	0.0156	0.0187	0.0226
40	0.0250	0.0125	0.0148	0.0178	0.0216
42	0.0238	0.0119	0.0142	0.0169	0.0206
44	0.0227	0.0113	0.0134	0.0161	0.0195
46	0.0217	0.0108	0.0128	0.0154	0.0187
48	0.0208	0.0104	0.0124	0.0148	0.0180
50	0.0200	0.0100	0.0119	0.0142	0.0173
52	0.0192	0.0096	0.0114	0.0137	0.0166
54	0.0185	0.0092	0.0109	0.0131	0.0159
56	0.0178	0.0089	0.0106	0.0127	0.0154
58	0.0172	0.0086	0.0102	0.0122	0.0148
60	0.0166	0.0083	0.0099	0.0118	0.0143
62	0.0161	0.0080	0.0096	0.0114	0.0538

A design of a concave knurl is shown in Fig. 6, and all the important dimensions are designated by letters. To find these dimensions, the pitch of the knurl required must be known, and also approximately the throat diameter B. This diameter, of course, must suit the knurl holder used, and be such that the circumference contains an even number of teeth with the required pitch. When these dimensions have been decided upon all the other unknown factors can be found from the formulas given in the following.

Let R = radius of piece to be knurled,
r = radius of concave part of knurl,
C = radius of cutter or hob used for cutting the teeth in the knurl,
B = diameter over concave part of knurl (throat diameter),
A = outside diameter of knurl,
d = depth of tooth in knurl,
P = pitch of knurl (number of teeth per inch circumference),
p = circular pitch of knurl.



Figs. 5 and 6. Concave Knurls

Then $r = R + \frac{1}{2} d$,

$C = r + d$,

$A = B + 2r - 3d + 0.010$ inch.

As the depth of the tooth is very slight, the outside circumference will be accurate enough for all practical purposes for calculating the pitch, and it is not necessary to take into consideration the pitch circle as is done when calculating gears.

Example:—Assume that the pitch of a knurl is 32, that the throat diameter B is 0.5561 inch, that the radius R of the piece to be knurled is 1/16 inch, and that the angle of the teeth is 90 degrees; find the dimensions required for making the knurl.

Using the same notation as above, we have:

$$p = \frac{1}{P} = \frac{1}{32} = 0.03125 \text{ inch,}$$

$d = 0.0156$ (see Table I) inch,

$$r = \frac{1}{16} + \frac{0.0156}{2} = 0.0703 \text{ inch,}$$

$C = 0.0703 + 0.0156 = 0.0859$ inch,

$A = 0.5561 + 0.1406 - 0.0468 - 0.010 = 0.6399$ inch.

Straight concave knurls, when very small, are generally made with a master convex knurl. When the knurls are large enough, a milling cutter with the proper radius is used for cutting the teeth. As it is very difficult to make a concave knurl when the radius is very small, and as the knurl in most cases is not required to be absolutely straight, the

method described in the following for spiral knurls, can be used for making straight concave knurls on the milling machine with teeth in planes practically parallel with the axis of the knurl.

Spiral Concave Knurls

It is, in general, very difficult to cut spiral concave knurls, especially when the radius of the knurl is very small. In Fig. 7 is shown a method which has worked very satisfactorily, and which is also easily accomplished. A hob as shown in Fig. 8 is used, the included angle of the threads of which is made to suit the material to be knurled. The hob is fluted similar to a master tap, excepting that the flutes are not as deep and a greater number of flutes is used. If the hob has more than a triple thread, for instance, the width of the lands should be to the width of the flutes in the ratio 2 to 1. The lead of the hob governs the angle of the spiral on the knurl, and the angle formed by cutting hobs with different leads can be derived, approximately, by means of the following formula:

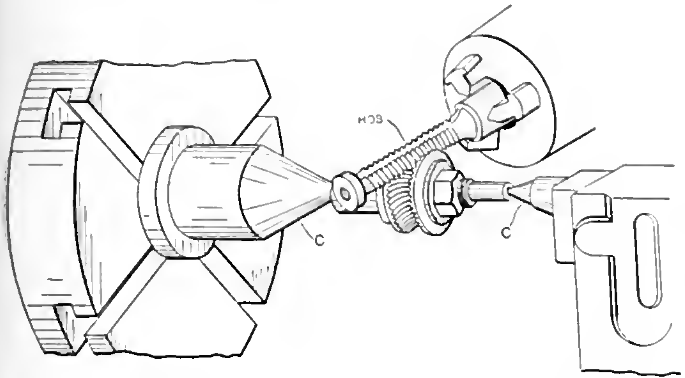


Fig. 7. Cutting a Concave Knurl by a Hob in the Milling Machine

Let α = angle required,
B = one-half the lead of the thread of the hob,
D = diameter of the hob.

Then $$\frac{B}{1.5\,D} = \tan \alpha.$$

Example:—If a hob has a double thread, the lead of which is ⅛ inch, and the diameter of the hob is ¼ inch, find the angle α.

B = ½ of the lead = 1/16, and therefore $\tan \alpha = 1/16 \div 3/8 = 0.1667$; $\alpha = 9\frac{1}{2}$ degrees.

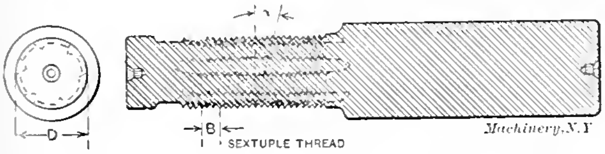


Fig. 8. Hob used for Cutting Concave Knurls in the Milling Machine

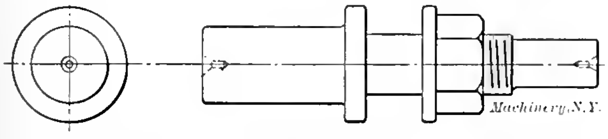


Fig. 9. Arbor for Cutting Concave Knurls in the Milling Machine

Cutting a Spiral Concave Knurl in the Milling Machine

It will be seen from Fig. 7 that when cutting a concave knurl in the milling machine, the knurl is held on an arbor shown in detail in Fig. 9. This arbor rotates freely on the centers C, the knurl being held tightly against the shoulder on the arbor by the nut shown. When the knurl has been tightened, the arbor is put between the centers and the table of the milling machine is raised so that the hob comes in contact with the knurl. The machine runs slowly at the start so that the hob will not be forced, but will space the teeth equally. The speed can be increased after the hob has started to cut properly. The hob is held in a chuck provided with a shank fitting the socket in the milling machine spindle. The work should be fed slowly at first, and care should be taken that the arbor rotates freely on the centers, as otherwise the knurl will not follow the lead of the hob properly, and a well-shaped teeth will not be produced. Care should also be taken to have the diameter of the concave knurl the correct size so that it will contain an even number of teeth, as required by the circular pitch. When the knurl has been cut, the corners should be removed as shown in Fig. 6, then no ragged edges are left on the work, as is the case if the corners are not removed. The table of the milling machine should not be set over when cutting knurls in this manner but should be left straight.

Designing and Cutting Diamond Knurls

The general methods of using diamond knurls are as follows:

1. When a knurl-holder, as shown in Fig. 10, can be used a pair of spiral knurls are used, one right- and the other left-handed.

2. When a cross-slide knurl-holder, as shown in Fig. 1, is used, only one knurl can be used, being cut both right- and left-handed. A knurl cut in this manner would produce a female knurl on the work; so if a male knurl is required on the work, the first knurl is used as a master knurl in cutting the second knurl which will produce a male knurl on the work.

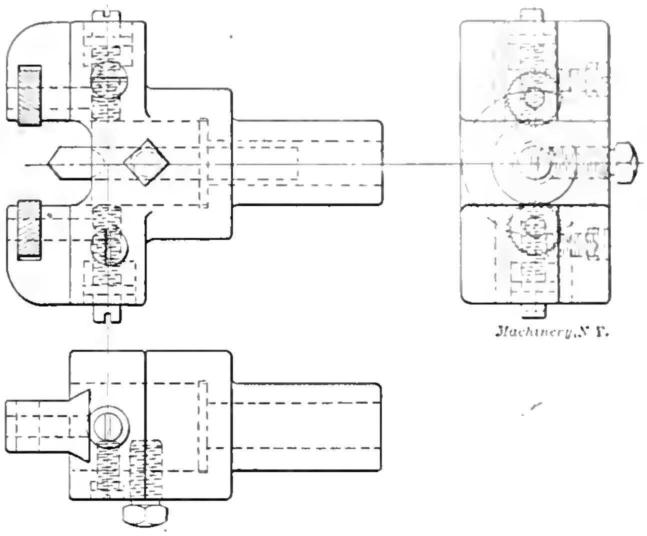


Fig. 10. Turret Knurl-holder for Brown & Sharpe Automatic Screw Machines

When only the pitch of the knurl required and the angle at which the teeth are cut, as indicated in Fig. 11, are known, then the number of teeth in the knurl must be found and also the spiral lead, as this governs the selection of the change gears used when cutting the knurl.

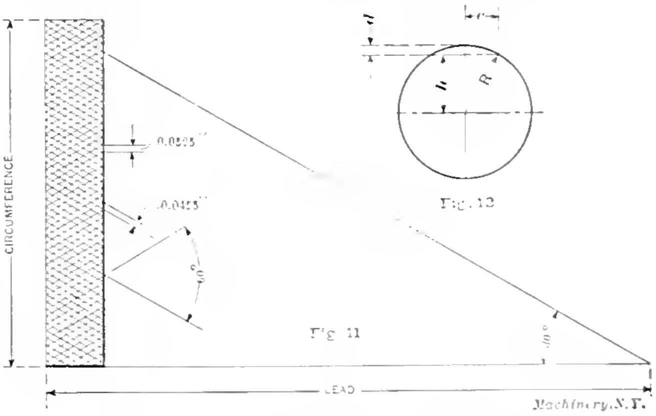


Fig. 11. Diagram for Finding Circular Pitch and Lead of Spiral Knurls.
Fig. 12. Diagram for Calculations Relating to the Feeds of Knurls

To Find the Number of Teeth on the Circumference of the Knurl

When the knurl is to form diamond shapes, as shown in Fig. 11, and the included angle is 60 degrees, the number of teeth can be found in the following manner. Let 22 be the normal pitch of the knurl. Then the circular pitch will be 0.0455 inch ÷ cos 30 degrees = 0.0525 inch, and the outside circumference divided by 0.0525 inch will be the number of teeth of the knurl.

To Find the Lead of the Spiral

To find the lead of a spiral of the knurl above, multiply the circumference of the knurl by the cotangent of 30 degrees. Assume that the knurl is 0.752 inch in diameter. Then the circumference equals 0.752 × 3.1416 = 2.3625 inches. The knurl has a circular pitch of 0.0525 and the number of teeth therefore equals 2.3625 ÷ 0.0525 = 45 teeth. The lead equals 2.3625 × cot 30 degrees = 4.09 inches.

* * *

THE RELATION OF DEPTH TO SPAN OF A GIRDER

FRED NEWELL*

In designing a girder or cantilever for any purpose where one is not tied to a particular depth by conditions or specification, it is often a matter of trial and error by those whose work or experience does not lead them to a knowledge of what will most surely be the best proportions of depth to span for a given deflection and stress. Even where one's knowledge of these proportions is of the best, the following table will prove a help in the first considerations of a design. It must, however, be remembered that the table is only of use where the girder is symmetrical in section about its neutral axis, and for a modulus of elasticity of 29,000,000, which is very general for structural shapes. The deflections used for calculating the table are those in most general use, being 1 inch per 100 feet span or $\frac{L}{1200}$, and 2 inches per 100 feet span or $\frac{L}{600}$, L being in inches. The lower limit is used where stiffness is necessary, and the higher limit where stiffness is not of primary importance.

If the modulus of elasticity is other than that taken in these calculations, the divisor of the expression in the last column of the table will be directly proportional to the value of the modulus. For each condition of loading, the divisor is inversely proportional to the assumed safe stresses.

To arrive at the results the writer has combined the bending mement formula $M = \frac{fI}{y}$, with the deflection formula $\delta = K\frac{WL^3}{EI}$, where

M = bending moment,
f = safe allowable stress,
I = moment of inertia of section,
d = depth of girder or cantilever,
y = distance of neutral axis from outer fiber = $\frac{d}{2}$ for symmetrical sections,
W = total load,
L = length of span,
δ = deflection,
K = constant depending on loading and support.

All dimensions are in inch-pound units. For example, take the simple case of a cantilever loaded at one end, and let $\delta = \frac{L}{1200}$, and $f = 10{,}000$ pounds per square inch.

$$M = WL = \frac{fI}{y} = \frac{2fI}{d};$$

$$\delta = \frac{WL^3}{3EI} = \frac{2fIL^2}{3EId} = \frac{2fL^2}{3Ed};$$

$$\text{but } \delta = \frac{L}{1200}; \text{ therefore } \frac{2fL^2}{3Ed} = \frac{L}{1200};$$

$$\text{and } d = \frac{2400fL}{3E} = \frac{2400 \times 10{,}000 \times L}{3 \times 29{,}000{,}000} = \frac{L}{3.625}$$

$$d = \frac{L}{3.625} = 0.276\,L.$$

Having arrived at the required depth for a given deflection, it is an easy matter to find a suitable section for the given stress; but in all cases where exact work is required, the actual deflection and stress should be obtained after the design has been completed.

RELATION BETWEEN DEPTH OF GIRDER AND LENGTH OF SPAN.

L = length of span in inches.

Conditions.	Safe Stress, Pounds per Square Inch.	Depth, Inches.
Beam supported at ends; load concentrated at middle; deflection, $L \div 1200$ or 1 inch per 100 feet	10,000 12,500 16,000 20,000	$L \div 14.5$ $L \div 11.6$ $L \div 9.05$ $L \div 7.25$
Beam supported at ends; load concentrated at middle; deflection, $L \div 600$ or 2 inches per 100 feet	10,000 12,500 16,000 20,000	$L \div 29$ $L \div 23\ 2$ $L \div 18.1$ $L \div 14\ 5$
Beam supported at ends; load uniformly distributed; deflection, $L \div 1200$ or 1 inch per 100 feet	10,000 12,500 16,000 20,000	$L \div 11.6$ $L \div 9.3$ $L \div 7.25$ $L \div 5\ 8$
Beam supported at ends; load uniformly distributed; deflection, $L \div 600$ or 2 inches per 100 feet	10,000 12,500 16,000 20,000	$L \div 23.2$ $L \div 18.6$ $L \div 14.5$ $L \div 11.6$
Cantilever; load concentrated at end; deflection, $L \div 1200$ or 1 inch per 100 feet	12,000 12,500 16,000 20,000	$L \div 3.625$ $L \div 2.9$ $L \div 2.27$ $L \div 1.81$
Cantilever; load concentrated at end; deflection, $L \div 600$ or 2 inches per 100 feet	10,000 12,500 16,000 20,000	$L \div 7.25$ $L \div 5.8$ $L \div 4.54$ $L \div 3.62$
Cantilever; load uniformly distributed; deflection, $L \div 1200$ or 1 inch per 100 feet	10,000 12,500 16,000 20,000	$L \div 4.83$ $L \div 3\ 87$ $L \div 3.03$ $L \div 2.42$
Cantilever; load uniformly distributed; deflection, $L \div 600$ or 2 inches per 100 feet	10,000 12 500 16,000 20,000	$L \div 9.66$ $L \div 7.74$ $L \div 6.06$ $L \div 4.84$

* * *

The United States government inaugurated a plan two years ago for the purchase of coal on its heating value. At the present time there are forty departmental buildings in Washington, the Panama Railroad, more than three hundred buildings throughout the United States, navy yards and arsenals buying coal on specifications, the prime element of which fixes the amount of ash and moisture. Premiums are paid for any decrease of ash below 2 per cent at the rate of one cent per ton for each per cent. Reductions are made at an increasing rate for each per cent of ash when it exceeds the standard established by two per cent. The advantages of buying coal on these specifications are: bidders are placed on a strictly competitive basis, as regards prices and qualities; the field for both the government and the dealers is broadened, as trade names are ignored and comparatively unknown coals offered by responsible bidders may be accepted; the government is insured against poor and dirty coal and is relieved of disputes arising from condemnation on the usual visual inspection; experience with the old form of government contract is not always expedient to reject poor coal because of the difficulty, delay and cost of removal. Under the present system rejectable coal may be accepted at a greatly reduced price.

* * *

CORRECTION

A transposition of the titles of Figs. 41 and 42 occurred in the article on the Chicago and Northwestern Railway shop practice, published in the May number of MACHINERY. It should also be stated that the practice referred to as the company's method of boring piston rings, is instead its method of boring bushings for cylinders.

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INCREASING THE EFFICIENCY OF A HORIZONTAL DRILLING, TAPPING AND BORING MACHINE

ALFRED SPANGENBERG*

A machine tool may be installed to handle work of a specific character and for the sake of economy in first cost it is frequently deemed advisable to select a standard type of simple design, and embodying only such features as are necessary for the work intended. Subsequently, if occasion requires, aditional features can be provided that will adapt the machine for a variety of work. The accompanying engravings illustrate a motor-driven, horizontal drilling, tapping and boring machine, and show a number of features that were recently added by the writer. This machine originally was designed for a class of work that would require comparatively short adjustments of the column, and therefore was provided with a hand ratchet movement.

The changes made were: Substituting a rapid power traverse for the column to enable quick adjustments on long work; providing a power feed for the head so that the machine could be used for milling; a new clamping arrangement for the column and also for the head, thus discarding open end wrenches and facilitating the clamping and loosening; providing means for shifting the sliding feed gears while the machine is running; and attaching a brass speed index plate to the controller and a pointer on the controller lever. This used in connection with a table of cutting speeds and feeds stamped on the brass plate shown fastened to the resistance box, provides the operator with a standard guide and eliminates all guess work as to the proper speed and feed for cutters of various diameters. The problem of applying features which are not in the form of standard attachments to a machine, and therefore were not contemplated in the original design, accounts for some of the devices appearing rather crude. The chief interest, however, lies in the fact that very little expense was involved, since the gears, handwheels and levers were taken from stock parts belonging to other machines.

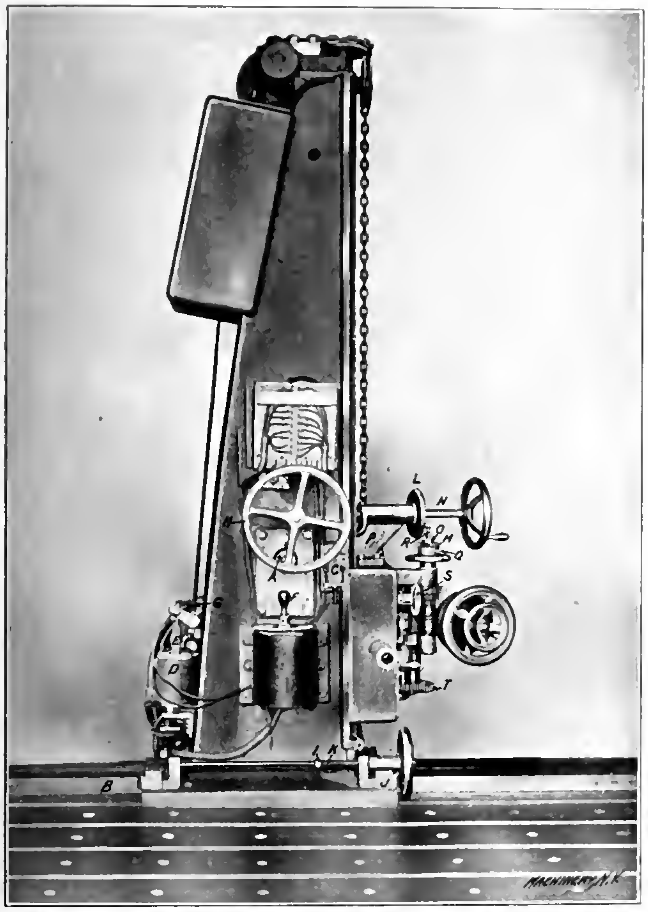

Fig. 1. Horizontal Drilling, Tapping and Boring Machine equipped with Power Traverse for the Column, Power Feed for the Head, New Clamping Devices for Column and Head, etc., to increase its Efficiency

A study of the engravings, Figs. 1 and 2, will make clear the application of the rapid power traverse for the column. Shaft *A*, Fig. 1, originally carried the ratchet wrench and transmits motion through bevel gears and a vertical shaft inside the column, to a rack pinion meshing with the rack *B*. For the purpose of deriving power from the motor, this shaft was replaced by a longer one that extends through the column and is also represented by the letter *A* in Fig. 2. Keyed to it is the spur gear *B* into which mesh the handwheel shaft pinion *C* and also the compound gearing driven by the pulley *D*. A belt that normally is loose, connects the pulley *D* with the motor pulley. The line engraving, Fig. 3, shows the method of fastening the latter onto the motor shaft. This was accomplished without removing the motor shaft by holding the drill in a ratchet wrench and feeding it in while the motor was running.

Fig. 2. Motor connected with Mechanism for the Column Traverse

When it is desired to traverse the column by power, the belt is tightened by closing the switch *C* (Fig. 1) which energizes the magnets *D* and they in turn bring the idler pulley *E* into position by means of the U-shaped magnet core, levers and shaft shown in the engraving. The column now can be run in either direction by operating the controller handle *F*. Spring *G* takes the weight of the magnet core and lever when the magnets are inactive. Final adjustment of the column is made with the hand-wheel *H*. The object of the belt drive was to avoid any accident, should the switch inadvertently be left closed and the motor started with the column clamped; and the sole reason for using the magnets was because they were a pair belonging to a discarded magnetic clutch planer drive. It will be observed that the idler pulley bracket cuts off some of the travel of the counterweight. This is of no consequence, however, as this particular machine never has to handle work requiring the head near the top of the column.

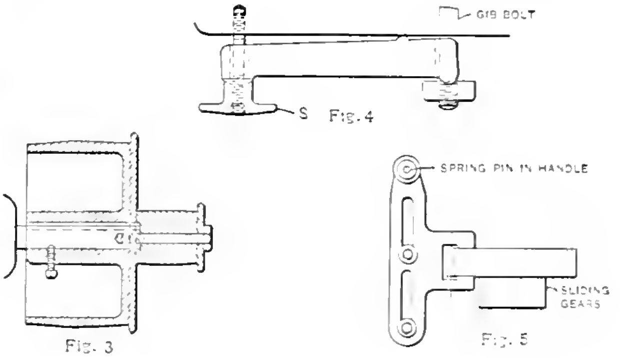

Fig. 3. Method of Fastening Rapid-traverse Driving Pulley on Motor Shaft. Fig. 4. Device for Clamping the Head without a Wrench. Fig. 5. Trunnion with Handle for Shifting the Feed Gears

The power feed for the head consists of the bevel gear *L* and sliding bevel pinion *M*. The axis of shaft *N* originally did not intersect with that of the vertical feed shaft *O*, and necessitated resetting the bracket *P*. A spring pin *Q* keeps the bevel pinion in mesh with the bevel gear when it is desired to feed the head by power. It was also necessary to

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lengthens the counter-shaft R. A crank wrench on the outer end of shaft N was superseded by the hand-wheel shown and the latter proved to be much more convenient. As stated previously, the primary object of a power feed for the head was to provide a feed for milling work, but when the spindle back gears are out, and the fast feed used, the adjustment of the head by power is quite rapid.

The clamping arrangement for the column is clearly indicated in Fig. 1. As will be seen, the clamping bolts are inverted and their heads beveled to fit the angle on the wedges *J*. Screwed on to the threaded end of each bolt is a block fitting the T-slot in the base plate. The hand-wheel sleeve is threaded to fit the tie-rod and the wedges act on the bolts by this means. Between the collar *I* on the tie-rod and the wedge *J* is a spring *K* which tends to keep the wedges loose when the hand-wheel is slackened off. Two turns of the hand-wheel is sufficient to clamp the column.

The line engraving, Fig. 4, shows the device for clamping the head to the column; the design is so simple that no explanation is necessary. The knob *S* is represented by the same letter in Fig. 1.

Means for sliding the feed gears *T* (Fig. 1) is shown in detail in Fig. 5. These gears formerly were shifted directly by band and held in place by a spring-pin that entered a groove in the shaft. The advantages of the new device at once are apparent.

An idea of the class of work this machine will handle to advantage is obtained from the half-tone, Fig. 6, which shows a 21-inch Pond rigid trurret lathe bed with the jigs in place ready to be drilled, bored and tapped. Four settings of the bed are necessary, as there are holes in both sides and ends. On work of this character the rapid power traverse is especially valuable. It will be of interest to note that this machine is also used to bore the head-stock for the bed just referred to. The head-stock and its jig was shown in Figs. 132 and 133 in the article on Jigs and Fixtures which appeared in the February issue of MACHINERY. For work of this character it is the practice to use universal joints for driving the cutter bars to avoid accurate setting of the jig; the machine only being used as a means for driving and feeding the bars and the jig acting as a guide. It must not be inferred, however, that this type of machine will not do accurate work without the use of jigs. As a matter of fact, the jig in question and nearly all of the jigs illustrated in the article above referred to were bored on a similar machine. For this work an adjustable outboard bearing is provided to support the end of the boring bar. These machines were built by the Pond Works of the Niles-Bement-Pond Co.

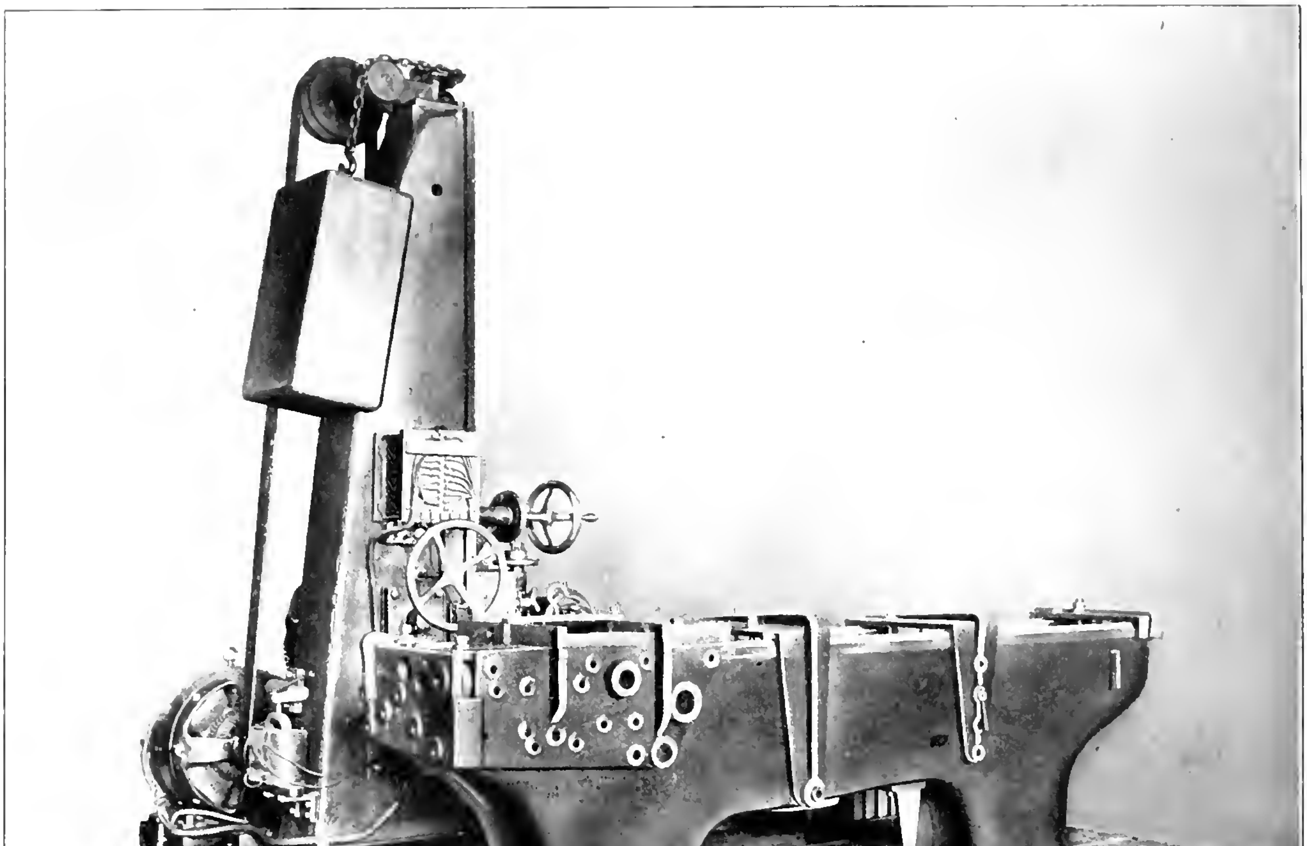

Fig 6. Twenty-one-inch Pond Rigid Turret Lathe Bed, with Jigs in Place, ready to be drilled

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Recent correspondence in the *Engineering News* attributes the disintegration of concrete work in sea water to alternative freezing and thawing. It has been noted that this disintegration occurs only in that portion of the concrete which is between the high and low tide levels, being to this extent similar to the decay which takes place in piling under the same conditions. It has been found that this disintegration takes place in winter. At high tide the water penetrates the minute pores in the surface. As the tide lowers, this absorbed water freezes, expanding as it does so, and loosening the surface of the concrete. When it is again submerged, it again thaws, and a new supply of water enters the pores, so that the loosening process is repeated at the next tide. It is suggested that the concrete work be covered with a cement facing mortar; or better yet, that all the cement used in concrete laid below the watermark be thoroughly waterproofed, either by a patented compound or by the admixture of clay. Concrete which is not exposed at low tide is perfectly safe from disintegration.

* * *

An inventory of the resources of natural fuel represented by the peat deposits of the United States has been made by Prof. Charles A. Davis of the United States Geological Survey, who estimates that the bogs and swamps of the United States contain approximately 13,000,000,000 tons of peat, representing a value of $38,000,000,000.

LOGARITHMIC PAPER FOR DIAGRAMS

J. NORMAN JENSEN*

Engineers may be divided into two classes, *i. e.*, those who use diagrams to aid them in their work, and those who do not. The latter class will impatiently pass over any article or book in which a curve is used to express the relation between two or more variables. Some of these men detest a diagram more than they detest the curling tail of an integral sign. If diagrams are not too complicated they have, however, a certain place in business and in engineering. In most modern offices the fluctuation of prices in different commodities is shown graphically so that one can tell at a glance the general tendency of the market at any time. In the office of the manager, the shop foreman, or the timekeeper, diagrams showing the relation between wages and production are of great value as by means of them "leaks" can readily be discovered.

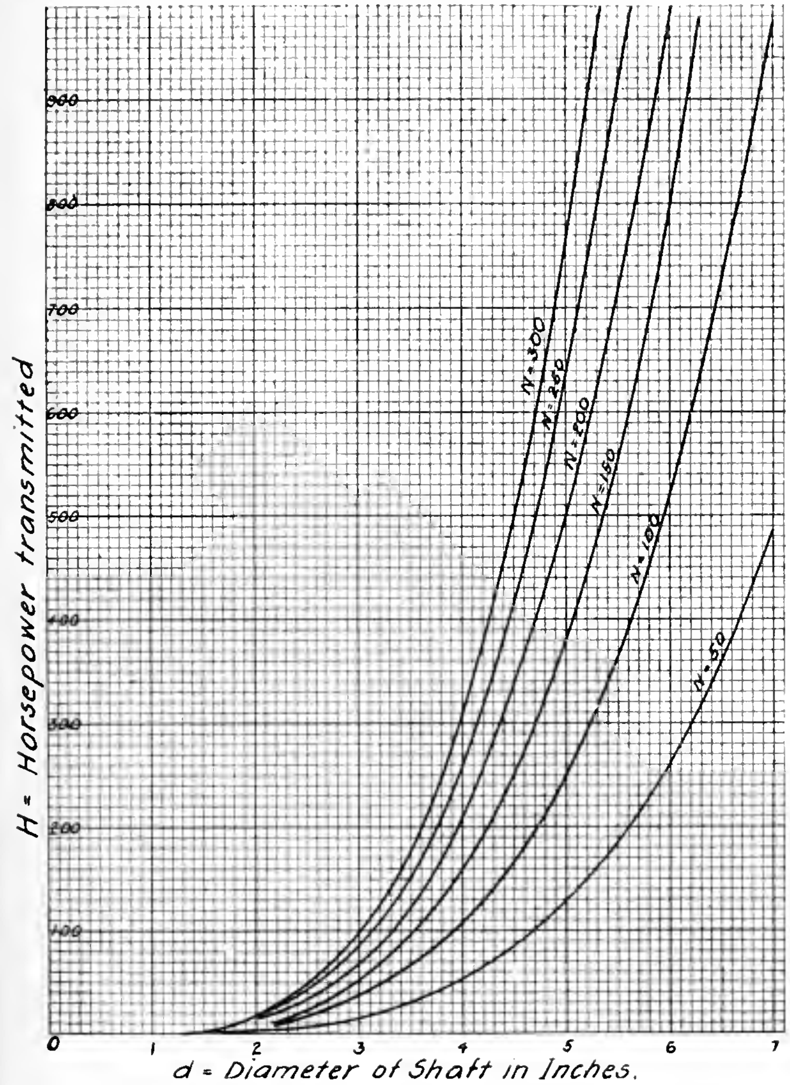

Fig. 1. Horse-power and Shafting Diagram Plotted on Regular Cross-section Paper

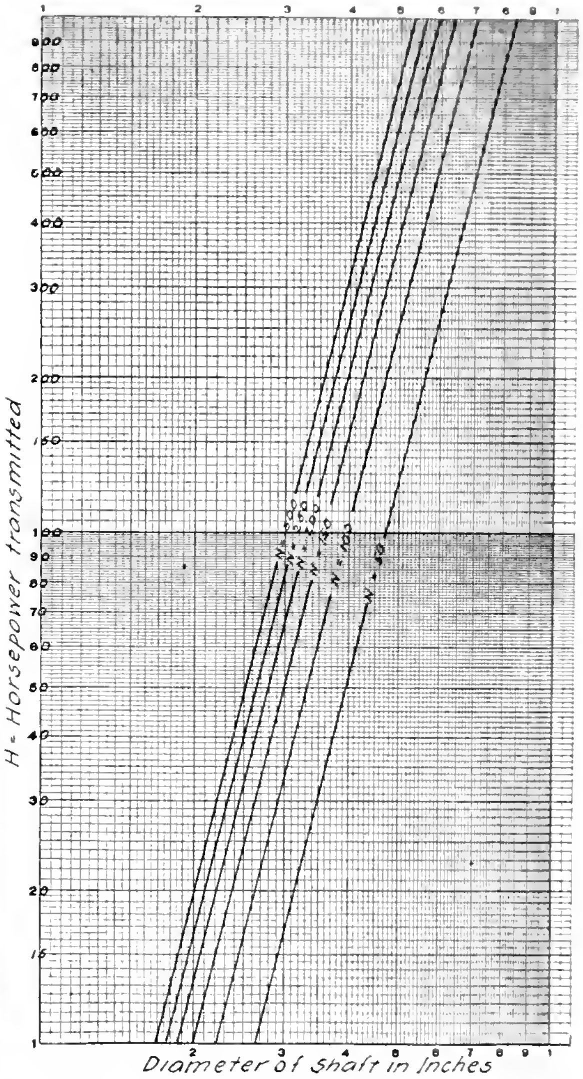

Fig. 2. The Same Diagram as in Fig. 1 laid out on Logarithmic Paper

It is the engineer, however, who uses and appreciates diagrams most. Oftentimes a row of figures does not tell very much, but when these same figures are plotted on cross section paper, a picture is obtained which clearly brings out the law of variation of the quantities involved. Another thing which may be said in favor of diagrams is that they are great time-savers. To the busy man this is the principal advantage.

The cross section paper on the market is ruled in the following ways:

1. Divided horizontally and vertically into centimeters and millimeters.

2. Divided horizontally and vertically into inches and eighths or tenths of an inch.

3. Divided horizontally into inches and tenths, and vertically, logarithmic, 1 to 10.

4. Divided both ways, logarithmic, 1 to 10.

5. Divided both ways, logarithmic 1 to 100.

In science and engineering the law of variation in quantities is usually expressed as an equation. When this equation is of the first degree, it is graphically plotted on cross section paper as a straight line. When the variable enters in any other power or root than the first, a curve results. On ordinary squared paper, plotting a curve is very laborious as a great many points must be found in order to obtain the shape of the curve. In tracing a curve through the plotted points it is difficult to obtain a draftsman's irregular curve which will "fit," and as a result the curve as drawn is only correct at the plotted points.

When the equation has the form $x = ay^{\frac{m}{n}}$, in which the exponents m and n are of any power or any root, logarithmic paper has a distinct advantage over ordinary squared paper. As its name implies it is divided logarithmically, that is, the distances of the abscissas and the ordinates from the origin are proportional to the logarithms of the numbers instead of the numbers themselves. The principle on which it is based will be readily understood by those familiar with the slide rule. In fact a slide rule can be made by anyone by merely setting the edges of two sheets of logarithmic paper in the proper position.

In order to compare logarithmic with ordinary cross section paper the accompanying diagrams were prepared. The curved lines are plotted on ordinary paper, the straight lines on logarithmic paper. The range of values is the same in both sets of curves.

The equation used is one in which the diameter of shafting is obtained by the formula $d = c\sqrt[3]{\frac{H}{N}}$ in which

$d =$ diameter of shaft in inches.

$H =$ horse-power transmitted.

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N = number of revolutions per minute.
c = a constant.

For long steel shafts c is usually 3.96. The equation which is to be plotted is $d = 3.96\sqrt[4]{\frac{H}{N}}$

For any particular curve N is a constant, so that all that is necessary to do is to solve for H with any given value of d. A numerical example may make this clearer. Take $N = 200$, $d = 2$ inches; then $H = 13$. Again, take $N = 200$, and assume $d = 5$; then $H = 508$.

On ordinary squared paper for any assumed value of N a large number of values of H and d must be found in order to obtain the true form of the curve. When completed, the curves thus plotted are unsatisfactory as they all approach the origin, so that they bunch together in a way that is annoying when calculations are involved wherein results near the origin are sought. In this particular instance the curves converge at the points where the diagram is most likely to be used.

Logarithmic paper reduces the labor of computation. All that is necessary is to plot two extreme points and draw a straight line connecting them. The equation is truly represented by this line and each point on this line is correct. To test the accuracy of the work an intermediate point may be calculated, and plotted on the diagram. If it falls on the line already drawn the work is correct. If it does not fall on this line, some mistake was made in calculating one or both of the end points.

To illustrate the use of logarithmic paper take the data previously calculated. Plot the point corresponding to $d = 2$, $H = 13$. In same way plot point $d = 5$, $H = 508$. Draw a straight line between the two points. This establishes the curve for $N = 200$. As a check it will be found that the point $d = 4$, $H = 208$ falls on the line drawn, showing that the end points were correctly plotted.

On plotting these different values of N on logarithmic paper it will be noticed that all the curves are parallel. This in itself is a check on the accuracy of the work, as a lack of parallelism in the lines indicates that something is wrong, so that the use of logarithmic paper in itself is a guard against inaccurate work. The directions given above are general for any equation of the form $x = ay^mz^n$. For any particular curve, y^m or z^n is a constant, and as a is a constant, the equation resolves into $x = ky^m$. Logarithmically expressed, the last equation becomes $\log x = \log k + m \log y$. This logarithmic equation is really the same as the equation $x = a + by$, an equation of the first degree, and explains why the curve becomes a straight line on logarithmic paper.

It will be readily seen that where a great many diagrams are to be made, this paper is a time-saver. It may be used for purposes of calculation in ways which will suggest themselves to the ingenious man. Among the more common uses to which it may be put are the following: Powers and roots of any and all indices; bending moment, shearing stress, or deflection of beams in terms of span or load; moments of inertia and radii of gyration in terms of a linear dimension; circumferences and areas of circles in terms of their diameters; sizes of bars, struts, shafts, etc., in terms of a linear dimension; hydraulic equations, etc.

* * *

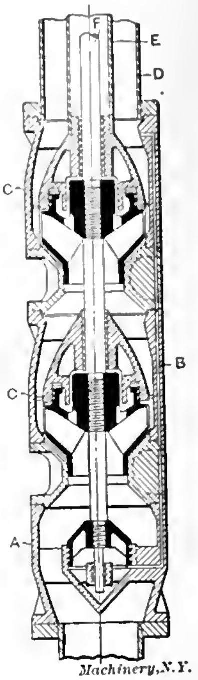
Consul William Bardel of Rheims reports that a new French plate glass has been brought out which is practically burglar-proof. While an ordinary plate glass, such as is usually put into jewelers' show windows, can be smashed by a single stroke of a metal-faced mallet, it is not possible to break this new plate glass in this manner. In an experiment made, a large piece of cast iron was thrown violently against the window, but the only effect on the glass was a small hole measuring one or two inches. Several shots of a revolver loaded with jacketed bullets were then fired at the show window, but the window suffered no damage except that the bullets entered to a depth of a fraction of an inch. The plate glass which will stand such usage is ordinarily made of a thickness of 7/8 to 1 inch. If desired, even a heavier glass can be made without diminishing the transparency.

CENTRIFUGAL PUMPS

JOHN B SPERRY*

Under the above title in the February issue of MACHINERY Mr. E. N. Percy writes as follows: "The common commercial volute pump seldom gives over 45 per cent efficiency, but can easily be designed to give 65 per cent and can be manufactured just as cheaply." This statement would have been true six years ago, but the manufacture of centrifugal pumps has improved greatly since then. Instead of using a rough runner in between the halves of a split casing, also without machined surfaces, and calling it a pump, the runners are machined thoroughly to gage and then accurately balanced to insure smooth running; the casing or volute is cast in one piece and machined to gage; the covers are also machined to gage. The bearings of the modern centrifugal pump are of the ring or chain oiled type, machined and babbitted to gage.

When Mr. Percy states that the volute pump seldom gives over 45 per cent efficiency, I think he is rather severe on that style of pump. I have copies of tests of five 4-inch centrifugal pumps of the volute type, no two of which were built by the same manufacturers. These tests were run at different speeds and covered heads ranging from 20 to 75 feet. The efficiency of all of the pumps was above 60 per cent and ran as high as 72 per cent. The maximum efficiency in these pumps varies according to the design. For one it comes at 25 feet, for another at 40 feet, and another at 60 feet. The efficiency on either side of this maximum decreases very slowly, and for this reason the patterns of these pumps are applicable to a wide range of heads, provided the speed is properly arranged. It might be of interest to add that it is customary by one manufacturer to guarantee at least 70 per cent on volute pumps 6 inches and larger; and 75 and 80 per cent on those 30 inches and larger. That he lives up to his guarantee is shown by his increasing business in pumps. Mr. Percy also states that European pumps give a higher efficiency than American pumps. In answer to this, I can cite instances where American pumps are taking the place of European pumps in Porto Rico and elsewhere. I also know of cases where pumps are being manufactured under European patents and the manufacturer does not dare to guarantee even as high an efficiency as that of some of the manufacturers of the volute pump, which type Mr. Percy considers low in duty.



A Two-Stage Pump for Deep-well Work

Mention was made of the electrically-driven, deep-well, multistage pumps which are now coming into use. The accompanying engraving illustrates a pump of this character that has been developed during the last two years by the American Well Works. The engraving shows a two-stage pump with a balancing chamber, or water step at *A*. This water step receives its pressure from the discharge side of the pump through the port *B*. The down thrust is still further relieved by the design of the runner, as shown at *C*. By this construction the suction pressure is admitted to the top of the runner, and the discharge pressure at the bottom; the difference in the two total pressures assists in floating the rotating member of the pump. Surrounding the shaft *F* is a tube *E* which forms a support for the guide bearings of the shaft and protects them from any sand that may be in the water. Outside of this and concentric with it is a larger tube that supports the pump from the top of the well. The annular space between the two tubes forms the discharge pipe. This type of pump is adapted for pumping from deep wells where a large quantity of water is required, such as city waterworks, factories, ice plants, railroads, mines and irrigation projects.

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DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—6

BRACED GIRDERS

R. B. BROWN

Reference was made on page 669, May issue, to the three types of braced girders commonly in use, of which the Warren type is the most suitable for ordinary traveler work. The details of construction of this type differ somewhat according to the size and span of the crane, but the nature and magnitude of the stresses, which have to receive primary consideration, are found by the same methods in all cases.

In order to become thoroughly familiar with this type of girder, it is best to study its construction "anatomically." Fig. 28 shows the outline of the construction of a Warren girder consisting of a compression flange *AA'*, and a tension flange *ADD'*. These flanges are kept in position by the diagonal struts *BD*, *BE*, *CE*, *CF*, etc., which are subjected alternately to tensile and compressive stresses as the position of the load varies. Apart from the compression in the top flanges, due to the maximum bending moment, there is an additional force, due to the bending moment in the top flange caused by the load of the crab wheels. In order to minimize this quantity the vertical members *GD*, *HE*, *IF*, etc., are added, thereby reducing the effective spans in the top flange by one-half. Girders of this type are made either parallel (Fig. 28), or fish-bellied, as shown in Fig. 29. The former have a satisfactory appearance and do not need to be made so heavy at the ends as the latter; they are cheaper to make, owing to the fact that the lower flange does not need to be bent, and one set of templets will in some crabs suit all the diagonals. The fish-bellied form is, however, often preferred and is sometimes most convenient and will, therefore, be considered also.

The stresses in the various members may be found either by moments or by diagrams. The former method is somewhat tedious and not often adopted, except perhaps for finding the maximum flange stresses for comparison purposes, or to check the diagrams. If the stress diagrams are carefully drawn, the forces given will be sufficiently accurate for practical purposes. It is not within the scope of this article to prove the methods employed, since such can be done by referring to the various works on girder construction, the principal object being to take an example of each particular type and show the quickest methods of obtaining those results which directly concern the designer.

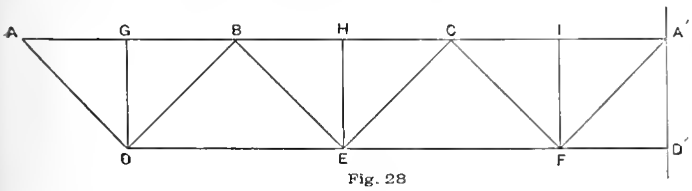


Fig. 28

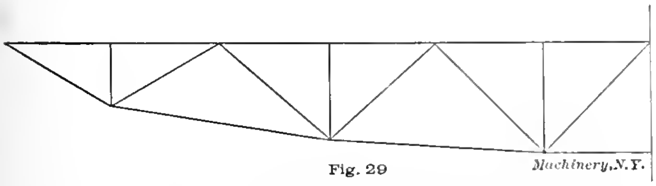


Fig. 29

Fig. 28. Warren Type Girder, Parallel Construction. Fig. 29. Warren Type Girder, Fish-bellied Construction

In designing girders of this type there are three distinct processes, as it were, to be gone through: 1. Draw an outline of the proposed girder, fixing the depth and number of bays; 2. Find the stresses which occur with the load in various positions in each member; 3. Select suitable sections to withstand the various stresses found.

Let Fig. 31 represent the outline of a Warren girder for a 15-ton crane of 72-foot span, weight of crab 5 tons, and centers of runners 6 feet. The most economical depth of these

Fig. 30. Enlarged Portion of Girder in Fig. 31

girders in relation to the span has been found to be about 1/12, so that in the present example the depth may be taken as 6 feet. It is preferable (but not essential) to divide the girder into an even number of bays on the top flange. No definite rule can, however, be given for the angle of the diagonals, which may be found to vary from 45 degrees in the case of light cranes to 60 degrees in those of heavier construction, but it is not economical to make the angle much *less* than 45 degrees. Other things being equal, the principal object is to have as few members as possible, and this result is generally gained by making the included angle of the diagonals as large as reasonable. There is, however, a limit to economy in this direction, which is reached when the span of the unsupported lengths of the top flange become so long as to require abnormally heavy sections to resist the combined bending moment from the crab wheels and compression in the girder itself. This quantity can only be settled by trial or comparison. In the example it will be seen that the top flange has been divided into six bays of 12-foot centers, the unsupported length being reduced to 6 feet by the insertion of the vertical struts. From the above figures it will be seen that the angle of the diagonals is 45 degrees, which represents a fair average for girders of this size.

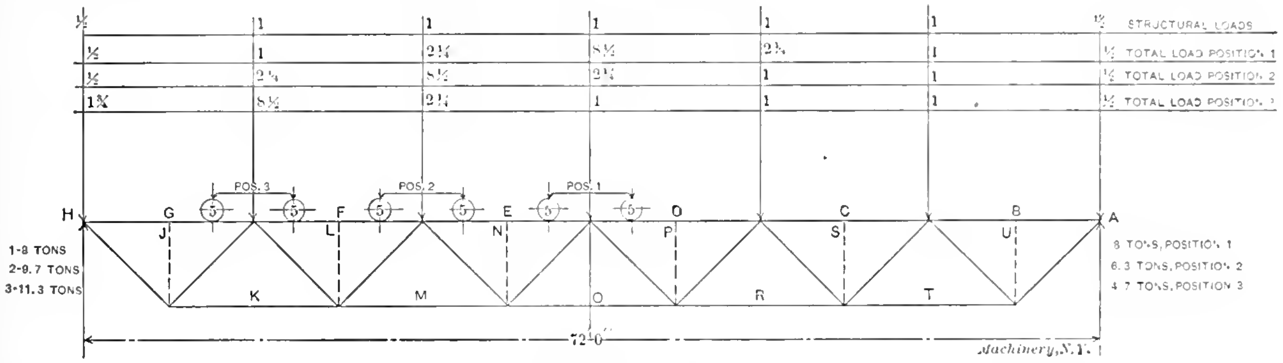


Fig. 31. Warren Crane Girder, 72-foot Span

The outline of the proposed girder is now complete, but before proceeding it is necessary to call attention to the fact that when possible the line drawn through the center of gravity of the various members should intersect at the same point, as in the case of the outline diagrams from which the stress diagrams are drawn. This precaution is necessary in order to minimize the secondary forces, which, although of no importance in small cranes, are sometimes considerable in heavy work; the girders and templets are also much more easily "set off" under these conditions. Before the stress diagram can be drawn, the loading of the girder must be considered, and it will be necessary to assume the weight of one girder together with its platform and cross-shaft.

In the present case this quantity may be taken at 6 tons, and since the girder will be of practically uniform construction, is equal to one ton per bay. The loading on the various bays from the crab wheels must be found by assuming the crab to be in the position shown in Fig. 30, where it would give the greatest reaction on any diagonals.

The effect of the above loads can be found from the skeleton diagram shown in Fig. 31. The first diagram is drawn for the loads as they occur when the crab is at the center of the girder. In reaching the loads from the crab wheels on to the apices of the various diagonals, no notice is taken of the intermediate vertical struts. This is not quite correct, since the vertical members convey part of the load direct to the bottom flange, but, as the inaccuracy is of little importance for small girders, it is simpler to eliminate the vertical struts from the diagrams altogether.

The first diagram for the load in the center is commenced by drawing the line *AH*, Fig. 32, which is the load or base line of the diagram. From *A* set off the distance *AB* equal to 0.5 ton at any convenient load scale, say, ¼ inch = 1 ton. This quantity represents the structural load acting directly over either abutment. Similarly, make *BC* = 1 ton, *CD* = 2.25 tons, *DE* = 8.5 tons, *EF* = 2.25 tons, *FG* = 1.0 ton and *GH* = 0.5 ton. Bisect *AH* at *V*, and draw a horizontal line through this point, as shown. The distance *VA*, or *VH* (8 tons) will be equal to the reactions at either point of support. The loads *AB* and *GH* are only set off on the load line to make the reactions complete, because, since they are directly over the abutments, they do not have any direct influence on the stresses of the structure itself.

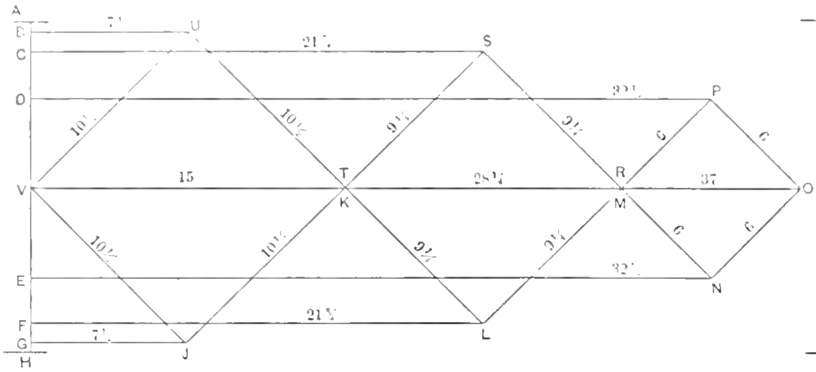


Fig. 32. Stress Diagram for Crane Girder in Fig. 31, Load in Center

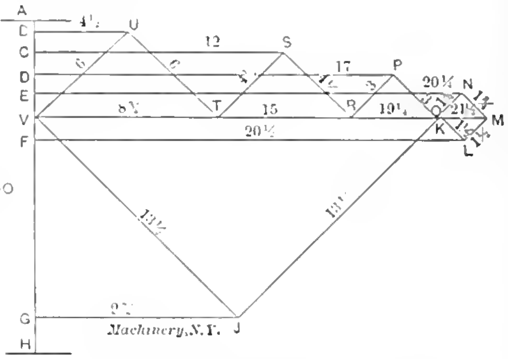


Fig. 33. Stress Diagram for Crane Girder in Fig. 31, Load in Position 3

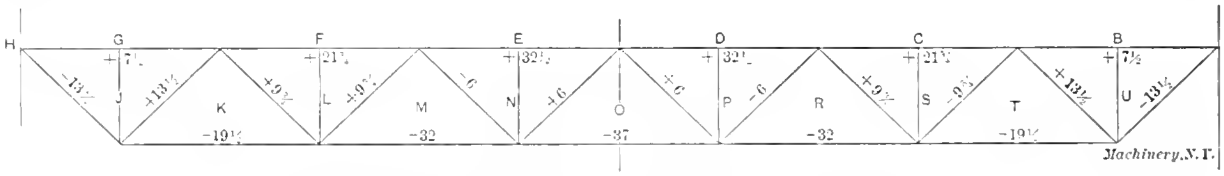


Fig. 34 Stresses in Crane Girder in Fig. 31, as determined by Stress Diagrams

From *V* draw a line *VU* parallel to the diagonal members in the skeleton diagram, producing same until it intersects a horizontal line drawn from *B* at *U*. Then the force in *VU* can be read off this line to the same scale as that adopted for the load line. Similarly draw *UT*, *TS*, *SR*, etc., parallel to their respective members in the skeleton diagram.

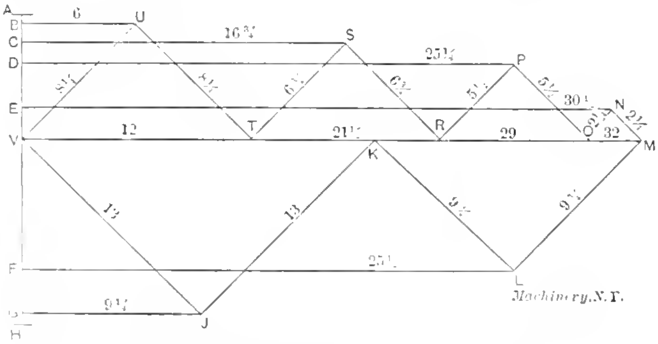


Fig. 35. Stress Diagram for Crane Girder in Fig. 31, Load in Position 2

When the diagram has been drawn on one side, the opposite side may be duplicated if required, since the loading is symmetrical. When the diagram is completed, the letters on the force diagram correspond to those given on the skeleton. Thus the maximum tension in the lower flange occurs at the center and is equal to *VO*, while the maximum force in the diagonals occurs at *U* or *J* and equals *VU*, *VJ*, *UT*, and *JK*. The various stresses occurring in each member have been scaled off and written in the skeleton diagram for reference.

In the case of small cranes, it will generally be found most economical in practice to make all the diagonals of one, or, at the most, two sections, since the difference between the maximum and minimum loads is not great, and when this is done, it is only necessary to draw one diagram in the center as shown in order to get the maximum flange stresses, and another with the load in a position near the end as shown in Fig. 33 to obtain the maximum diagonal stresses. When, however, the girders for cranes above 20 tons are being designed, it is better practice to find the maximum stresses occurring in each member and proportion the sections to suit; and this will be done in the present case, in order to show the method used.

In drawing the diagram, Fig. 35, for position 2, Fig. 31, the load line will be drawn as in position 1, with the order of loading, in accordance with the re-distribution of loads as in the skeleton diagram, Fig. 31. The reactions at the abutments from both the rolling and structural loads must be found in the usual way, and set off on the load line as shown. From *V* draw a horizontal line and then draw the diagonal stress lines as in the previous example. If the diagram is correctly drawn, the last force line will join at the starting point *V*, thereby checking itself, but it should be borne in mind that unless the position of *V* is exactly to scale, the diagram will not close and cannot be considered correct.

The stresses are found when the load is in position 3, as shown by the diagram, Fig. 33; this process could be repeated for any number of bays.

Since there is no definite relation between the centers of the crab wheels and the pitch of the diagonals, it is difficult to say beforehand whether the loads in the positions already considered give the maximum stresses on the diagonals; generally speaking, they do, but in heavy cranes it is better to make certain by drawing another set of diagrams for other positions. Having found the stresses arising from the loads in the various positions, it is convenient to record the highest stress found on any diagram for any particular member, on another skeleton diagram, as shown in Fig. 34.

Under certain conditions, it might have been preferable to make the above girder fish-bellied in form, as previously referred to, and, in order to make this treatise complete, the diagrams shown in Figs. 36 and 37 have been drawn to suit the altered design. The diagrams are constructed in precisely the same manner as in the previous example, the only exception being that the force lines for the lower flange must be drawn parallel to their corresponding members. By comparing these diagrams with those for the parallel girders, it will be seen how unsuitable, comparatively speaking, the fish-bellied girder is, for at the point where the diagonals have the maximum stress, they are inclined at the smallest angle, and consequently receive the greatest possible stress

which, generally speaking, is so heavy that sufficient rivets cannot be put into a suitable strut, and web plates, or very large gusset plates, must be used. The stresses in the end struts may be minimized by shortening the length of the bays at the ends, as shown in Fig. 37.

The corners or sets on the lower flange do not form a parabolic line as may be the case in a plate girder, but are more a question of practical judgment, the main object being to make the end bays as deep as possible. In details of construction this girder is practically the same as the parallel type.

When the stress sheet is finished, the designer may pass on to the first operation of selecting suitable sections to withstand the strains. There are four different types of girder sections commonly in use, as shown in Figs. 38 to 41. The type shown in Fig. 38 is suitable for cranes up to 3 tons capacity, and over 40 feet span, when no platforms are specified, as in the case of small cranes worked from the floor level. By placing the channel forming the top flange horizontal, as shown, the girder receives the necessary lateral stiffness in the right place, and, since the wheel pressures are light, there is always sufficient strength to resist bending in the other direction.

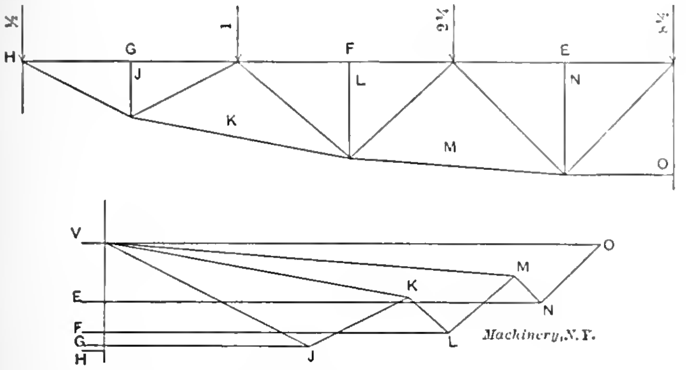


Fig. 36. Stress Diagram of Fish-bellied Girders

When platforms are required, and for all cranes above 3 tons and up to 20 tons, of more than 65 feet span, the construction shown in Fig. 39 has been found suitable. Lateral strength is given to this type by the addition of braced platform girders. For cranes of 25 tons capacity and upwards, and over 65 feet span, the box-latticed types shown in Figs. 40 and 41 are most suitable. The channel construction shown in the top flange of Fig. 41 generally becomes necessary for cranes of 40 tons capacity and upwards. When these types are used, it is cheaper to make the girders strong enough laterally, and attach ordinary platform brackets, as shown, although this arrangement is not suitable for high speeds. The type of girder used in the previous example will be the same as shown in Fig. 39.

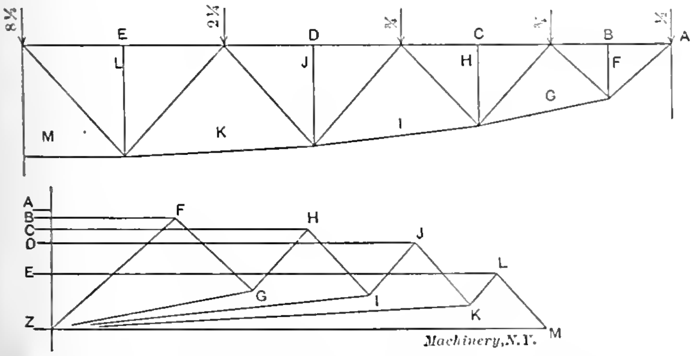


Fig. 37. Length of Bays at End of Fish-bellied Girders Shortened to equalize Stresses in Struts

The scantlings of the bottom flange can be determined without difficulty, since no lateral stiffness has to be provided for in the girder itself. The width of flanges becomes principally a question of convenience, adding a rail and web to suit the top flange, as shown in Fig. 42. It will be seen that in this case the rail has been riveted on continuously in such a manner that it can be regarded as a useful part of the section.

As a preliminary guide in assuming a suitable section the designer may select such sizes as will give an area which will correspond to not more than from 2 to 3 tons per square inch. The depth of the web varies according to the load, but is generally proportioned to suit the riveting of the diagonals. When the section has been assumed in this manner, the next step is to find the modulus in the usual way

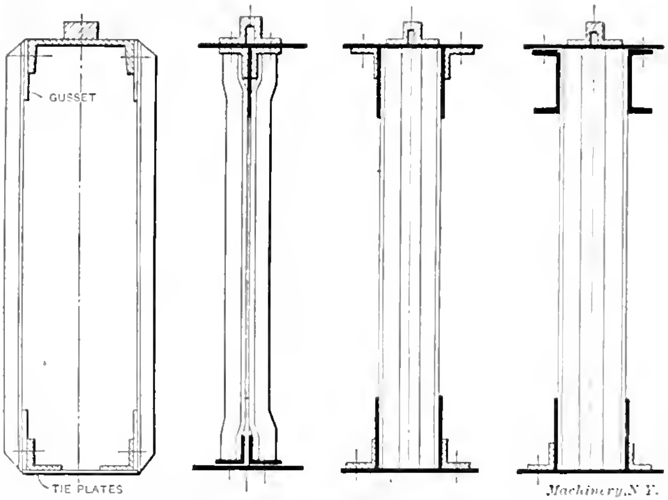
Draw the section full size, and from the vertical line *AB*, drawn parallel to the center of the section, set off the net section, as shown in Fig 42. Determine the center of gravity in each piece, together with its area. When these particulars have been fixed, the center of gravity of the whole mass may be found in the ordinary way, by multiplying the area of each piece by the distance from *AC* to its center of gravity, and dividing the sum of these products by the total area of the section, thus:

Section 1. $2.2500 \times 0.5625 = 1.2656$
2. $1.1250 \times 1.6875 = 1.8984$
3. $1.2187 \times 2.4375 = 2.9707$
4. $3.8437 \times 2.8125 = 10.8105$
5. $1.5937 \times 3.1875 = 5.0800$
6. $1.9687 \times 4.6875 = 9.2285$
7. $3.0000 \times 7.0000 = 21.0000$

Complete area = 15 square inches; sum of moments = 52.2527. Then

$$\frac{52.2527}{15} = 3.48,$$

or about 3½ inches from *A* to the center of gravity and neutral axis of the section.



Figs. 38 to 41. Types of Girder Sections in Common Use

The next step is to find the moment of inertia of each half as divided by the neutral axis.

The moment of inertia of a section taken about its base is equivalent to 1/3 $b\,h^3$; therefore the moment of inertia of the section shown will be found as follows:

$1/3\,[\,(3.5^3 - 2.375^3) \times 2 + (2.375^3 - 1.25^3) \times 1 + (1.25^3 - 0.875^3) \times 3.25 + (0.875^3 - 0.5^3) \times 10.25 + (0.5^3 - 0.125^3) \times 4.625 + (1\tfrac{1}{8}^3 \times 1.125)] = \frac{80.7}{3} = 26.9$ = moment of inertia of the upper half.

The moment of inertia of the lower part can be found in a similar manner, as follows:

$1/3\,[(7.5^3 \times 0.375) + (2.5^3 \times 0.75)] = 56.6$ = moment of inertia of lower half.

Total moment of inertia of section = $26.9 + 56.6 = 83.5$.

This quantity, divided by the distance from the neutral axis to the upper or lower outer edge of the section, will give the compression and tension moduli, respectively, thus:

$$\frac{83.5}{3.5} = 23.8 = \text{compression modulus.}$$

$$\frac{83.5}{7.5} = 11.13 = \text{tension modulus.}$$

It is also necessary to know the maximum bending moment in the unsupported part of the top member, which, in the present case, occurs when one wheel of the crab is in the

center of the bay. It is difficult to say how much benefit is due to the fact that the unsupported parts of the top flange form a more or less continuous girder. The results due to taking the bending moment as being equal to $\frac{WL}{6}$ give satisfaction; the bending moment, in this case, is therefore equal to

$$\frac{5 \times 72}{6} = 60 \text{ inch-tons.}$$

The stress in the section from this load alone will be:

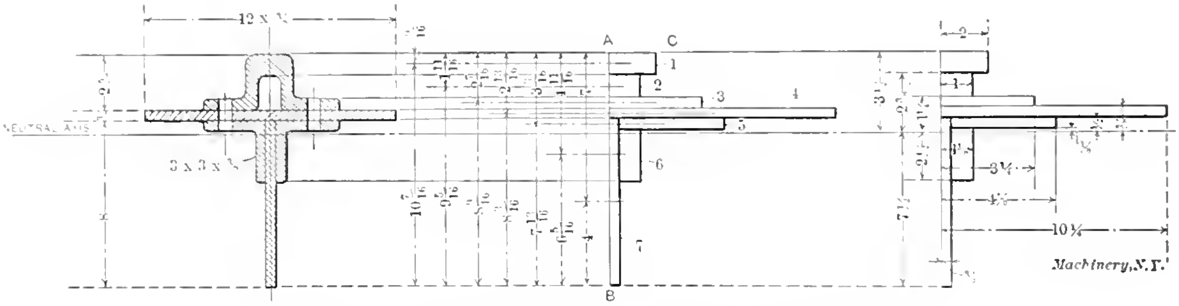
$$\frac{60}{23.8} = 2.5 \text{ tons per square inch, compression.}$$

$$\frac{60}{11.13} = 5.4 \text{ tons per square inch, tension.}$$

the values given in Table XII will be found useful. The safe loads given in this table are calculated by Gordon's formula. The factor of safety is five.

Generally speaking it is safe to consider that the struts have the ends fixed, in the plane of the rivets, but free in the opposite direction. Matters may be more nearly equalized between these two conditions if a small tie plate is used to tie the two sections forming one strut together. When, however, the work throughout is light, it is safer to take all struts as having free ends, and thereby avoid the possibility of flexure in different directions. A sufficient number of rivets should be allowed for at the joints to limit the stress to 5 tons per square inch in shear, and 8¾ tons per square inch of bearing.

Generally speaking, the last bay should be plated in, in order to stiffen the end joint and provide sufficient section to meet the shearing stresses.



Figs. 42 and 43. Lay-out for Calculating Section Modulus of Girder Section

The maximum compression in the members from the load is equal to about 2.2 tons per square inch, and to this quantity the compression found above must be added, making the total maximum compression = 2.2 + 2.5 = 4.7 tons per square inch.

The above method is approximate and only suitable for the comparatively small girders used in crane work, and is not directly applicable to large bridge girders.

The stresses from bending alone should be kept as low as possible, in order to minimize the possibilities of deflection, which detracts from the value of the member as a strut. The safe working stress of this member, taken as a strut, pure and simple, and fixed in the plane of the joints, is generally taken as equal to about 4½ tons per square inch for a section having a radius of gyration of from 1/30 to 1/40 of the unsupported length. In fixing the size of the struts, some consideration should be given to the practical economy effected by using as few sections as possible, so that, although in the case of heavy cranes it is advisable to select sections to suit the varying stresses, it is better to select, say, two sections equal to the maximum stresses and use these throughout for girders of moderate size.

Angle sections are generally used both for diagonal and vertical struts, and in order to avoid continual calculations,

TABLE XII. SAFE LOADS IN TONS FOR ANGLE IRONS WHEN USED AS STRUTS

F = fixed ends R = round ends Factor of safety = 5

Size of Angle, Inches	Safe Loads in Tons for Different Length of Strut													
	4 Feet		5 Feet		6 Feet		7 Feet		8 Feet		9 Feet		10 Feet	
	F	R	F	R	F	R	F	R	F	R	F	R	F	R
$6 \times 6 \times \frac{5}{8}$	32.3	19.4	31.4	18.8	30.2	18.1	28.9	17.3	27.4	16.4	25.9	15.5	24.1	14.5
$6 \times 6 \times \frac{3}{4}$	38.3	23.0	37.2	22.3	35.8	21.5	34.2	20.5	32.5	19.5	30.6	18.4	28.5	17.1
$5 \times 5 \times \frac{1}{2}$	21.1	12.7	20.2	12.1	19.1	11.5	17.9	10.7	16.5	9.9	15.1	9.1	13.6	8.2
$5 \times 5 \times \frac{5}{8}$	26.0	15.6	24.9	14.9	23.5	14.1	22.1	13.3	20.4	12.2	18.6	11.2	16.8	10.1
$4\frac{1}{2} \times 4\frac{1}{2} \times \frac{1}{2}$	18.5	11.1	17.4	10.4	16.3	9.8	15.0	9.0	13.4	8.0	12.0	7.2	10.6	6.4
$4\frac{1}{2} \times 4\frac{1}{2} \times \frac{5}{8}$	22.7	13.6	21.5	12.9	20.1	12.1	18.4	11.1	16.6	10.0	14.7	8.8	13.1	7:9
$4 \times 4 \times \frac{1}{2}$	15.8	9.5	14.7	8.8	13.4	8.0	12.0	7.2	10.6	6.4	9.2	5.5	8.1	4.8
$4 \times 4 \times \frac{5}{8}$	19.4	11.6	18.1	10.9	16.6	10.0	14.7	8.2	13.0	7.8	11.3	6.8	9.9	5.9
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	10.2	6.1	9.2	5.5	8.2	4.9	7.1	4.3	6.1	3.7	5.2	3.1	......	......
$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{1}{2}$	13.3	8.0	12.1	7.3	10.6	6.4	9.2	5.5	7.9	4.7	6.8	4.1	......	......
$3 \times 3 \times \frac{5}{16}$	6.9	4.1	6.0	3.6	5.1	3.1	4.3	2.6	......	......	......	......	......	......
$3 \times 3 \times \frac{3}{8}$	8.1	4.9	7.0	4.2	6.0	3.6	5.0	3.0	......	......	......	......	......	......
$3 \times 3 \times \frac{1}{2}$	10.6	6.4	9.2	5.5	7.8	4.7	6.5	3.9	......	......	......	......	......	......
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$	4.1	2.5	3.4	2.1	2.6	1.6	......	......	......	......	......	......	......	......
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{5}{16}$	5.0	3.0	4.1	2.5	3.3	2.0	......	......	......	......	......	......	......	......
$2\frac{1}{2} \times 2\frac{1}{2} \times \frac{3}{8}$	5.9	3.5	4.9	2.9	3.9	2.3	......	......	......	......	......	......	......	......

It is seldom necessary to make any extra provision for shearing stresses at the various flange joints for small and medium sized girders, but for large girders these stresses should always be calculated and checked.

* * *

An interesting piece of apparatus employed by electricians is the "fish wire," used for threading insulated wire through pipes and other long narrow conduits. This fish wire is a finely tempered steel tape about 1/4 inch wide and 1/16 inch thick having slots in the ends for attachment to the wire that is to be pulled through. The fish wire is introduced into the pipe and pushed in as far as it will go by direct pushing. When it meets obstruction because of bends or the friction of the wire against the sides of the pipe, the workman then propels the wire along by pushing it in until the wire bends up, and then "snapping" it. A wave motion is transmitted along the wire or tape with the result that the far end jumps ahead a short distance. The operation is repeated indefinitely, and in this way long distances are threaded by the slender wire. It is even possible to guide the wire through a number of right angle bends, provided the elbows are of easy curvature. The secret of the process lies in taking advantage of the fact that wave motion can be produced by crumpling up the wire and snapping in that position.

EXPERIMENTS ON TWIST DRILLS—2

The following continuation of the article in the May number, gives the results of experiments conducted to obtain more accurate data for larger drills and heavier feeds. These experiments, briefly stated, are as follows:

(*e*) A series of experiments to determine the twisting moment or torque and end-thrust on twist drills of varying diameter when operating on soft cast iron with different rates of feed. No lubricant used. Termed ordinary trials.

(*f*) A set of experiments similar to the above when operating on Whitworth's medium hard (fluid-pressed) steel. No lubricant used. Termed ordinary trials.

(*g*) A set of trials on soft cast iron to determine the variation of torque and thrust with different cutting speeds. No lubricant used. Termed speed trials.

(*h*) Trials to determine the variation of thrust and torque on soft cast iron and medium hard steel with different diameter of drills and rate of feeds. An initial hole equal to the width of the chisel point was drilled in the specimen operated upon. No lubricant used. Termed minus-chisel-point trials.

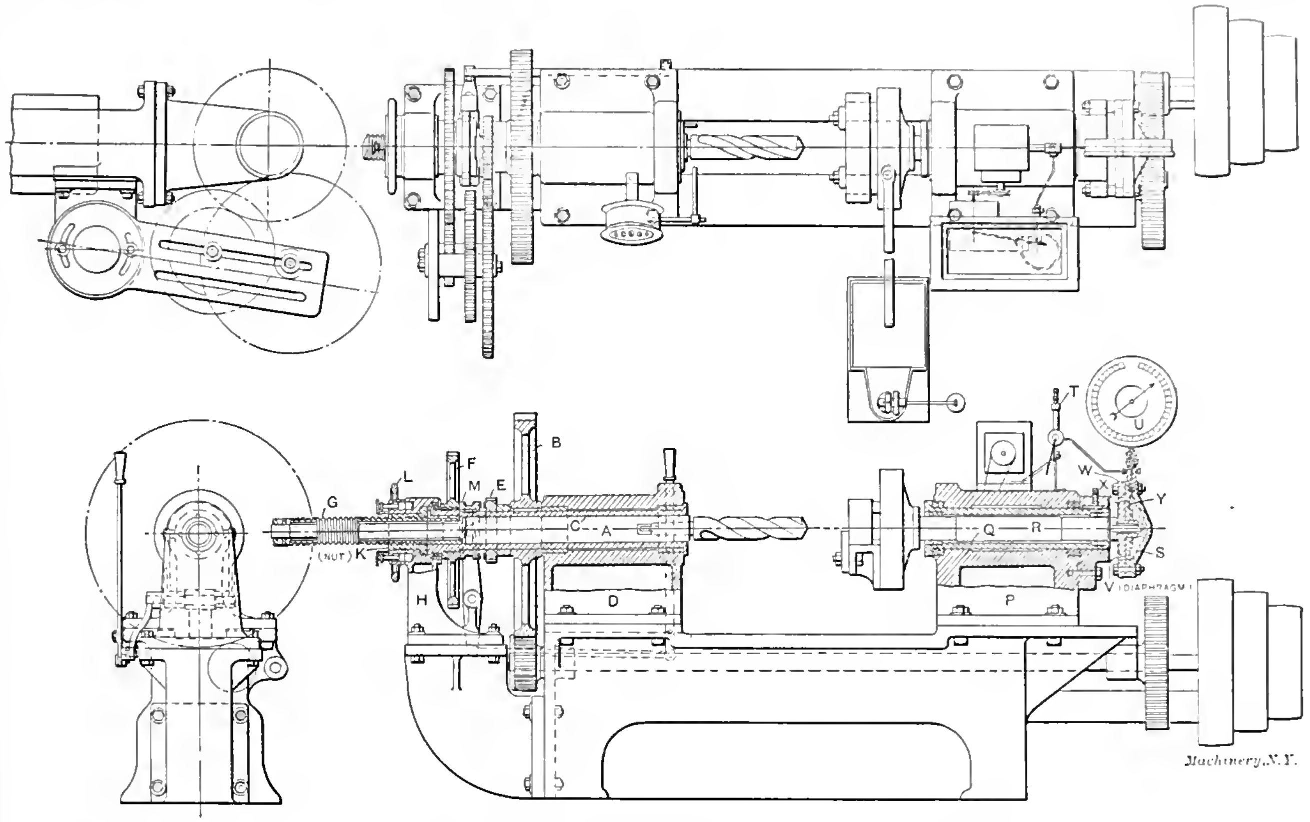


Fig. 2. Section and Elevation of Apparatus used in Second Set of Experiments

(*i*) A set of experiments to determine the variation of thrust and torque when operating on soft, medium and hard cast iron. No lubricant used. Termed hardness trials.

(*j*) A set of experiments similar to the above when operating on Whitworth soft, medium and hard (fluid-pressed) steel. No lubricant used. Termed hardness trials.

(*k*) A set of trials similar to (*j*) but with a lubricant of oil and water. Termed lubricated trials.

(*l*) A set of trials to find the effect produced by varying the point angle when operating on soft cast iron. No lubricant used. Termed point angle trials.

(*m*) A set similar to (*l*) when operating on soft (fluid-pressed) steel and lubricated with a mixture of water and oil. Termed point angle trials.

Description of Second Apparatus

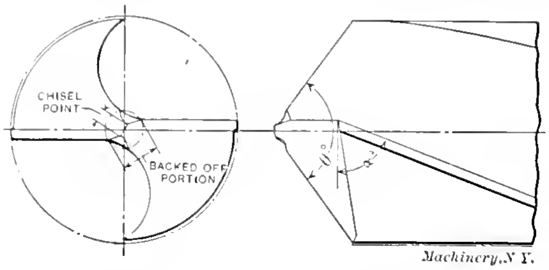
The experiments (*e*) to (*m*) were carried out on a horizontal milling machine which had been reconstructed and modified. The arrangement is shown in detail in Fig. 2, and by the half-tone in Fig. 4. The power was obtained from a motor which drove a countershaft whereon was mounted a three-stepped cone pulley similar to that on the machine. Two pairs of wheels were introduced between the cone and the driving spindle, but one pair could be suppressed to allow of an increased speed to the spindle. The arrangement permitted of a total speed variation to the drill of from 5 to 150 revolutions per minute. A counter fixed to the front of the machine and actuated from the spindle indicated the revolutions. The drill was held in the rotating spindle *A*, and could be advanced at varying rates, from 0.0025 to 0.050 inch per revolution, by suitable change wheels driven from the spindle sleeve and a square threaded cylinder on the end of the spindle. The work was supported on an angle plate bolted to the face-plate on the spindle in the tail stock. This latter spindle, being free to slide, transmits the thrust on the drill to the diaphragm dynamometer fixed to the end of the spindle. The twisting force is taken by an arm bolted to the face-plate and having a knife edge on its further extremity which rests on a scale pan.

The driving gear *B* is keyed to the cast iron sleeve *C* which rotates within the bearings of the headstock *D*. A long key fitted at the end of the sleeve *C*, nearest to the work, drives the spindle *A*, while permitting it to slide longitudinally. The employment of a sleeve as a driver in this manner reduces the twist that would otherwise come on the spindle if it were driven from the gear *B* direct. It also divides the wear due to rotation and sliding. As the wear due to the former is greatest, adjustment for the same is provided. It is clear that if the spindle is allowed any freedom it will wobble, thereby enlarging the hole and in all likelihood breaking the drill. The feed to the drill is secured through the pinion *E*, mounted freely on the sleeve *C*, which engages the train of gears on the quadrant, bolted to the bed, and the gear *F* keyed to the threaded cylinder *G*. The gear *F* is held in bracket *H* by an annular plate, while immediately ahead of it is a nut *K* which embraces the screw *G* and is held to the bracket by pins through the hand-wheel *L*. The cylinder *G* rotates independently of the spindle and is prevented from moving longitudinally thereon by a shoulder at one end and lock-nuts at the other. Friction washers are introduced between these members to take the wear. Thus, on the engagement of the clutch *M* (which is keyed to *C*) with the pinion *E*, a definite horizontal movement is given to the spindle per revolution of the same. The hand-wheel *L* is keyed to *K* and furnishes a quick withdrawing motion to the drill, on the locking pins being withdrawn.

The torque on the drill is obtained by multiplying the load on the scale pan (after the initial load due to the weight of the arm and unbalanced weight on the face-plate has been

subtracted) by the length of the arm measured from the center of the hole to the knife edge.

Balls have been fitted in pockets of the cast iron sleeve *Q* to allow the spindle *R* to slide longitudinally with the minimum of frictional resistance. The hydraulic support to take the end thrust of the drill consists of a phosphor bronze casing *S*, fitted with a filling plug *T* and a standard pressure gage *U*. The diaphragm *V* is of cold drawn brass 0.010 inch thick. It is held to the casing by bolts and a steel ring *W*. The thrust pad *X* is provided with a cup-shaped recess to receive the spherical end of the spindle *R*. The pad is made fast to *V* by the nut *Y* within the casing. The end-thrust on the drill deflects the diaphragm at that part which is free (about 1/8 inch) between *S* and *X*, thereby producing a pressure in the fluid which is shown on the gage. The fluid in this case is water. A small filling plug is fitted in the end of the gage tube to allow any air to escape in order that the diaphragm deflection may be as small as possible. When the fluid is air-free, the diaphragm will only yield by the amount necessary to supply the increased volume of the gage tube due to the added pressure. The spring of the tube is sufficient to bring the diaphragm back to its original position when the load is removed.



Machinery,N.Y.

Fig. 3. Form of Point of Drill used in Experiments

The shape of the point of a 3-inch drill used in the experiments is shown in Fig. 3. The width of the chisel point (or thinned down web) is approximately 0.096 *d*, and the width of the backed-off portion 0.168 *d*. The average cutting angle at right angles to the lip at the periphery is 68 deg. 48 min.

Results of Second Set of Experiments

Experiments (*e*) showed that the torque does not increase as fast as the feed for any given diameter of drill. The formula below closely agrees with the results obtained for all sizes of drills and all feeds:

$$T = 785\, d^{1.82}\, t^{0.72 - 0.0065d} \qquad (20)$$

The coefficient and exponents of the right-hand term in the formula above may be modified, and the error in the simplified formula

$$T = 740\, d^{1.8}\, t^{0.7} \qquad (21)$$

is inappreciable. A safe approximation without fractional exponents may be given in the form

$$T = 10\, d^2 + (14d^2 + 3)\, 100\, t \qquad (22)$$

As the drill entered the specimen, the torque gradually increased, and the torque at starting at no time exceeded the value obtained when drilling the full diameter hole. The torque increases almost in proportion to the square of the diameter of the drill, for any given feed.

The cutting pressure *f*, in tons per square inch, is found from the formula

$$f = \frac{35.4}{d^{0.2}\, t^{0.3}} \qquad (27)$$

It is clear from the above equation that the cutting pressure per square inch decreases with an increased diameter and also with increased feed. The cutting pressure, which is exerted along the radial cutting edges and resists rotation, should not be confused with the end thrust which is exerted in the direction of the axis of the drill.

Experiments for Determining the End Thrust

The following formulas, of which the latter is an approximation of the former, express the results obtained in the experiments for the determining of the end thrust when drilling soft cast iron:

$$P = (d - 0.4)\, 325 + (24\, d + 65)\, 1{,}000\, t, \qquad (28)$$

$$P = 240\, d + (24\, d + 65)\, 1{,}000\, t, \qquad (28a)$$

For ordinary feeds the following approximation is fairly correct:

$$P = 200\, d + 10{,}000\, t. \qquad (28b)$$

The end thrust can also be expressed by an equation of the form:

$$P = 35{,}500\, d^{0.7}\, t^{0.75} \qquad (30)$$

At no time did the force required for starting the drill exceed that when the drill was cutting a full diameter hole, and the first sets of experiments were thus confirmed. In this, the results of the experiments differ from those given by Prof. Breckenridge; the results also differ from those obtained by Messrs. Bird and Fairfield, who found that the thrust increased much faster than the feed. The results obtained by Messrs. Bird and Fairfield may possibly be accounted for by the high-speed at which they ran the drill, which produced a bluntness affecting the thrust more than the torque. In the trials at the Manchester School of Technology the speed was kept at 10 revolutions per minute in order that the blunting would not affect the results.

Experiments on Medium Hard Steel

The experiments (*f*) on medium hard steel showed much regularity. The torque was found to increase in a slower proportion than the feed, and it was also found that the torque did not increase as the square of the diameters of the drills, but in a smaller ratio, so that as far as the torque is concerned, the most economical way to remove metal is to use a coarse feed and a large diameter drill. A fairly simple, although approximate expression for the torque when drilling medium hard steel is:

$$T = 28\, d^2\, (1 + 100\, t). \qquad (32)$$

Another approximation may be expressed by the formula:

$$T = 1{,}640\, d^{1.8}\, t^{0.7}$$

which is fairly correct for all feeds in common use.

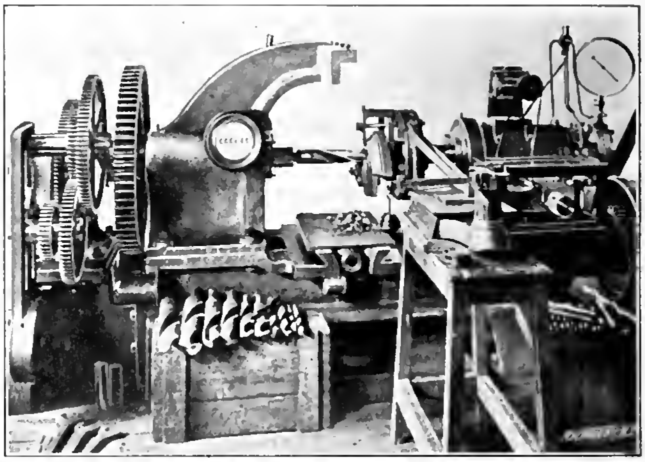


Fig. 4. Apparatus used in the Manchester Drill Experiments

For the end thrust the two following formulas are given, which are fairly simple in their form, but which, however, are only approximations which are correct for the range of feeds ordinarily used in practice. The latter formula, however, closely agrees with the rather complicated exact equation which was obtained from the experiments. While no experiments were undertaken at this time with blunt drills, it was noticed during the trials that the thrust may increase as much as 20 per cent by the dulling of the chisel point alone. This, of course, indicates that for ordinary shop practice it is useless to insist on anything but the approximate formulas.

$$P = 750\, d\, (1 + 150\, t), \qquad (35)$$

$$P = 35{,}500\, d^{0.7}\, t^{0.6}$$

Variations of Cutting Stress with Cutting Speed

In experiments (*g*), the speed, instead of remaining constant at 10 revolutions per minute was varied from 7.5 to 126 revolutions, with the object of determining the variation of thrust and torque due to speed. There did not seem to be any marked difference due to the speed, and in this particular, these experiments, therefore, confirm those made by Messrs. Bird and Fairfield.

The experiments show that metal is most economically removed by increasing the feed or diameter of drill rather than

the speed, since the power in the latter case is directly proportional to the speed. The friction horse-power of the machine is practically proportional to the speed, so that if the speed is doubled the power is also doubled. When, on the other hand, the feed is doubled, the frictional horse-power remains about the same. By increasing the number of lips to three or more, the torque and the thrust are increased for any given feed as the feed actually taken by each lip is $\frac{1}{n}$ of the whole feed, where n is the number of lips.

Tables I and II have been calculated from the above results for the speed and feed recommended by drill makers for ordinary shop use. There is no general agreement among the makers of high-speed twist-drills as to what the cutting speed should be for ordinary shop practice. Some decrease the speed with the increase of diameter of drill, some recommend the reverse, but most makers advise a constant periphery speed throughout. The mean of these values is about 60 feet per minute with a feed per revolution of $\frac{d^{\frac{1}{3}}}{100}$ for machine steel. For cast iron it is usual to decrease the above speed 20 per cent and increase the feed by a similar amount. Using these figures and the experimental force values previously given, an estimate of the net horse-power required for drilling can be made. With the object of presenting these results in concise form and to show at a glance the influences of speed, feed and diameter, the values so deduced have been tabulated in Tables I and II.

TABLE I. REVOLUTIONS PER MINUTE, FEED PER REVOLUTION, CUBIC INCHES REMOVED PER MINUTE, AND HORSE-POWER WHEN DRILLING CAST-IRON WITH HIGH-SPEED STEEL DRILLS

1	2	3	4	5	6	7	8
Diameter of Drill in Inches	Revolutions per Minute $N=\frac{12\times 48}{\pi d}$	Feed in Inches per Revolution of Drill $t=\frac{d^{\frac{1}{3}}}{84}$	Cubic Inches removed per Minute $1.715\,d^{\frac{4}{3}}$	Cutting Horse-power $1.16\,d$	Feeding Horse-power $\frac{d^{\frac{1}{4}}}{142}$	Total Horse-power	Horse-power per Cubic Inch of Metal removed per Minute
0.25	735	0.0075	0.27	0.29	0.005	0.295	1.092
0.375	490	0.0086	0.462	0.435	0.0055	0.4405	0.954
0.5	368	0.0094	0.682	0.58	0.0059	0.586	0.862
0.75	245	0.0109	1.17	0.87	0.0066	0.8766	0.748
1.0	184	0.0119	1.715	1.16	0.007	1.167	0.681
1.25	147	0.0129	2.32	1.45	0.0073	1.457	0.628
1.5	122	0.0136	2.92	1.74	0.0078	1.748	0.598
1.75	105	0.0144	3.63	2.03	0.0081	2.038	0.563
2.0	92	0.0150	4.32	2.32	0.0084	2.328	0.539
2.25	81.7	0.0156	5.05	2.61	0.0086	2.619	0.519
2.5	73.5	0.0162	5.82	2.9	0.0089	2.909	0.500
2.75	66.75	0.0167	6.6	3.19	0.0091	3.199	0.486
3.0	61.3	0.0172	7.4	3.48	0.0093	3.489	0.472
3.25	56.5	0.0176	8.22	3.77	0.0095	3.78	0.46
3.5	52.5	0.0181	9.05	4.06	0.0096	4.07	0.45
3.75	49	0.0185	10.0	4.35	0.0098	4.36	0.436
4.0	46	0.0190	10.8	4.64	0.00995	4.65	0.431

The cubic inches of metal removed per minute (V) is found approximately from the equation:

$$V=\frac{\pi}{4}\,d^2\,t\,N,$$

where $N=$ revolutions per minute.

The cutting horse-power is obtained by multiplying the torque for each feed and diameter of drill by $\frac{2\,\pi\,N}{33{,}000}$.

$$\text{Cutting horse-power}=\frac{2\,\pi\,N\,T}{33{,}000}.$$

The horse-power required for feeding is obtained by multiplying the end thrust for each feed and diameter of drill by $\frac{t\,N}{33{,}000}$.

$$\text{Feed horse-power}=\frac{P\,t\,N}{33{,}000}$$

Minus-chisel-point Experiments on Soft Cast-iron and Medium Steel

These experiments were undertaken with the object of determining the difference in the thrust and torque due to the chisel point of the drill. Many efforts were made at the outset to drill a hole with a chisel shaped and ground similar to that on the drill itself. Frequent breakages, particularly when operating on steel, led to the abandonment of this procedure in favor of that where a hole was initially made in the specimen, having a diameter equal to the width of the chisel point of the drill to be employed. The tests were then made with different feeds and diameters of drills at a speed of 10 revolutions per minute as in the ordinary trials previously discussed.

It was found that the torque in these experiments was practically the same as the torque obtained in the regular experiments. Of course, the torque in the minus-chisel-point trials should be smaller, but the difference is so insignificant as to be lost sight of in the approximate formulas adopted. Considerable difference, however, is found in regard to the end thrust when a piece is removed in the specimen equal to the diameter of the chisel point. Thus, for cast iron the end thrust

$$P=12{,}600\,d^{0.7}\,t^{0.6} \qquad (39)$$

Comparing this equation with those just obtained in the ordinary trials (e), it will be seen that twenty-five per cent of the end force for feeds commonly required, is due to the chisel point.

The end thrust for medium steel in the minus-chisel-point trials was

$$P=27{,}000\,d^{0.73}\,t^{0.6} \qquad (40)$$

which is about twenty-one per cent less than the end thrust in the regular trials.

TABLE II. REVOLUTIONS PER MINUTE, FEED PER REVOLUTION, CUBIC INCHES REMOVED PER MINUTE, AND HORSE-POWER WHEN DRILLING MEDIUM HARD STEEL WITH HIGH-SPEED STEEL DRILLS

1	2	3	4	5	6	7	8
Diameter of Drill, in Inches	Revolutions per Minute $N=\frac{12\times 60}{\pi d}$	Feed in Inches per Revolution $t=\frac{d^{\frac{1}{3}}}{100}$	Cubic Inches removed per Minute $1.8\,d^{\frac{4}{3}}$	Cutting Horse-power $2.85\,d$	Feeding Horse-power $\frac{d^{\frac{1}{4}}}{77}$	Total Horse-power	Horse-power per Cubic Inch of Metal removed per Minute
0.25	920	0.0063	0.284	0.712	0.0092	0.721	2.54
0.375	614	0.0072	0.485	1.068	0.0102	1.078	2.22
0.5	460	0.00795	0.716	1.425	0.0109	1.426	1.99
0.75	306	0.0091	1.23	2.14	0.0121	2.152	1.75
1.0	230	0.01	1.8	2.85	0.013	2.863	1.59
1.25	184	0.0108	2.44	3.56	0.0138	3.574	1.47
1.5	153	0.0114	3.08	4.27	0.0145	4.285	1.39
1.75	131	0.0121	3.81	4.99	0.015	5.005	1.31
2.0	115	0.0126	4.54	5.7	0.0155	5.715	1.26
2.25	102	0.0131	5.3	6.42	0.0159	6.436	1.21
2.5	92	0.0136	6.12	7.12	0.0163	7.136	1.165
2.75	83.5	0.014	6.92	7.84	0.0167	7.857	1.135
3.0	76.5	0.0144	7.76	8.55	0.0171	8.567	1.105
3.25	70.5	0.0148	8.66	9.25	0.0175	9.267	1.07
3.5	65.6	0.0151	9.5	9.98	0.0178	9.998	1.05
3.75	61.25	0.0155	10.48	10.7	0.0181	10.718	1.024
4.0	57.5	0.0158	11.4	11.4	0.0184	11.42	1.0

Results of Experiments Undertaken on Different Kinds of Metal

The experiments on the variation of torque and thrust when drilling different grades of cast iron showed that the torque and thrust increased very rapidly with the percentage of carbon.

The experiments on the variation of torque and thrust when drilling steel of different kinds without and with lubricant, showed that there is little difference between the torque and thrust for soft and medium steels when not lubricated. This, no doubt, is due to the high percentage of manganese in the soft steel. Roughly speaking, the torque and thrust are practically proportional to the combined carbon and manganese contents for any given feed. In the lubrication tests, it was found that the percentage of decrease in the torque

due to lubrication was almost the same in soft and hard steel, and that this decrease is most conspicuous in the finer feeds. The average torque for each feed in these trials varies from 72 per cent with the 0.0025 inch feed to 92 per cent with the 0.0285 inch feed of that obtained when operating dry.

The thrust for soft, medium and hard steel is 26 per cent, 37 per cent and 12 per cent, respectively, less than that obtained when operating dry.

Variation of Torque and Thrust with Angle of Drill Point

The experiments for determining the torque and thrust due to different point angles were carried out with three drills having 90, 120 and 150 degrees included point angle, respectively. These experiments indicate that the torque decreases as the included angle becomes larger, but the end thrust increases. It will thus be noted that while the 90-degree included angle drill has a smaller end thrust, the torque is larger, and the 150-degree included angle drill has a larger end thrust but a smaller torque. Two distinct opposite effects enter in the determining of the correct angle, and the experiments were insufficient to assign a value to each of these effects; but it may be assumed that the commonly accepted angle of 118 degrees included angle is the most advantageous to use, as here both the torque and the end thrust have average value.

Conclusions of First Set of Experiments

(*a*) The horse-power for a given diameter of drill and feed is proportional to the revolutions or the cutting speed.

(*b*) The horse-power $\dfrac{2\pi N T}{33{,}000}$ is proportional to the torque, and for a given drill and speed does not increase as fast as the feed.

(*c*) Since the torque is practically proportional to the square of the diameter of the drill, the horse-power, for a given feed and cutting speed, is directly proportional to the diameter of the drill.

(*d*) The horse-power per cubic inch of metal removed is inversely proportional to the feed and independent of the drill and cutting speed.

(*e*) The work required to drill a given hole, when one drill only is used, is greater than that required to drill the same hole in two operations with drills of different diameters. The greater the difference in the drill diameters, the greater the saving in work, speed and feed remaining the same throughout. This is due to the fact that the mean cutting angle of the single drill is greater than the average angle in use for the two drills and that the stress is proportional to the angle.

(*f*) With twist-drills having the usual proportions, the cutting angle is not sufficiently keen to drag the drill into the work when enlarging a hole in cast iron or steel.

Conclusions of Second Set of Experiments

(*g*) The horse-power when operating on soft cast iron or medium steel varies as $t^{0.7}$ for a given drill and speed; ($t =$ feed per revolution).

(*h*) The horse-power for a given feed and speed does not increase as fast as the diameter but varies as $d^{0.8}$; ($d =$ diameter of drill).

(*i*) The torque and horse-power when drilling medium steel is about 2.1 times that required to drill soft cast iron with the same drill speed and feed.

(*j*) The horse-power per cubic inch of metal removed is inversely proportional to $d^{0.2}\,t^{0.3}$ and independent of the revolutions.

If d remains constant, and feeds of 0.0025 inch, 0.010 inch and 0.040 inch be taken, the corresponding horse-powers will be in the order of 1, 0.66 and 0.435. If t remains constant and values of $d = 1\frac{1}{2}$ inch, 2 inch and 4 inches be taken, then the horse-power for each successive drill will be in the order of 1, 0.76 and 0.66.

(*k*) The power required to enlarge a hole may be estimated from the pressures given by equation $f = \dfrac{0.44}{t^{0.33}} \times$ cutting angle in degrees, for cast iron, and 2.1 times that value for medium steel.

(*l*) In a two-lipped drill the actual depth of cut taken by each lip is $\dfrac{t}{2}$; in a three-lipped drill, $\dfrac{t}{3}$; and so on. If the number of lips is increased, and t kept the same the pressure produced is equivalent to that for a proportionately decreased feed. If the lips are unequally ground, so that one lip does all the work, the cutting pressure is the same as that obtained by doubling the feed. By gashing the lips of the drill in such a manner that the cut taken by one lip is the metal left by the other, the pressure is the same as that given for twice the feed.

The finer the feed the greater the cutting pressure, and consequently the greater the power required per cubic inch of metal removed.

(*m*) The end-thrust when operating on cast iron or steel does not increase in *proportion* to the feed for a given diameter of drill or in proportion to the diameter for a given feed.

(*n*) While the chisel point scarcely affects the torque, it is accountable for about 20 per cent of the end-thrust.

(*o*) The lubricated trials on steel when compared with the dry tests show a diminution in the torque and horse-power, varying from 28 per cent with the 0.0025 inch feed to 8 per cent with the 0.0285 inch feed. This may be due to the lubricant washing away the small metal chips which tend to jam between the walls of the hole and the drill, and to the preserved cutting edge. The end-thrust is reduced by about 25 per cent for all feeds.

(*p*) The drill most commonly adopted in practice has an included angle at the point of 120 degrees. [United States, 118 degrees.—EDITOR.] If this angle is increased the torque diminishes, but the end-thrust increases, while if this angle is decreased, the reverse is the result. So far as economy in power is concerned the torque is the factor to consider, as the feeding horse-power is only about 1 per cent of the whole in small drills and very much less for the larger sizes. From this point of view the drill with the larger point angle is to be preferred. The accompanying increased end-thrust, however, strains the machine parts in proportion. When the point of the drill breaks through the metal at the bottom of the hole, a considerable portion of the end load is removed. The strain due to that load is released, thereby causing the drill to advance more than its rated feed and possibly break the drill. The drill with the greater included angle will be most likely to give trouble in this direction, both on account of the increased strain and torque.

(*q*) By decreasing the spiral of the drill a keener cutting angle with a decreased end-thrust and torque can be obtained without altering the point angle above the accepted standard. This, however, would in turn affect the durability of the drill.

(*r*) With a small included point angle there is little metal to support the cutting edge at the chisel point, and trouble due to blunting of this part is to be expected.

(*s*) In estimating the time required to drill a hole of given depth the length of the drill point must be taken into account. The length of the point for different included point angles is:

for 90 degrees $= 0.5\,d$.
for 120 degrees $= 0.29\,d$.
for 150 degrees $= 0.134\,d$.

* * *

A correspondent, in a recent letter commenting on the reluctance of some good mechanics to subscribe to a journal devoted to their business, mentions a case illustrating the ignorance of a round-house foreman who prided himself on being well-informed. This man came to the writer one day much excited over the wonderful exhibit of a new apparatus which with a tiny flame enabled the operator to either weld or cut steel with rapidity. With it, the foreman said, he would be able to cut a piece of high-speed steel in two, and weld it together again if it were requird, and so on at length. The writer, after some questioning, discovered that the apparatus was the oxy-acetylene torch used for autogenous welding and cutting, the work of which has been described several times in MACHINERY. Had the foreman been a reader of technical journals, he would not have displayed his ignorance of an apparatus that has practically demonstrated its value and which already is being used to a considerable extent for repair work, etc.

MACHINES AND TOOLS FOR AUTOMOBILE MANUFACTURE[*]

C. B. OWEN[†]

C. B. Owen[‡]

Upon first thought the design and construction of tools and jigs for automobile manufacture may not appear to present any problems radically different from those involved in the manufacture of any other power producing and transmitting machinery; but after a thorough consideration of the conditions under which a motor car necessarily operates, the importance of a standardized, interchangeable, simple and strong construction is realized. As one of the requirements of a car is maximum power with minimum weight, the use of nickel and other steel alloys is required, which, in turn, necessitates the use of high-speed steel in the machine tools. As an automobile engine is necessarily a high-speed engine, the provisions for adjustment of wearing parts and the cheap replacement of them when worn out, are of primary importance.

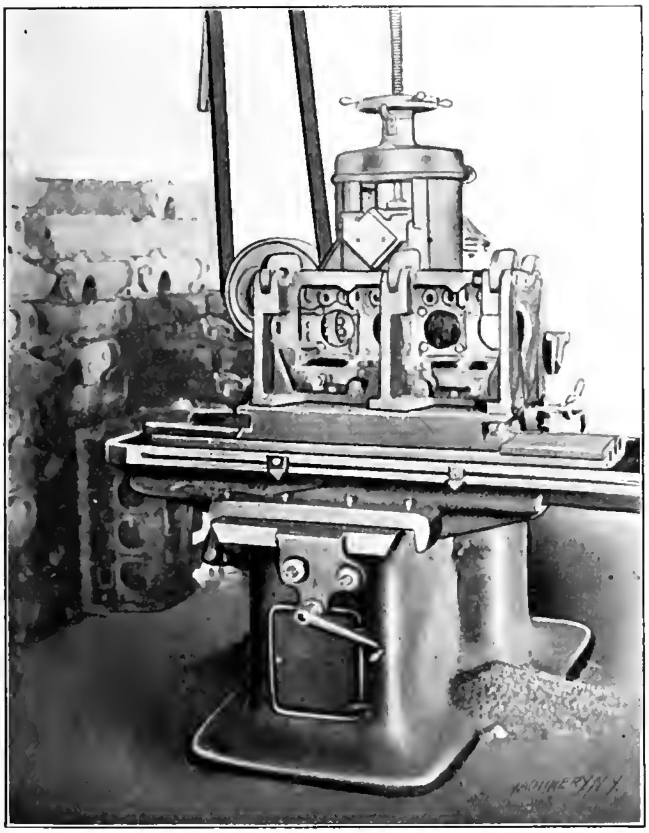


Fig. 1. Milling Engine Frames

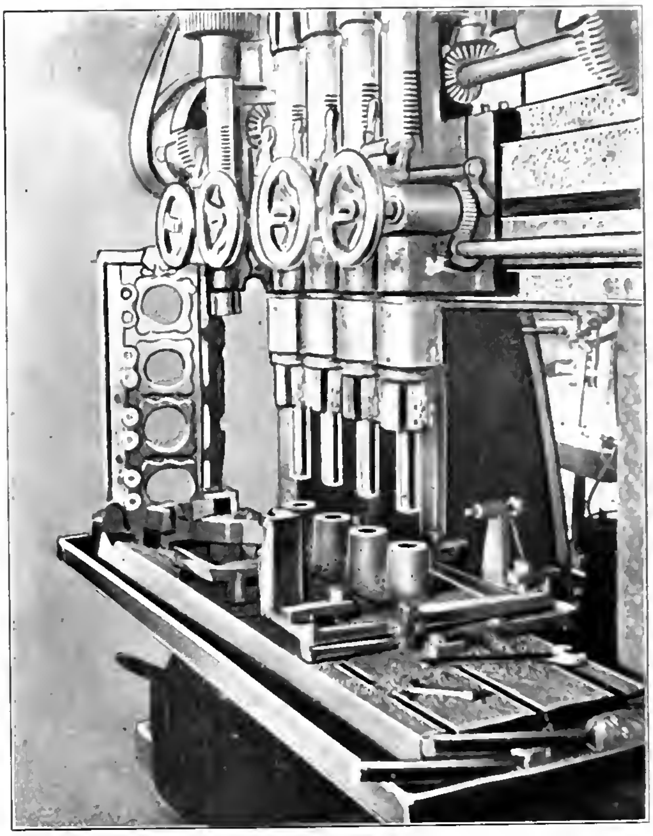


Fig. 2. Machine for Boring Frames

As the great majority of automobile owners are not mechanically inclined and wish the greatest amount of service with the least possible attention to their cars, the necessity of simple and reliable construction is apparent; and, as the motor car is forced by road conditions to do its hardest work on the poorest roads (which are usually farthest from the best repair facilities), under which conditions breakages are most likely to occur the advantages of interchangeable construction, the parts of which are so designed that they can *not* be incorrectly assembled, are apparent especially when road repairs must be made by men not thoroughly familiar with the construction of all cars. These are facts that the motor car designer must have seriously in mind, and which must reflect themselves to some extent in the tool design.

It is the purpose of this article to show how these ideas are carried out in practice, in the factory of the Cadillac Motor Car Company, Detroit, Michigan, and while space permits showing only a few of the several thousand special tools jigs and fixtures, it is thought that those shown will illustrate the care taken to secure absolute interchangeability and perfect alignment of parts. As the construction of the motor includes some very interesting tools, these together with some testing jigs are shown and described.

Engine Frames

As the engine frame is in two parts, divided horizontally at the shaft center, accurate milling and drilling is required. Heavy Brown & Sharpe, Cincinnati, and Leland & Faulconer machines fitted with heavy jigs and large inserted tooth cutters are used on this work. Fig. 1 illustrates the L. & F. machine milling the top face of the engine frame where the cylinders bolt on. This machine is very satisfactory for manufacturing, as the low table permits rapid handling of work, and its heavy construction, large bearing surfaces and all geared feeds and speeds provide for heavy and rapid cutting. The teeth of the cutter are seen through the openings in the work.

Fig. 2 shows the method of boring the seats for the cylinders in the engine frame. This operation follows that shown in Fig. 1. The cutter heads have a floating drive and are centered by the ground pilots entering inserted bushings in the jig bosses. The whole jig slides forward and back against a stop to facilitate inserting and removing the work.

Fig. 3 shows the lower half of the crank-case (shown in Fig. 7 of the article on "Organization and Equipment of an Automobile Factory in Machinery for March, 1909) clamped in the jig for drilling 24 holes for studs and cap-screws. The 24 spindle Baush machine drills these holes in about two minutes, including inserting and removing the work. A similar style of jig is provided for the upper half of the crank-case, which has 18 holes to be drilled in the lower face.

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[*] For additional information on this subject see the following articles previously published in MACHINERY: Special Automobile Factory Tools and Devices, May, 1909; Special Tools and Devices for Automobile Factories, April, 1909. Organization and Equipment of an Automobile Factory, March, 1909; Automobile Engine Building in a Steam Engine Plant, April, 1907.

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Fig. 5 shows the jig provided for boring the cam-shaft bearing seats in the upper half of the crank-case. These seats are indicated by the letter A, and are a very close fit for the five bronze bearings which carry the cam-shaft. The work locates over the two large bosses in the center of the jig, and rests on hardened and ground plugs inserted in the base. The swing clamps shown bear directly over the plugs. The boring tool, which is driven by a face-plate fixture, is seen projecting through one of the guides. The B. & S. plug gage seen on the lathe carriage, allows only 0.002-inch variation in the size of the holes. A similar type of jig (not shown) is used for boring the main bearing seats in the lower half of the crank-case, and an adjustable hand reamer with a very long pilot is used for finishing them. The variation in size allowed on the bearing bushings is only 0.0015 inch and only 0.001 inch on the shaft bearings.

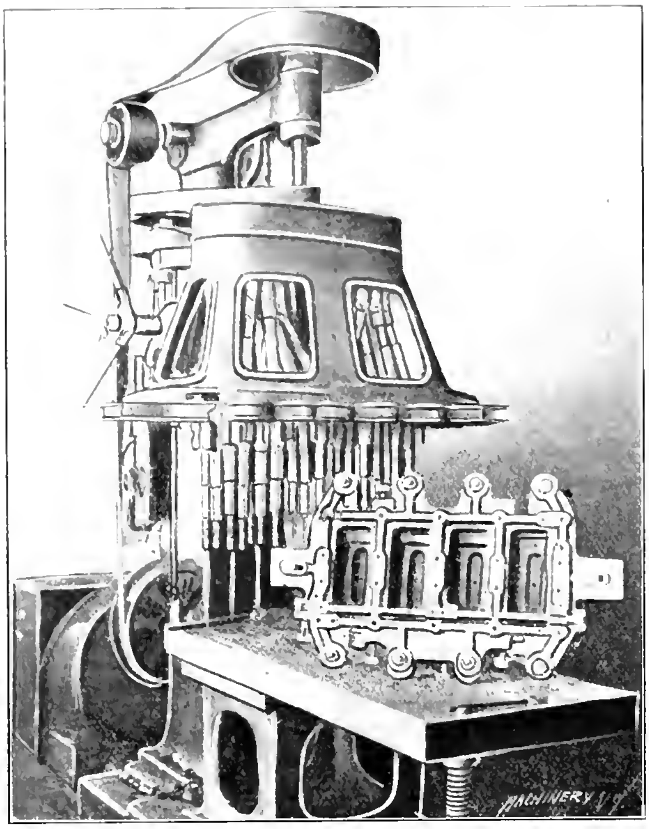

Fig. 3. Twenty-four-spindle Machine for Drilling the Frames

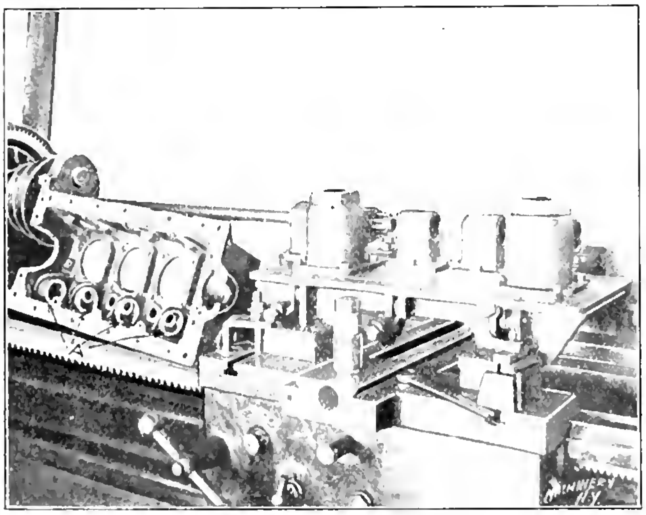

Fig. 5. Fixture for Boring Cam-shaft Bearings in Engine Frame

Cam-shafts

Fig. 6 shows both the cam-shaft drilling and reaming jigs on the same machine table, for convenience. The drill jig (seen in front) is of steel with hardened bushings with an adjustable stop-screw in the end. This jig gives the correct position of the holes for the eight cams and the drive gears. As the holes are to be reamed in pairs and each pair is 90 degrees from others, the reaming jig is designed with a view to extreme accuracy. In operation the first hole reamed is the one by which the drive gear (Fig. 3, March issue) is pinned on. The taper reamer is guided by the bushing in the clamping fixture at the right, and the collars are so adjusted as to ream the hole to the required size. The shaft is then slipped through the square, hardened-and-ground steel block seen at the left in the illustration, and a master pin is inserted. The block is then slipped along in the frame of the jig and clamped by the screws seen on top of the fixture as the various holes come under the reamer. The projecting block seen at the extreme right end of the jig, forms a rest for the cam-shaft as it is passed along. As the taper holes in the cam-shaft, cams and cam-gears, must bear the correct relation to each other, a set of master pins is provided for testing the depth of the reaming. These are hardened and ground tool-steel pins having two fine lines 0.020 inch apart around them at the point where they project through the hole in either the shaft, the cam or the gear. As a variation of 0.001 inch in the diameter of a standard taper pin hole permits the pin to enter 0.040 inch deeper into the hole, the accuracy of this work can be realized when it is known that no hand reaming is required in assembling the cam-shaft. The

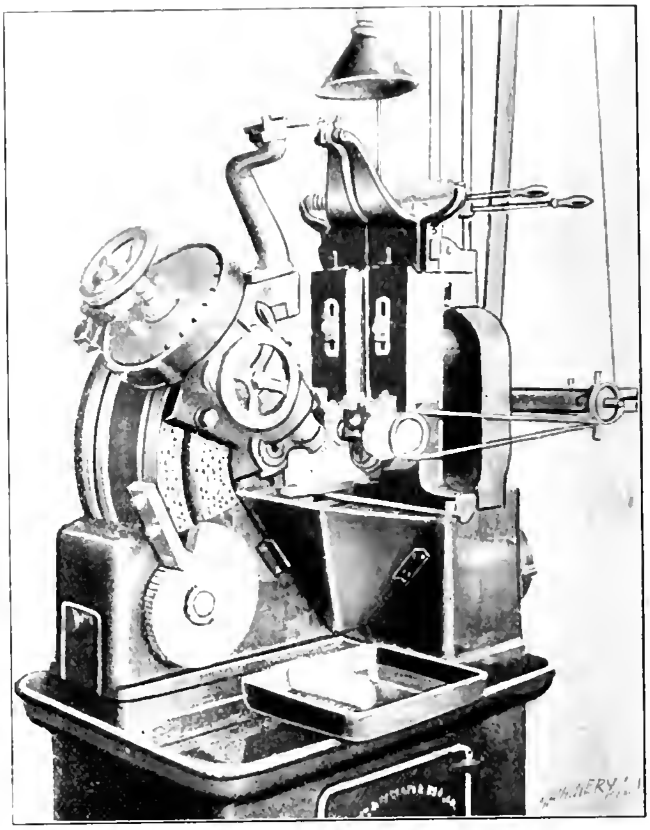

Fig. 4. Bevel-gear Milling Machine of the Templet Type

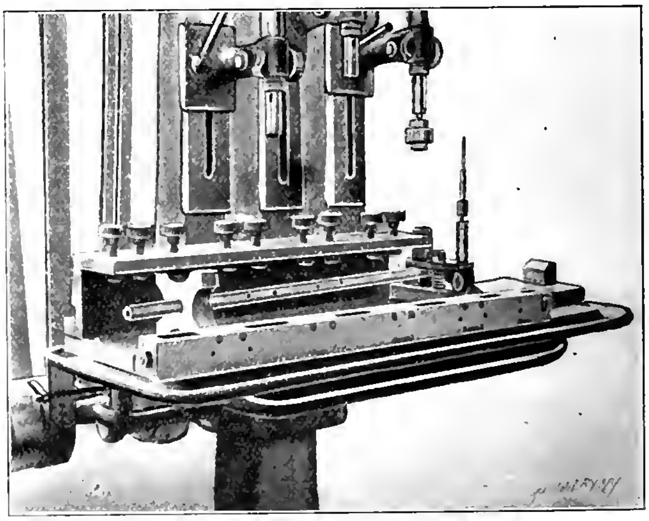

Fig. 6. Fixtures for Drilling and Reaming Cam-shafts

cams are drilled and reamed in similar jigs, which, in all cases, locate the cams by the eccentric portions. The inlet cams are alike and interchangeable, as are also the exhaust cams. The cams are of selected steel, properly hardened and finished by grinding the working surfaces in the correct relation to the pin holes.

Cylinders

Fig. 7 illustrates the method of boring the cylinders in a double spindle Beaman & Smith machine, with a turn-table fixture whereby two cylinders may be changed while two others are being bored. As the cylinder castings are very uniform in size, the boring leaves the walls very uniform in thickness. After being bored and reamed the cylinders pass to the testing bench where water pressure of 700 to 800 pounds per square inch is applied to test them for leakage. Those passing the test are taken to the screw machine department and put on an expanding arbor in a large Potter & Johnston machine for facing and tapping the top and turning the portion of the cylinder which enters into the crank-case of the motor. The machine and tools for these operations are seen in Fig. 8. The turret tools in the foreground are those used in roughing off and boring the upper end of the cylinder for the cylinder head nipple. The heavy overhanging turret tool finishes the flange on the cylinder for the copper water jacket. The rear cross slide carries the tools for roughing this flange and also the flanges through which the studs pass for fastening the cylinders to the engine frame, while the forward cross-slide tools finish the stud flanges and a portion of the cylinder where it enters the bored seat in the engine frame.

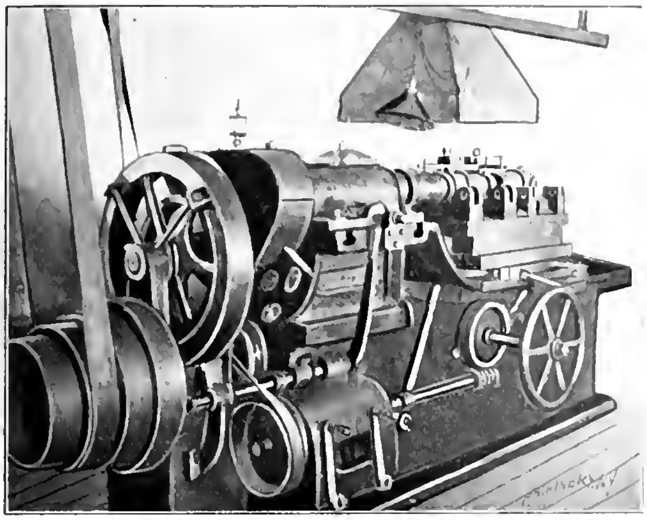
Fig. 7. Boring Cylinders

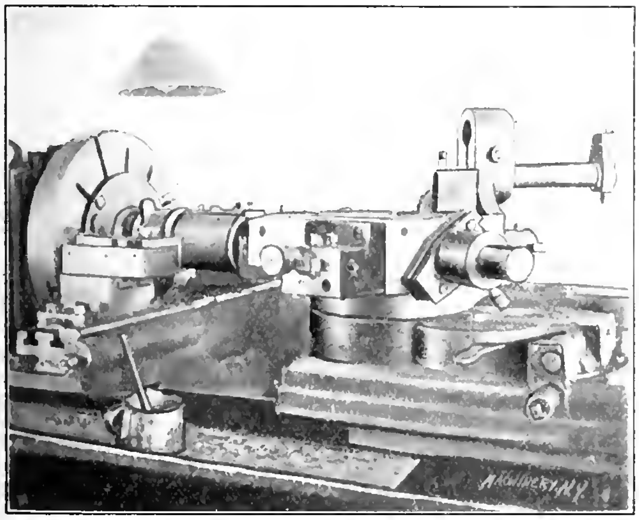

Fig. 8. Turning Cylinders

The cylinders are finished by grinding in Brown & Sharpe and Heald machines. A heavy angle-plate fixture, bored and faced to a very close fit on the cylinder diameter, is fitted to the table of the machine as shown in Fig. 9. The cylinder is clamped to this fixture exactly as it is held later in the assembled motor. Cooling water is supplied to the outside of the cylinder, and the air tube seen at the extreme right conveys the particles of metal and emery to a suction fan at the rear of the machine. The "Go" plug gage seen on the machine table, is 4 inches in diameter and the "Not Go" gage is 4.002 inches in diameter.

Pistons and Rings

The second operation of roughing off the pistons in a Gridley automatic turret lathe is shown in Fig. 10. The first operation is not shown, as it consists only in chucking and roughing off the outer diameter of the head end for about an inch to permit the steadying roll passing over the end. The upper roll has but slight travel, as it forms a part of the end facing tool. The heavy turning tool is carried in the rear tool-holder, which also carries another roller; this roller supports the piston against the side thrust on it, caused in cutting the ring grooves. The view shows the very heavy character of the tools, and the provisions for adjustment. The piston is held by an internal draw-in fixture, thus permitting the turning tool to travel its entire length. (An illustration and description of a similar fixture will be found in the article "Automobile Engine Building in a Steam Engine Plant" which was published in the April, 1907, issue of MACHINERY.) The finish is by grinding in heavy Brown & Sharpe and Norton machines, as illustrated in Fig. 11. The greatest variation in size permitted is 0.002 inch. A finishing cut is taken from the open end of the piston in a special reaming fixture just before grinding, which prevents any possible distortion of the piston due to changes in the metal after the open end has been machined. The piston pin hole is bored in box jigs and 0.001 inch is left for hand reaming previous to assembling the piston and connecting-rod. A final light finishing cut is taken from the piston ring grooves after the piston is ground.

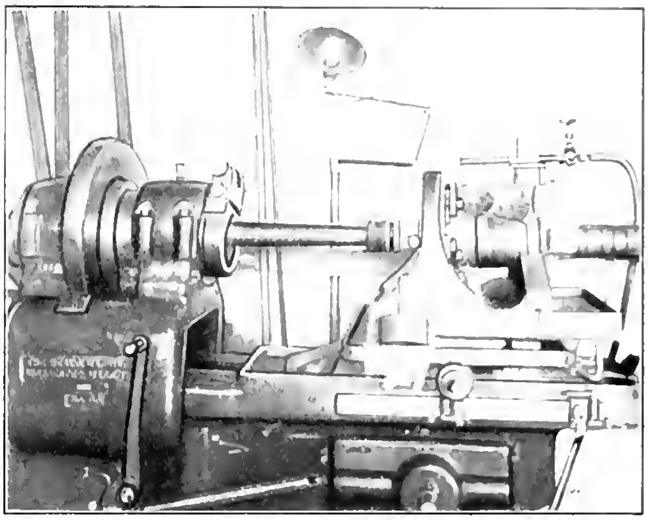
Fig. 9. Grinding Cylinders

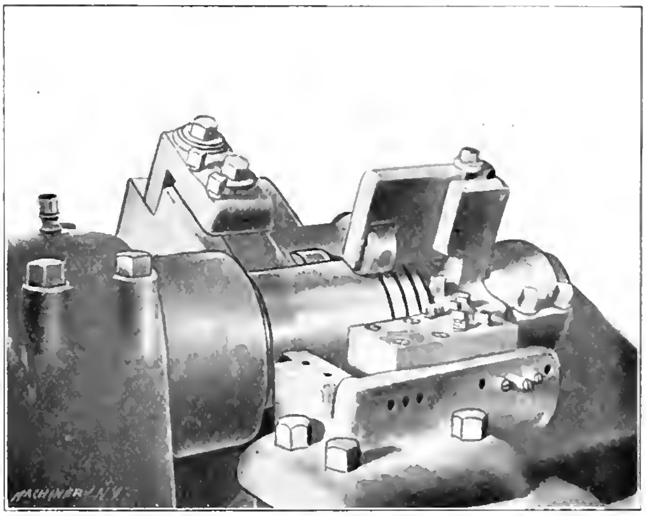

Fig. 10. Turning Pistons

The piston rings are of a special close-grained iron mixture, and are turned and bored on Gridley machines, and finished

by grinding. The ring joint is the standard 45-degree angle joint which has always given good results in practice.

Connecting Rods

The connecting-rods are drop forgings of H-section, having a pressed-in bronze bushing bearing for the piston-pin, and a hinged cap carrying babbitt-lined bronze half-bushing bearings for the crank-pins. While the machining of the rods requires a set of very complete and accurate jigs and tools, limited space prevents their illustration. Two of the fixtures for testing the alignment of the assembled rods, however are shown in Figs. 13 and 14. Fig. 13 shows the method of locating the piston-pin bushing central with the crank-pin bearing, which is held in the hinged end of the rod by large brass dowels. A plug is placed between the half bearings, and the adjusting screw tightened down sufficiently to hold them tightly in place. The piston-pin bushing having been pressed in approximately central and hand reamed, is then slipped on the ground arbor which is pressed into the casting and positively held by a large hexagon nut. The knurled nut *A* is then screwed on the outer end of the arbor, thus holding the piston-pin bushing against a ground shoulder on the fixed arbor. The micrometer screw is then brought up until it touches the edge of the crank-pin bearing, a reading taken, and the screw backed away. The nut *A* is then loosened, the connecting-rod slipped off, turned over and replaced on the arbor and another reading of the micrometer screw is taken. The difference in the two readings thus indicates the amount the two bearings are out of line with each other. For overcoming this variation, the two knurled nuts *B* and *C* are provided. Nut *B* is internally threaded to fit a threaded portion of nut *A*, and in use screws up against the face of the connecting-rod forging for pressing it farther on the bronze bushing. Nut *C* which is internally threaded to fit a portion of the fixed arbor, operates to move the rod forging in the opposite direction. When the rod is thus centralized, a dowel of brass tubing is put in, which prevents disalignment and also conveys oil to the piston-pin bearing.

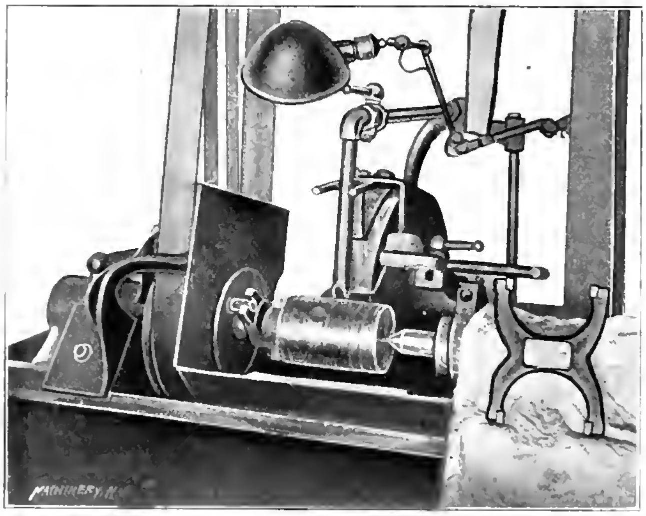

Fig. 11. Grinding Pistons

For testing the parallelism (both vertical and horizontal) of the rod bearings, the fixture shown in Fig. 14 is provided. In operation, two ground arbors which are tight-fits in the rod bearings, are inserted, and the rod laid in the fixture as shown. A pair of flat springs *A*, press the smaller arbor against the inserted hardened and ground plugs opposite them. A similar pair of plugs are seen in the other end of the fixture; between these and the arbor is inserted the taper strip seen in the foreground. The taper is such that the cross lines which are about 1/4 inch apart each give a reading to 0.001 inch. The two flat strips attached to the lower end of the fixture are so placed for convenience in reading any variation in the position of the taper strip. As all four horizontal surfaces on which the ends of both arbors lie are ground to the same plane, any wind in the connecting-rod is seen by the failure of all four points to touch at the same time.

Bevel-gear Templet Milling Machine

A pair of bevel gears are used to drive the short, vertical, commutator shaft from the cam-shaft of the motor, and as the relative positions of the commutator to the cam-shaft and main shaft of the motor must be accurately maintained, the necessity of correctly cut and carefully mounted gears is apparent. The arrangement of these gears is shown in Fig. 3 of the article referred to in the March issue. For producing these bevel gears a specially designed machine is employed, which is shown in Fig. 4. The machine is one of the templet type, which templet or form (seen on the arm at the top of the machine) is primarly developed by rolling contact with a rack. This produces a magnified tooth form which is mathematically correct, and even if it contained any errors these would be reduced in the actual work in the same proportion which the gear tooth bears to the form.

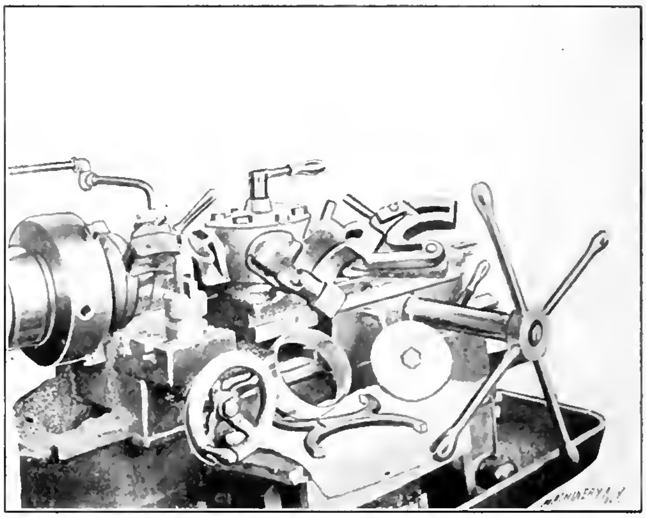

Fig. 12. Turning a Spherical Ring

The machine consists of two principal parts: the work spindle and its driving and indexing mechanism, and the cutters with their driving mechanism. The cutters are driven by round belts, at a high speed, and are mounted on geared spindles which are carried in two vertical slides, which, in operation, have a reciprocating motion on lines divergent from the cone center of the gear to be cut. The cutting edges of the cutters are thus always traveling along lines which become the clearance lines of the gear tooth. The gear blank is roughed out on a special gashing machine as the templet milling machine is not intended for roughing.

The work spindle is carried in the head, which has a working range of 75 degrees between the horizontal and vertical planes. This head is locked to the movable graduated quadrant, which is pivoted at a point coincident with the center of the gear. The work spindle has an end movement of several inches, for convenience in changing the gear blank, and has a draw-in arbor attached to the hand-wheel seen above the index plate, for locking the gear blank in position. The index plate is seen at the top of the work spindle. The index trip is set at the desired position on the rear slot of the stationary quadrant. In operation the large cam under the work spindle raises the pivoted quadrant to which the work spindle is locked, and gradually feeds the work forward between the two cutters, which are gradually forced to change their position by the action of the large tooth form entering between the two rolls on the cutter slide arms. The indexing is, of course, automatic, and occurs at the position of the cam shown in the engraving. This cam has, as shown, an edge consisting of a series of small steps, rather than a gradual curve, and is so geared to the cutter spindle mechanism that the work is fed into the cutters at the ends of the stroke of the cutter slides, rather than during a cut. The index mechanism shows careful thought in its design, in that the index pin enters the slots in the index plate in such a manner as to have no sliding contact on the master edge of the slot. An automatic trip stops the machine when the gear is finished. This machine is one of a series which was built by this company (then the Leland & Faulconer Manufacturing

Company) in 1898-1899, for producing either soft or hardened and ground bevel gears, the machine being designed to produce finished soft gears, or semi-finished gears for hardening.

Commutator Testing

Fig. 15 shows a fixture employed for testing the accuracy of the spacing of the contact points of the commutator. This fixture consists of a central portion carrying the commutator shaft, and of an outer graduated steel disk movable on the central part of the fixture. In operation, a commutator is slipped on over the stationary shaft and the bearings adjusted. The commutator brush is then placed on the shaft and locked in place, leaving the commutator body free to be revolved. A battery and coil which are a part of the fixture, indicate the electrical contact by the buzzing of the coil. The pointer is then put in place and clamped, and the commutator turned until a contact is indicated. The large outer disk (about 18 inches in diameter) is then turned around under the pointer until one of the 90 degree graduations are directly under the pointer. The commutator and pointer are then turned to bring the other contacts to the brush, and their variation read on the large disk, which is graduated in degrees at four equi-distant points around its edge. The requirement is that the commutator contacts be spaced 90 degrees apart, and the variation allowed is only one-half a degree, as the relation of the firing to the piston and valve movements must be very exact.

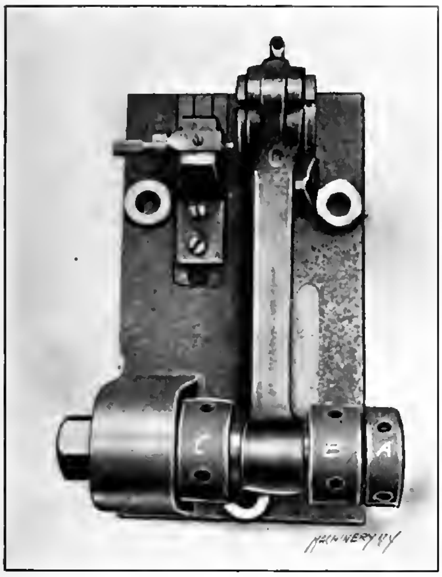

Fig. 13. Fixture for Testing the Relative Lateral Positions of Connecting-rod Bearings

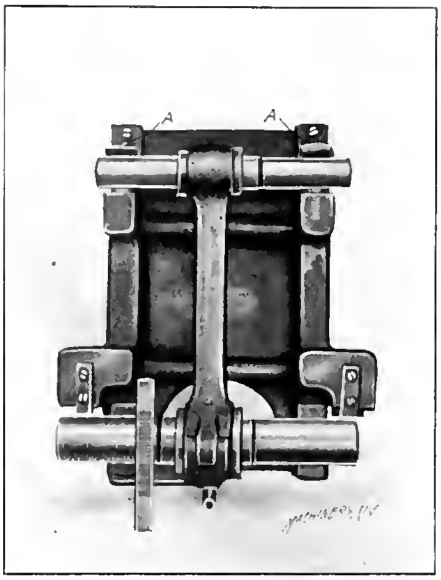

Fig. 14. Fixture for Testing the Parallelism of Connecting-rod Bearings

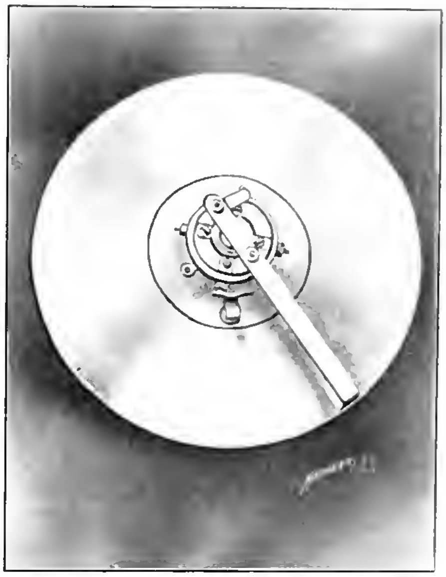

Fig. 15. Fixture for Testing the Accuracy of Commutator Contact Points

Fig. 12 illustrates a nice piece of screw machine work in the brass shop. The ring seen leaning against the machine is of bronze. The diameters of these rings range from 6.497 inches to 6.500 inches and the bore from 5.878 inches to 5.880 inches. The outside is spherical in shape, and the ring forms a part of the rear universal joint housing that the rear axle driving shaft casing pivots and also slides in to compensate for the rear spring action. Slight variations in size and a fine finish are necessary to make this joint oil tight. A casting is seen in the machine, and a roughing cut is being taken from the outside. It has already been rough bored, enough metal being left for a fine finishing cut to be taken after the outside is finished. The castings have heavy flanges for inside chucking, so that little trouble is experienced by their springing after being parted. The illustration clearly shows the construction of the spherical turning tools, and two of the gages used.

* * *

German engineers were comparatively slow in adopting the steam turbine for ship propulsion until its merits had been sufficiently proved; but at the present time the realization of the importance of steam turbines in connection with both merchant and war vessels is clearly evidenced by the fact that nearly all German ship-building yards are now building steam turbines.

A COLLECTION OF MACHINE SHOP RULES

ETHAN VIALL*

A booklet has recently been issued by the H. Mueller Mfg. Co., Decatur, Ill., for the employes of the shop, containing a number of directions for the use of tools. As these rules will doubtless be of general interest the essential points are given below.

Rule 1. A file must not be used as a hammer, chisel or pry.

Rule 2. Do not use a monkey wrench as a hammer.

Rule 3. A wrench used on the head of a bolt or screw, or on a nut, should fit closely, otherwise it will gradually round the corners.

Rule 4. Never use a large wrench on a small bolt, screw or tap, without considering the amount of strain that the bolt, screw or tap will stand.

Rule 5. When chucks are placed on the lathe spindle, be sure that the threads on the spindle and in the chucks are cleaned and oiled. Then screw the chuck on by hand within one-quarter turn of the shoulder, and finally give it a quick turn by hand against the shoulder. This will tighten it sufficiently to keep it in place, without causing difficulty when taken off. The chuck should be oiled at least once every twenty-four hours, though a more frequent oiling will do no harm.

Rule 6. All working parts of tools should be kept well oiled. The shanks of the tools should also be oiled slightly and wiped, before inserting into the holders, to keep them from rusting. The holes in the turrets which are not in use should be plugged up with wooden plugs, so that the chips cannot enter and get into the working parts.

Rule 7. Never accept a taper shank drill from the toolkeeper if it has a broken or distorted tang. It may cause damage to the socket.

Rule 8. Gages of all kinds must be handled with care. Never force a piece of work into or onto a gage. Do not slip a ring gage over a set-screw on the machine and allow it to remain while the machine is operating. The constant jarring of the machine will cause the gage to work on the set-screw, and gradually spoil it. Threaded plug gages should be screwed into a cap when not in use, in order to protect the threads.

Rule 9. Tools should not be forced into the holes in the turret, because it is then very difficult to remove them; the hole in the turret may be enlarged, which would damage it for use with regular tools. The tool shank should fit easily, so that it can be inserted by hand.

Rule 10. If a tool cannot be removed from the turret, try some of the following rules for removing it. For centers: If after loosening the set-screw, the center cannot be removed by hand, tap it lightly with a lead hammer; do not tap it too hard; if the center is flattened on one side, use a monkey

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* Associate Editor of MACHINERY.

wrench to give it a turn; centers in hollow spindles should be driven out with a rod, from the rear. For tool holders: These can generally be loosened by applying a monkey wrench to give them a turn. For tap holders: The last piece of every job should not be taken out of the chuck until the tap holder has been extracted from the turret. If it is too tight to be moved by hand, the tap in the holder should be screwed into the work; then run the carriage back, and pull the tap holder out of the turret; this method can also be applied for adjusting the tap holder to the work. For die heads: These can be removed by running the die on the last piece of work, and moving the carriage back in the same way as for tap holders; if a self-opening die, hold the lever of the die-head, so that the chasers cannot open up. For chasers: A bar of lead or a piece of wood should be used to tap the chasers lightly, if they cannot be extracted from the die by hand.

Rule 11. A wrench, hammer or a piece of brass or steel should never be used for adjusting the tools in the turret, even a fraction of an inch. The tools should be tapped lightly with a lead hammer.

Rule 12. No hard material of any kind must be laid on the ways or bed of a lathe. The unused portion of the lathe bed should be covered by a smooth board.

Rule 13. When putting a tool into a turret or holder, turn the flat side of the shank so that the set-screw will rest on it. If the set-screw is tightened at the round part of the shank, it will set up a burr. The set-screw should never rest on the extreme end of the shank, as it is likely to tip the tool out of true.

Rule 14. Handle the shifter of the counter-shaft with care. If the machine is running at full speed, rest the shifter at the neutral position for a few seconds before reversing. Make the reverse as gradual as possible. Slipping and stretching of the belts, working out of the clutch, breaking of clutch fingers, loose counter-shafts, and the heating of bearings, are some of the bad effects of sudden reversal at high speed.

It will be seen that the foregoing rules were primarily intended for the men in the turret lathe department. Several of the rules may seem unduly elaborate, but often turret lathes are operated by comparatively inexperienced help.

* * *

THE LIVE PRESS

C. TUELLS

Business was booming at the old novelty shop, and lots of orders were in, some of which were marked "special rush" in large red letters, so it was only natural that the press department should be taxed to its full capacity for turning out punchings. The floor was littered with scrap-brass and the fly-wheels of the presses were spinning merrily around to the tune the dies played as they snapped through the stock.

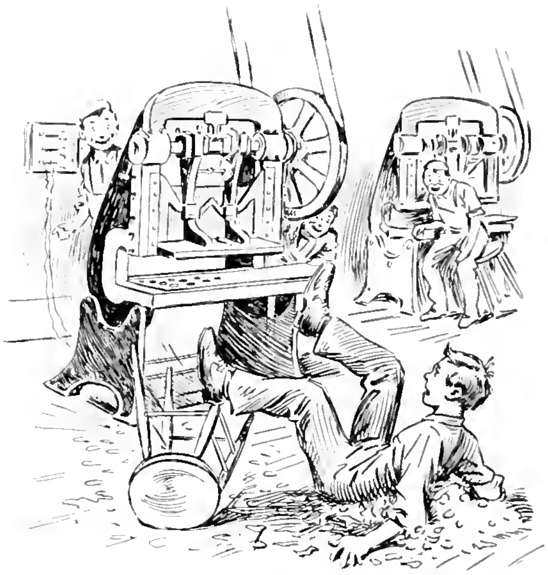
During the rush an unlucky press-hand had cut a scallop out of the end of one of his fingers in spite of the warnings of Jim (the "master-mechanic" of the press-room), to keep his fingers clear of the dies. Press-hands were not hard to get, so the next morning a new boy appeared on the scene to take his place. The foreman had brought him around and told Jim to start him at work, so he was soon initiated into the mysteries of running a punch-press, and though the piece-work price was only thirty cents a thousand, the counter on his press was soon clicking around as fast as any of those on the other presses.

The boys working on the nearby presses were jealously watching him and speculating as to how much he would make and how long he would last—just as the old hands in any shop always keep tab on a new man to see how he gets along and what mistakes he makes.

The new boy was a hustler; in fact the other press-hands decided he was "killing the job"—so fast did he work—and, full of envy, they began to put their heads together to devise a way to "do" him. After much scheming they hit upon an idea, and while he had gone to the stock rack for more brass they detached the wires from an electric switch and connected them to the back of the new boy's press in such a way that a foot on the treadle and a hand on the press-bed completed the circuit.

Back came the press-hand with his arms full of sheet-brass, all stripped and ready to be punched. He sat down on his stool, started a strip of stock under the die, and put his foot on the treadle—but no, he didn't press it—the treadle pressed him. He jumped back about two feet, looked at his hands, at the stock, and at the press; they looked all right, so with an expression on his face that was partly pained and partly puzzled he pluckily sat down and tried it again, with the same result—only more of it.

"Shocking" was a new and decidedly disagreeable experience to him, and he didn't understand it, so he went off looking for Jim, the cure-all for press troubles. The rest of the boys were convulsed with laughter, but before Jim got there they had replaced the wires, and, naturally, he found the press all right, and though the new press-hand looked on with fear and trembling, Jim tripped the press a few times and told him to get to work again.



"Over he went, stool and all, into a pile of scrap-brass"

As soon as Jim had left, back went the wires while the press-hand's back was turned, and by the time he was ready to start, the press was ready too, and the minute his foot touched the treadle, over he went, stool and all, backward into a pile of scrap-brass, letting out a yell that would have done credit to Sitting Bull. The other boys could hold in no longer, and amid their shouts of derisive laughter he got up, gave one last look at that press, and bolted for the door, grabbing his hat as he ran—the worst frightened boy that shop had ever seen, and if the expression on his face counted for anything he should be going yet.

Next morning a large placard appeared in the office window. It read: "BOY WANTED."

* * *

A great deal has been written from time to time decrying the mechanic who does his work so that it is merely "good enough." However, there is something to be said in favor of the man who does his work merely "good enough," provided it is always as good as required. It is not in harmony with modern manufacturing conditions to finish work to a thousandth of an inch, when a limit of a thirty-second inch is amply accurate, and it is no special virtue in the man to carefully work within close limits to the dimensions on the drawing without using his judgment as to which dimensions should be as accurate as possible and which would be "good enough" if they were within one-sixteenth inch. In fact, the man who is able to judge for himself, in every case, exactly when his work is "good enough" for each specific purpose, is really the best mechanic. In years gone by, exceptional skill only was supposed to be the final qualifications of the master of mechanics, but to-day skill alone is not enough. It is skill combined with sound judgment and good common sense that is required in any successful mechanic, and the man who is able to decide for himself in every case exactly when his work is "good enough" for the purpose intended, is really the best man to have around a manufacturing plant.

POWER HAMMERS AND FORGING APPLIANCES*

JAMES CRAN†

Power hammers, previous to the advent of steam, were of the helve and trip types, usually operated directly by the shaft of a water wheel, and principally used in the manufacture of wrought iron and steel. They were crude and cumbersome, but they were equal to the needs of a past generation of iron and steel workers, who were more noted for the thoroughness with which they did their work than the speed with which it was accomplished.

The steam hammer was invented by James Naysmith about 1842. Naysmith's hammer was direct acting, and was a decided improvement over the helve and trip types; but it was defective in several ways. The valves were operated by hand, and it was often difficult to raise the ram immediately after a blow was struck. This had a tendency to chill the metal being worked. The steam hammer remained in this condition until Robert Wilson applied a valve motion which enabled the blows to be regulated both in speed and force, thus bringing the hammer at all times under perfect control of the operator.

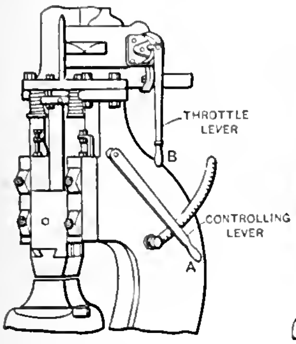
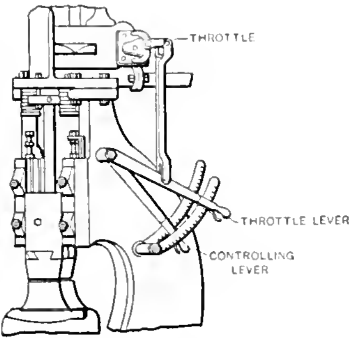


Fig. 1. Single Frame Steam Hammer, showing Common Arrangement of Levers



Machinery,N.Y.

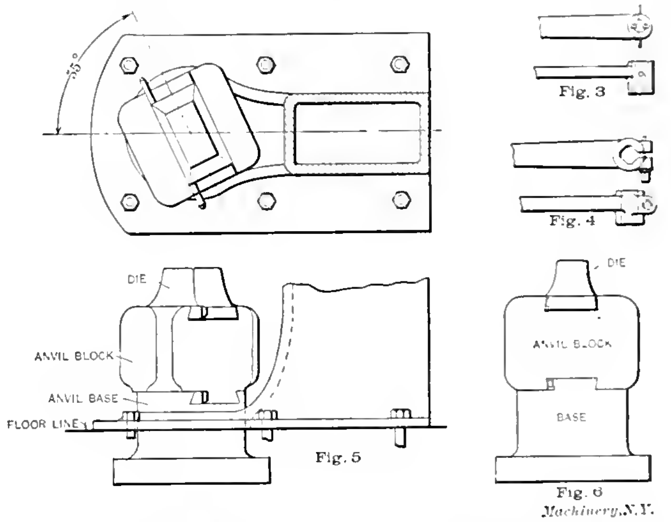
Fig. 2. Improved Arrangement of Throttle Lever

The steam hammer has been the most potent factor in the development of the iron and steel industry. When considering the important part it has played in the development of machinery, and the effect it has had upon progress and civilization, it is natural to suppose that no pains would have been spared in perfecting this useful tool. This has, however, not been the case, and the steam hammer of to-day is but slightly superior to that made by Naysmith and Wilson. The improvements made since it was originally invented have mostly been on the valves, the guides for the ram and the general construction of frames. Minor details, in the majority of cases, have been left to take care of themselves.

Take, for example, the arrangement of the hand levers on most of the single-frame hammers in general use. It will be found that the greater part of them are made as shown in Fig. 1. To manipulate levers arranged as shown, the operator is placed not only in a cramped, awkward position, but so that he can only with difficulty see the work being done. The controlling lever *A* being held in the right hand, makes it necessary for the operator to use his left hand for the throttle lever *B*. When working under a full head of steam, his left arm comes directly in front of his face, obscuring his view of the work. He must remain in this position until the operation on the work is completed; should he release his hold upon the throttle lever, the jar of the hammer would immediately bring that lever to the perpendicular position and shut off the steam. The operator's view of the work being obscured is also often responsible for his mistaking the signs which must necessarily be used while work is being done at a steam hammer on account of the noise. On some makes of hammers this defect has been overcome by placing both levers on the same stud, and operating the throttle by means of a connecting rod connecting the lever with a short lever directly attached to the stem of the throttle valve, as shown in Fig. 2. This permits the operator, at all times and under all conditions, to get an unobstructed view of the work.

The methods of attaching the levers may also be improved. The usual method for attaching them is shown in Fig. 3. The lever hubs are fitted or at least placed on round stems and kept from turning by keys. A taper pin is driven through the hub on the lever and the stem, to keep it in place. It is, generally, but a very short time before levers attached in this manner work loose, no matter how well they may be fitted. Lost motion is an annoyance on any kind of machinery, but is actually dangerous on a steam hammer. If the levers were made with a binder across the end of the boss, as shown in Fig. 4, and fitted to square stems, there would be little danger of lost motion, or of the levers working loose; and their removal when repairs are necessary would be an easy matter compared with removing pins and keys.

There is also room for improvement on the common method of fitting and attaching the anvil-block to the base. Almost invariably the male part of the dovetail is a projection of the anvil-block and fits into a recess in that part of the base which projects through and a little above the flange which forms the base of the frame, as shown in Fig. 5. Should the key which is necessary to hold anvil-block and base firmly together be driven in too tight, the chances are that the side of the recess will be broken away. When this happens, there is no possible means of effecting repairs and the base must be replaced by a new one, which can only be done by disconnecting all pipes to and from the hammer and raising the whole frame to allow the old base to be removed and a new one placed in position. Apart from the work and expense, the hammer is out of commission from one to two weeks. If the dovetailing were reversed, making the male portion part of the base, as shown in Fig. 6, it would be almost impossible either to break or damage the base accidentally, as the driving of a key however tight would only tend to compress it. Should the anvil block happen to be broken, the replacing of that would be but a trivial matter compared with replacing the base.



Machinery,N.Y.

Fig. 3. Common Method of Attaching Throttle and Controlling Levers Fig. 4. Improved Method of Attaching Levers Fig. 5. Anvil and Dies of Steam Hammer set at an angle with the Frame; also shows Usual, but Objectionable, Method of Dovetailing Fig. 6. Improved Style of Anvil Block and Base

Upon nearly every other class of machinery weaknesses and defects of the kind mentioned have either been overcome or guarded against by placing the pieces most liable to break in positions where removing or replacing them can be done at the least expense. The probable reason for the details of steam hammers not receiving the attention that is usually given to machinery used in other branches of metal working may be that designers as a rule never have any practical forge shop experience apart from that taught in the industrial departments of schools and colleges, which at the best is only elementary and does not, usually, bring them in contact with forging appliances other than those used by hand around the anvil. Much valuable information relative to steam hammers and other forging appliances could be gathered from the blacksmith, who has every opportunity of not-

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* For further information on this and kindred subjects, see MACHINERY, May, 1909: Anvils and Forges, and the articles there referred to. See also MACHINERY'S Reference Series No. 44: Machine Blacksmithing, and No. 45: Drop Forgings.

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ing their efficiency and their weak points as well; but suggestions from him, no matter what his experience may be, are seldom considered, rarely adopted, and often have a similar effect upon the manufacturer and designer that a red rag has upon a bull.

Nearly all kinds of machinery used in the different branches of metal working, outside of the forge shops, are constructed so that they can be adjusted or set to work to any angle. Tool equipments for any particular class of work are made and supplied, and all the data and instructions that will insure that the machine will give satisfaction in turning out work to its full capacity are given. When a special tool or a fixture for some particular piece of work is required, it is designed and constructed in strict accordance with mechanical principles. Steam and power hammers, however, are supplied with no tool equipment whatever, more than a plain-faced pair of dies which are of comparatively little use in the making of forgings without an equipment of tools to be used in connection with them. Such tools the builders of hammers do not supply, nor do they generally give any information that could be turned to good account in making them. It is usually "up to the blacksmith" who has to use such hammers and appliances to design and construct such tools and fixtures as facilitate the making of forgings and make the machines paying investments.

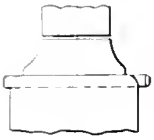

Fig 7. Common Form of Dies

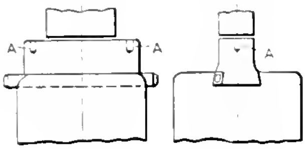

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Fig 8. Improved Form of Dies for General Use

Steam hammers are built in a variety of styles to suit the different classes of forging. The smaller sizes are of the single frame type, while those intended for the heavier work have an arched or double frame. For medium weight and light forging, the single frame hammer with the anvil and dies set at an angle of from 55 to 60 degrees from the frame, as shown in Fig. 5, will be found to be the most suitable, as work of any length can be forged either across or lengthways of the dies without its coming in contact with the frame.

Nearly all dies supplied with steam hammers are tapered from the shank to the face, as shown in Fig. 7, and are only suitable for plain straight forging, as it is impossible to work close up to a shoulder on a forging, on account of the taper, or to break down work except by using special tools, as the faces of both dies are the same length. If the dies were made as shown in Fig. 8, where the lower die is considerably longer than the upper one, with the sides of both perfectly straight, several advantages are gained over the more common shapes. The square sides allow of working close up to shoulders, and the extra length of the lower die permits of breaking down work without the use of special tools. Work is also much more easily straightened, and there is more space upon which to place formers or special tools. The hole at each end of the lower die, as shown at *A*, adds considerably to the utility, as these holes can be used for stakes to keep formers from moving while they are being used. Work of irregular shape can also be butted against the stakes while the hammer is used to finish some portion that otherwise would have to be done by hand. Forks could also be used to keep spring swages from being moved with the work when it is forced or drawn through them.

To make a steam hammer as useful and handy a machine in the forge shop as a lathe with a taper attachment is in the machine shop, a lower die as shown in Fig. 9, can be used to draw and finish tapers to any angle. The rougher part of the work is done on the rounded end *B*, and the finishing on the adjustable end *D*. The level portion *C* in the center can be used for flat work. The adjustable section *D* of the die is about one-third of the entire length, circular in shape, and corrugated on the lower side which is provided with a T-slot. A T-headed bolt fits into the slot, and the adjustable section is held firmly in place at any angle by a wedge-headed bolt *E*, which is passed through a slot in the T-bolt and is tightened by a nut on the end which projects through the other end of the die. When the end of the adjustable section is raised above the level of the face of the die, as shown by dotted lines, a piece shaped as shown at *A* can be placed on the center of the die to prevent the upper die coming in contact with it.

To set dies of this kind accurately to any desired angle, the adjustable gage shown in Fig. 10 should be used. The gage is jointed at all the corners, and locked at any angle by means of a thumb-screw. It can be adjusted by means of a protractor and is used by placing it between the upper die and the adjustable section in the lower one while the bolt that keeps it in position is loose.

The arrangement of piping to and from hammers is also worthy of consideration. Generally both the supply and exhaust pipes are placed overhead, where they offer an obstruction to the free use of jib cranes, which are essential in the handling of heavy work. Besides, any steam that is condensed in the supply pipe, is supplied to the hammer in the form of water, especially when the hammer is installed any distance from the point at which the steam is generated. When water is supplied to a hammer in any considerable quantity, it generally finds an outlet other than the drip cocks and is one of the greatest annoyances to the workman. If it gets on the dies it is spread in a fine spray in all directions when a blow is struck.

The trouble with leaking water can be overcome to a great extent by placing both supply and exhaust pipes under the level of the floor and providing the supply pipe with a trap which would take care of the greater part of the water caused by condensation. The fact that the steam is supplied from below instead of from above would tend to prevent water reaching the cylinder of the hammer in quantities sufficient to cause trouble. The absence of overhead pipes would allow of the free use of cranes or any other conveying devices.

Among forging appliances the steam hammer is paramount; it can be used for any kind of forge work from the lightest to the heaviest; but for some of the lighter grades of forging some of the lighter types of power hammers may be used with equal, and perhaps better, results than could be obtained with the average steam hammer, because they are lighter and capable of striking blows much more rapidly. When the term power hammer is used without qualification it applies to the types of hammers that are operated by a belt from a countershaft almost directly over them. The belt is just long enough to clear the lower side of the pulley attached to the hammer; it runs constantly and is rendered operative by a tightening pulley or idler controlled by the foot of the operator. Hammers of this type are generally referred to by forgemen as trip hammers. The term is misleading, and is only a survival of the name applied to one of the earliest types of power hammer now almost obsolete. Power hammers are built in a variety of different styles, each of which is designed with reference to its adaptability to certain kinds of work that may be done by them somewhat more economically than by the other types.

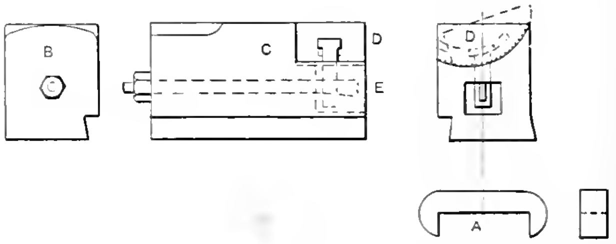

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Fig. 9. Adjustable Lower Die for Drawing and Finishing Tapers

The types of power hammer best adapted for general forge work are those with the ram running in guides. This arrangement insures their striking a square blow upon any size of material within their capacity. They require less adjusting than most of the other types, and their utility is such that they can be advantageously used for any operation in the making of light forgings with the exception of upsetting.

The helve hammer is extensively used for the making of any kind of light forging that can be done in open dies such

as round work, edged tools, cutlery and springs. On this type of hammer the head is mounted on the end of a wooden beam which is cushioned both on the upward and downward stroke either by blocks of rubber or springs, making the blows, which can be delivered with great rapidity, very elastic. These hammers, however, are poorly adapted for general forge work because the head is raised and returned upon a radius which makes adjustment for each size of material necessary. If not properly adjusted, the side of the work nearest to the fulcrum will be drawn thinner than the side away from it. Generally the arrangement of dies in helve hammers as they are supplied by the manufacturer are as shown in Fig. 11, the rounded ends being toward the fulcrum. This is all that is necessary when the hammer is to be used exclusively for the drawing of stock to smaller dimensions, but for general forging they should be reversed as it is often necessary to spread stock to greater width, which can only be done to advantage when the rounded ends of the dies are accessible. The dies could be used equally well for all the purposes for which helve hammers are generally used if placed cross ways in the head and anvil.

When floor space is an item of importance, the upright power hammer, of which there are various styles, is more compactly built, equally as efficient, and can be installed and manipulated in less space than most of the other types.

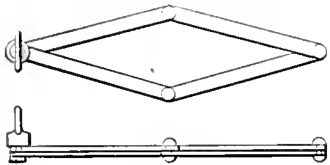


Fig. 10

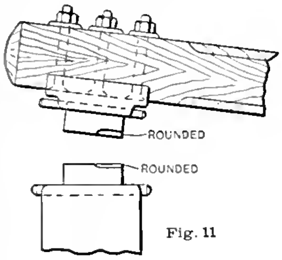


Fig. 11

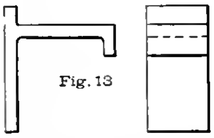


Fig. 13

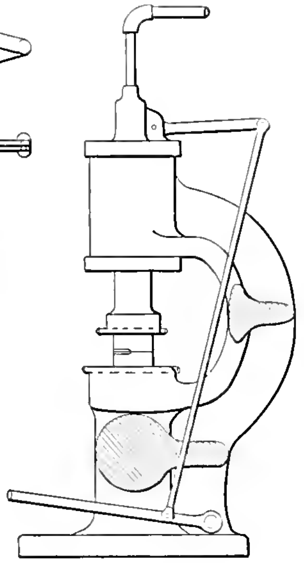


Fig. 12

Machinery, N.Y.

Fig. 10. Gage for Setting Adjustable Die to any angle. Fig. 11. Common, but Objectionable, Way of Placing Dies in Helve Hammer. Fig. 12. General Appearance of Pneumatic Hammer for Light Forging. Fig. 13. Piece that can be forged to Advantage in the Forging Machine

Lately marked attention has been given to the development of pneumatic or compressed air hammers, which without doubt is a step towards progress. Pneumatic tools have proved their efficiency and utility in other branches of manufacturing, and there is no apparent reason why they cannot be advantageously used in forge shops, providing they are designed and constructed for that class of work. Compressed air is quite often used for the operation of ordinary steam hammers and has proved to be a very efficient substitute; but when it is possible to operate a hammer by steam direct, it can be done as effectually, and at less cost, than would be the case indirectly through an air compressor.

With the modern pneumatic hammer it is an entirely different case, as it is built self-contained with air compressor attached, and can be operated either by belt power or an attached motor, the advantage of which needs little explanation. No piping to speak of is required, power is used only while the hammer is being operated, and its utility for work within its capacity combines most of the advantages of steam and belt driven hammers.

There is another type of pneumatic hammer that so far has not received much thought or attention, but which has proved itself to be a valuable addition to the equipment of forge shops where it has been tried. The working parts are constructed upon the same principle as the hand pneumatic hammer used for chipping, and is simply larger and mounted upon a frame in the shape of a G clamp supported by a column and base as shown in Fig. 12. Hammers of this type are so compact that they can be installed and operated in about half the space required for any other type of hammer of the same capacity. They can be used for the very lightest of forge work and the exhaust from the cylinder can be utilized to keep the dies free from scale, which is important when smooth, clean forging is essential.

For making duplicate forgings in large quantities, there is no forging appliance that is so extensively used as drop hammers. As the term implies, the heads of drop hammers are raised to sufficient height for the required blow, released and allowed to fall on the work being forged, after the principle of pile drivers. There are various methods of raising the heads of this class of hammers. The most common for forge work is by friction. A hardwood board is attached to the hammer head and passed between two rolls which rotate in opposite directions on the top of upright guides. These rolls are rendered operative by a mechanism controlled by the foot of the operator. When the head has been raised to sufficient height, a projection on the head engages a dog which releases the board from the rolls and allows the head to drop upon the work. Blows may be struck automatically or their force can be regulated at the will of the operator. Drop hammers are designated by their falling weight and are built in all sizes up to 3,000 pounds, which is the limit at which a friction drop can be successfully operated.

Duplicate forgings larger and heavier than can be economically made by drop hammers are either made by steam drops, which are practically steam hammers designed for the making of forgings in dies. Hydraulic presses may also be used.

The only disadvantage in using hammers of the kind mentioned is that the dies used in connection with them must necessarily be made with from 3 to 5 degrees of draw in the impressions to allow of easy removal of the forgings after each blow is struck; otherwise scale would accumulate in the impressions and be worked into the surface of the pieces being made. Hot material left for any length of time in dies has also a tendency to soften them. It is therefore obvious that forgings of a shape other than round or oval cannot be made perfectly parallel on all sides except by more than one forging operation.

In the making of duplicate forgings such as are used on cars, wagons, agricultural implements, etc., where smooth surfaces are not so essential as shape, strength, and level bearings, there is no forging appliance that can be used to greater advantage than the modern forging machine. Take, for example, a forging of the shape shown in Fig. 13; it is plain, and looks as if it should not be difficult to make. This however, is just the kind of work for which the drop forging process falls short. By being roughly bent to shape it can, however, be forged complete at one stroke of a forging machine.

The bulldozer is also worthy of attention although it can not be used to advantage for work other than bending. In the modern forge shop it is indispensable for that work alone, as there is no bending job, however complicated, that can not be done by it with properly constructed fixtures.

If an equal amount of thought, ingenuity and skill were devoted to the improvement of forging appliances and methods of working hot iron and steel, that has been given to the manufacture and finishing processes in the machine shop, it would be just as easy for the blacksmith to make light forgings within 1/16 inch, medium weight within 1/8 inch, and heavy pieces from 3/16 inch to 1/4 inch of finished size, as it is to turn out the shapeless pieces that must be hogged to shape by high-speed tools in the machine shop, where the part of the material that has been refined by hammering is removed, leaving the soft core for the finished product, at a cost out of all comparison with a good clean forging.

* * *

The making of flying machines is rapidly becoming a commercial proposition. The French company which has bought the French patent rights for the Wright brothers' aeroplane has, according to *Industritidningen Norden*, so far contracted for the building of more than 25 flying machines.

COIN AND MEDAL DIES

CHESTER L. LUCAS*

Chester L. Lucas†

The making of dies for coins, medals, trade checks, etc., is a branch of the die-making trade apart from the general run of work. The conditions to be met are peculiar to themselves, and even in making dies for jewelry work more latitude is given, both in measurement and design, than is allowed in the best of medal work.

The steel used in this class of work is necessarily of the very best, as steel that would give satisfaction when made into dies for other work is often inadequate to stand the enormous pressure to which coining dies are subjected while in use. Different die-makers prefer different makes of steel for this class of work, and the best steel obtainable is none too good for coin and medal dies. Personally, the writer prefers Jessops' steel for these dies, on account of its uniformity and the fact that dies made from this steel can be hardened to a greater depth than is possible with other steels. Another point in favor of Jessops' steel is that it will not crack as easily if overheated during the hardening process; in other words, it will stand more abuse.

In making a set of coining dies for use either in the regular type of coining press or in the drop press, the first part to be considered is the ring shown in cross section in Figs. 1 and 2. The object of this ring is to confine the metal blank while being embossed between the top and bottom dies. The tendency is for the metal to squeeze out sideways from between the two dies when the blow is struck; but as this ring, which is a close fit around the dies, confines the metal to the space between the dies, it is obvious that if sufficient pressure is applied, the metal must fill every impression in the dies, as it can go nowhere else. In making the ring to be used in a coining press, which is the modern machine for producing coins, the outside diameter is turned to fit the steel ring holder of the press, usually from three to four inches, according to the size of the press. For independent use in the drop press, the stronger this ring is made the better. A good rule is to have its diameter at least four times the diameter of the coin, and its thickness equal to the coin's diameter; thus, a coin one and one-half inch in diameter will require (when used in a drop press) a ring six inches in diameter and one and one-half inch thick. The hole in this ring gages the size of the coin, and should be ground and lapped to a mirror finish after the ring has been hardened and drawn to a dark straw color.

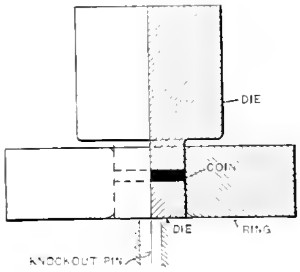
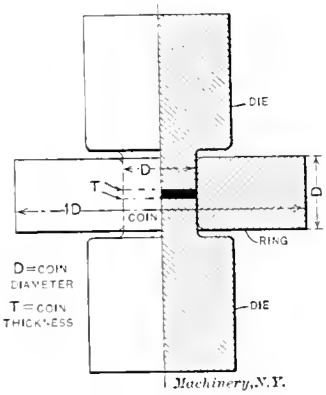


Fig. 1. Coining Dies and Ring for Coining Press

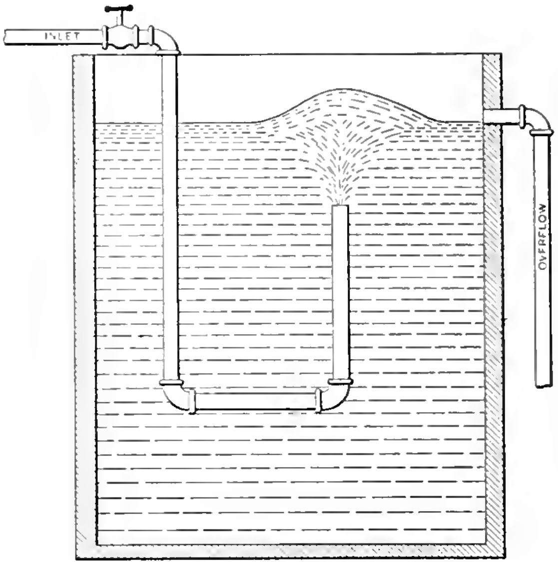


Machinery,N.Y.

Fig. 2. Coining Dies and Ring for Use in Drop Press

The next step is the turning of the die blanks. Fig. 1 shows a pair of dies and a ring for coining press use. In turning this pair of dies it is best and quickest to make the two dies in one piece and then, with the cutting-off tool, cut off that part to be used for the lower die, which as the illustration shows is simply a small piece of steel the same diameter as the coin and about half as thick as the coin's diameter. Every coining press is fitted with a knockout which automatically raises this lower die at the end of each stroke of the press, thus ejecting the coin and leaving the dies free to receive another blank.

Fig. 2 shows a pair of dies and ring for use independently in the drop press. The drop press is not an economical machine for making coins or medals, but is many times used in shops where there is no coining press or where the coin is too large to be struck in the coining press with which the shop is equipped. The process of striking up coins with the drop press is slow, because after each coin is struck, the ring must be taken from the lower die (on which it rests during the striking) and the coin driven out with block and mallet. While this method seems crude, the work is equal in quality to coining-press work, and it often helps a small shop to "get by" on jobs which it otherwise could not do.



Machinery,N.Y.

Fig. 3. Hardening Tank for Coining Dies

When finishing the faces of the die blanks, all borders, plain or knurled, and rings or circular panels should be turned before removing the blank from the lathe. The finished dies should be a sliding fit in the ring. The blank dies are now ready to be lettered and engraved with any required designs. After laying out the lettering on a piece of lead or cardboard to make sure of the way it is going to appear on the die, it is stamped into the steel die blanks with die-letters. Die-letters differ from ordinary stamping letters in that they are made reverse; and great care is exercised in the making to have each one as nearly perfect as can be made regarding size and shape. It is obvious that with good die-letters and careful stamping, taking pains to have the letters properly spaced and of even depth, the results will be satisfactory.

After all lettering has been stamped into the die and the roughness caused by stamping removed, the dies are ready for the engraving of any design that it is necessary to reproduce on the finished medal. When the design is very deep, most of the steel may be removed by hammer and chisel and only the finishing done with rifflers, gravers, etc. It is, however, best to avoid deep designs whenever possible, for they are very hard to strike up. If it is absolutely necessary to employ such designs, they should be placed on a sunken panel, as was the figure on the religious medal next to the "Eric Pape" medal in the center of the half-tone illustration, Fig. 4. At this stage of the die-making, the dies may be placed in the press and a lead impression taken to make sure that they are perfect in every detail before hardening.

In hardening these dies, or any dies which must withstand heavy pressure, the essential point is to cool the face of the die as rapidly as possible after the proper heat has been attained. For this purpose it is advisable to have a strong

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jet of cold water run into the hardening tank in the manner illustrated in Fig. 3. If properly arranged, the water should come up like a geyser, and into this bubbling mound of water the red-hot die should be plunged, face down. After the first few minutes the face of the die will be glass-hard and the back end may be cooled more slowly so as to lessen the danger of cracking. In the case of the small lower die for coining press use, however, it is necessary to harden it all over; otherwise it would spread out when used and stick in the ring. As soon after hardening as possible, the temper should be drawn to a light straw color.

The matter of hardening coining dies is an important factor of the work, for the heavy pressure which they receive would quickly "dish" any die not hard enough, or crack any die that has been overheated or left too hard. To give an idea of the great amount of pressure exerted in embossing United States currency, the following table, which appeared in MACHINERY, October, 1905, is given. The comparative coining properties of gold, silver, and nickel will be noticed by observing that the gold half eagle, silver quarter, and nickel five-cent piece require the same pressure of 60 tons, though the sizes and weights differ greatly:

Double eagle, gold	155 tons
Eagle, gold	110 tons
Half eagle, gold	60 tons
Quarter eagle, gold	35 tons
Standard dollar, silver	160 tons
Half dollar, silver	98 tons
Quarter dollar, silver	60 tons
Dime, silver	35 tons
Five cents, nickel	60 tons
One cent, copper	40 tons

Much of the pleasing effect of a good coin or medal is due to the polished or matt surface, as the case may be, which is given to it by the dies. The contrast between a polished background and a matt or frosted panel is very effective. The glossy finish is given to the dies by means of stoning and polishing with crocus in the lathe. The frosted or matt finish is given by first polishing and then applying nitric acid for a few minutes.

Some designs, especially human heads or figures, are more easily engraved on a hub, which is afterwards hardened and struck into a piece of steel a little larger in diameter than the die to be made. When this impression has been struck deeply enough the piece of steel is held in the lathe chuck, and after centering up the impression, the die is turned in the usual way. An example of the results of this process is the Lincoln medal shown in Fig. 4. The keystone on the Masonic medal with its sunken letters was done in the same way, for the sunken letters were, of course, raised in the die and could not have been produced in any other manner. The hubbing process is also used when duplicate dies are to be made, as it is not only quicker, but each successive die is an absolute fac-simile of the original, and for this reason this process is extensively used in the government mints for making dies for currency.

Fig. 4. A Collection of Coins and Medals struck in the Coining Press and Drop Press

The sheet metal stock from which blanks for coins are cut must be kept free from scratches and other defacing marks, and after cutting, the blanks should be annealed and dipped. The coins and medals in Fig. 4 were made of copper, brass and aluminum, and all were embossed in coining presses with the exception of the central medal, which was struck in a very heavy drop press.

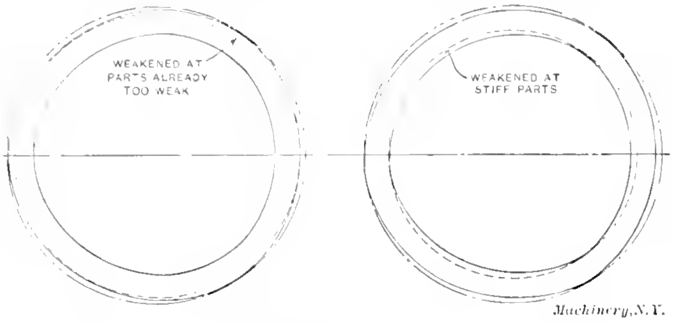
* * *

Manufacturers in the United States and Europe appear to have a just cause for grievance in regard to the Argentine law of trade-marks. According to this law, anyone who first registers a trade-mark in the Argentine Republic becomes the lawful owner of the same, in spite of the fact that the foreign importer may be the sole owner of the mark in all other countries, and that his goods may be known everywhere by that particular trade-mark. In some cases it has been necessary for the foreign importer to purchase the right of his own mark from unscrupulous individuals who have secured the registration for the purpose of extortion.

THE MANUFACTURE OF PISTON RINGS*

JAMES McINTOSH†

While a great many other details of gas engines for automobiles have been standardized, there are hardly any standard dimensions or methods for making piston rings. Some makers prefer wide rings and some narrow, some favor an eccentric ring and others a concentric, some prefer the stepped joint and some the diagonal slot, etc. Cast iron, however, may be considered as the standard material for piston rings, but there are many kinds of cast iron. A suitable grade of cast iron for piston rings should be as hard as is consistent with the machining of the rings, in order to give the maximum wear, and the ring metal must have sufficient spring. To get uniform results, great care should be taken from the start. A good metal pattern should be used and a minimum amount of stock allowed for finishing. The castings should be machine molded, as they will then be more uniform. When too much stock must be removed, the best part of the casting is removed, and the resulting ring will have a short life.



Figs. 1 and 2. Illustration of Result of Grinding Piston Rings on the Outside and on the Inside

When machining, the ring blank can be rigidly held in a chuck by a flange cast on one end, which is somewhat larger in diameter than the blank proper. This flange need not be more than one-half inch thick; the edge should be tapered so that the chuck jaws will tend to draw the blank against the chuck. The ring may be further stiffened by the addition of an inside flange somewhat wider than the outside, so that considerable pressure can be applied without distorting the blank. To prevent the blank from turning in the chuck, a stop may be cast on the edge of the flange which bears against the chuck jaw. If the rings are to be made in quantities, a very suitable tool for the machining is the Gridley automatic turret lathe. This machine can be arranged to turn, bore, and cut off the rings whether they be concentric or eccentric. The lead and timing of the cutting off tools may be such that the cutting off of the rings begins before the blank is completely turned and bored. Blanks five to seven inches long may be used successfully by this method.

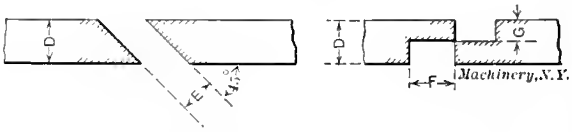
To avoid trouble due to the fact that the rings lack the proper amount of spring, it is well to test the material after the first operation has been performed. A simple test is to have a taper block with a stop on it, and then cut a few of the rings from each cast and spring them over the block, so that the amount of spring will be slightly in excess of that required when the ring is mounted on the piston. The opening at the joint in the ring before and after the test is noted to see that it is not in excess of the limits allowed for different kinds and sizes of piston rings. If the rings stand this test, it is safe to assume that all the rings in the same lot will be satisfactory when finished; but there is no reason why all the rings should not be tested in a similar manner when completed.

The second operation is the finishing of the sides of the rings to a standard width. This can be best done by the use of a magnetic chuck. The Heald ring grinder will be satisfactory for this work; it is regularly fitted with a magnetic chuck and has a micrometer feed to gage the width of the rings. The next operation is the cutting of the slot at the joint of the rings. This can be done on a hand miller with a suitable fixture. There is some difference of opinion as regards the proper form of joints; some prefer the stepped joint, while others favor the diagonal slot. The stepped joint is more expensive to make and more difficult to fit and it is more easily broken than the diagonal joint. If the joint is open, say one-sixteenth inch, when made according to either system, the area for leakage is approximately the same; in one case the gas may have a straight flow, and in the other it must pass around under the ring to get by the joint. The writer personally prefers the diagonal joint.

The next operation is the finishing of the outside of the ring. Great care should be exercised in order to obtain good results with the larger sizes. These are usually closed with a suitable band, clamped between two surfaces, one at a time, and a light cut taken off the outside; but this method is rather slow in automobile building. The usual method in this manufacture is to have a suitable arbor and sleeve, the arbor being built up with a spindle having a fixed collar at one end, and an adjustable one at the other end. The latter should be fitted with a key or pin to keep the collar from turning while tightening the nut, otherwise the rings will be distorted. The collars should be made so that the diameter of the inner edge equals the diameter the ring is to be ground to, and the outer edge the diameter of the sleeve, so that the rings may be readily centered on the arbor, care being taken to see that the large diameter of the collar is far enough from the inside so that the grinding wheel can pass over the rings without touching the large diameter. The collars should be hardened and ground, so that the edge will keep its shape and hold the ring better.

A suitable sleeve is best made of cast iron. The sleeve may be light, but should have a band cast on each end to keep it in shape, and should be provided with a lug with clamp screws at each end. The sleeve is more easily removed when it is split and then clamped by the lug screws. The hole in the sleeve is bored to fit the large diameter of the collars on the arbor.

PISTON RING DIMENSIONS



A = amount piston ring is larger than the cylinder
B = thickness of piston ring at heavy side
C = thickness of piston ring at light side
D = width of piston ring
E = width of cutter for 45 deg. diagonal opening in ring joint
F = width of cutter for stepped opening in ring joint
G = depth of joint step

Cylinder Diameters.				A	B	C	D	E	F	G
8	$7\frac{3}{4}$	$7\frac{1}{2}$	$7\frac{1}{4}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{9}{64}$	$\frac{9}{16}$	$\frac{15}{32}$	$\frac{11}{16}$	$\frac{9}{32}$
7	$6\frac{3}{4}$	$6\frac{1}{2}$	$6\frac{1}{4}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{13}{32}$	$\frac{19}{32}$	$\frac{1}{4}$
6	$5\frac{3}{4}$	$5\frac{1}{2}$	$5\frac{1}{4}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{64}$	$\frac{3}{8}$	$\frac{11}{32}$	$\frac{1}{2}$	$\frac{3}{16}$
5	$4\frac{3}{4}$	$4\frac{1}{2}$	$4\frac{1}{4}$	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{32}$	$\frac{5}{16}$	$\frac{9}{32}$	$\frac{13}{32}$	$\frac{5}{32}$
4	$3\frac{3}{4}$	$3\frac{1}{2}$	$3\frac{1}{4}$	$\frac{3}{32}$	$\frac{1}{8}$	$\frac{5}{64}$	$\frac{7}{32}$	$\frac{7}{32}$	$\frac{5}{16}$	$\frac{7}{64}$

There is one question of marked importance when using this method. Assume that the rings are too large in diameter. Then, when slotted, the circumference of the ring when closed is greater than that of the sleeve inside, causing the joint to crowd. Again, if the ring be too short, or open at the joint, the ring will touch on three or more points, and the irregularities which the grinding is supposed to correct will be increased, and the ring may be worse than before grinding. The writer would recommend that if a joint is desired with least amount of end clearance, the ring be ground a certain fixed amount open and that allowance for that amount is made on the diameter when grinding.

To correct irregularities on the outside diameter of the piston ring, by either turning or grinding on the outside is incorrect. Assume, for example, that a ring shows high spots when put in a cylinder. The high spots are due to excessive bending at those points, and the low spots to stiffness, which prevents the ring from conforming to the bore, or, in other

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* For previous articles on piston ring manufacture, see Finishing Fly Wheels, Hoist Drums and Piston Rings on the Libby Turret Lathe, July, 1908; Making Piston Rings, May, 1908, and Finishing Pistons and Piston Rings on the Gisholt Turret Lathe, March, 1908.

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words, the stiff parts do not touch the bore. We cannot, therefore, correct the high spots, which are weak, by removing more stock from these points by grinding on the outside, but if we reverse the method and grind on the inside, then the irregularities on the outside will be corrected. The high spots on the outside cause the part opposite on the inside to be further from the center of the arbor or sleeve, and the low spots on the outside will be nearer the center, and when grinding on the inside, these will be the first points to be touched by the wheel. When grinding, these stiff portions will become weaker and tend to bend more, and by leaving the weak spots alone the stresses in the ring will be equalized and there will be a uniform bending all around. This is illustrated in Figs. 1 and 2. Fig. 1 shows the effect of grinding a piston ring, when out of true, on the outside. Dash-dotted line shows true bore of cylinder; full line, piston ring out of round; and dotted line piston ring ground on the outside. Note how the weak parts of the ring have been made still thinner by grinding. Fig. 2 shows the effect of grinding a piston ring, when out of true, on the inside. Note how grinding weakens the ring at the stiff points, thereby equalizing the stresses and making the ring spring out at these points and bear evenly all around, as mentioned.

The accompanying table gives piston ring dimensions based on the writer's experience, and conforming to good average practice. The dimensions are so arranged that the same general sizes will suit four different ring diameters so that the tools and gages required are reduced to five sets to take care of twenty cylinder diameters. The width *D* of the piston ring may, of course, be increased with a corresponding increase in wearing surface, but the dimensions given give satisfactory results. The inside of the ring should always be machined, because if the casting surface is not machined, irregularities in the casting will prove a source of trouble. The practice of annealing cast iron ring blanks does not seem desirable to the writer, as internal stresses due to cooling in a mold are rather remote with a ring blank of uniform thickness.

* * *

UNIQUE CALCULATING DEVICE

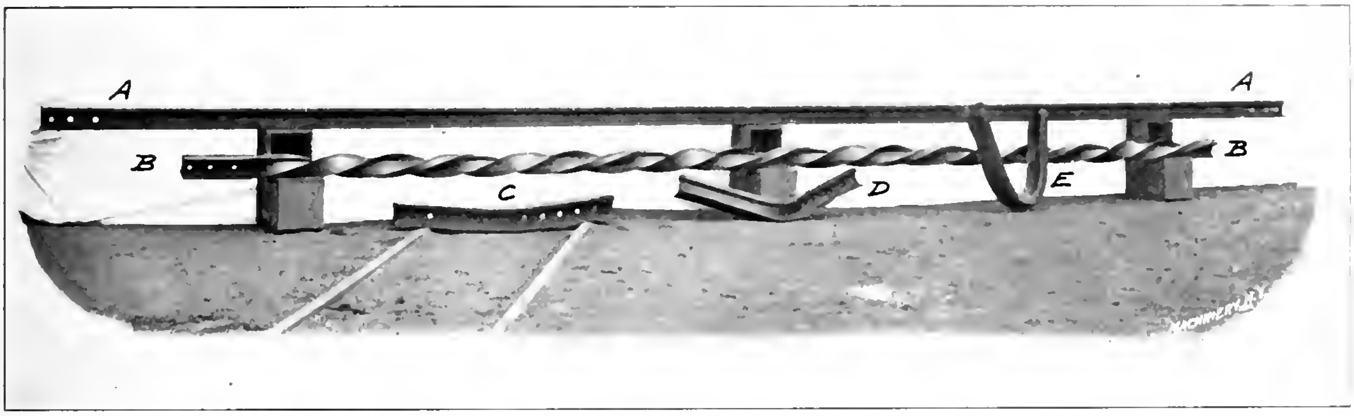
An interesting calculating table with some rather novel and unique features (*Graphische Rechentafel*) has been brought out by the Rechen-Apparate-Fabrik Fr. Schneider, Munich, Germany. The device consists of two tables with logarithmic scales printed on celluloid. The upper table or scale is made of thoroughly transparent material, so that the figures and graduations on the scale below can be read as clearly with the upper table in place as with it removed. The arrangement permits of much closer readings than are possible on the ordinary slide rule, due to the fact that the total length of the logarithmic scale on the lower table in the device is 110 inches. The method of graduating also differs to some extent from that of the ordinary slide rule, and it is possible by means of the device to multiply three factors at one setting as well as to carry out two divisions at once. This feature of being able to multiply three numbers at once is unique, and the only drawback of the instrument is that it is somewhat difficult to work the upper scale on the lower, there being no other guiding means than that of the hand of the operator. Were it possible to provide the instrument with quickly operated slides in two directions, the device would be a most convenient and accurate slide rule.

* * *

REMARKABLE PHYSICAL CHARACTERISTICS OF ROLLED MANGANESE STEEL RAILS

The Pennsylvania Steel Co. showed, at the recent convention of American Engineering and Maintenance of Way Association at Chicago, Ill., a remarkable exhibit of rolled steel rails, which had been bent and twisted to a degree almost unbelievable, considering the excellent condition of the pieces, after the tests. These rails differ from the manganese rails heretofore used, in that they are rolled instead of being cast. The rolled product is given a trade name of "Manard." The company succeeded in producing rolled manganese steel after several years of experiments, as the difficulties of rolling so peculiar a material on a commercial scale were hard to overcome. This steel has much the same red-hardness characteristic at the proper rolling temperature as high-speed steel. Ordinary rail mills are not applicable for the work, special designs of rolls and special rolling methods being necessary to achieve successful results; and the machinery is of extraordinary power and strength.

The rolled rails are much superior to the cast rails, and what this means may be inferred when it is known that the experience of the Boston Elevated Railway Co. shows that the ordinary cast manganese steel rails used by that company had a life fifty times that of the ordinary Bessemer rails on curves and in other difficult situations. The rolled rails show a uniform structure throughout when fractured, whereas the cast rails have a spongy head and coarse grain. Test bars forged from the head give a tensile strength of 150,000 pounds to 159,000 pounds per square inch, with 50 to 60 per cent elongation in 8 inches.



Rolled Manganese Steel Rails subjected to Twisting and Bending Tests

In the illustration showing rolled Manard manganese rails, *A* is a 100-pound 33-foot rail of the 1909 Pennsylvania Railroad standard section; *B* is an 85-pound rail American Society of Civil Engineers standard section twisted cold until six twists remained as a permanent set in 26-foot length; *C* is an American Society of Civil Engineers standard section with ten 1 1/16-inch holes in the web, bent on the drop testing machine. The total work done represents a dynamic force of about 45,000 foot-pounds, and the rail showed no signs of failure after the bending. *D* is a 100-pound A. S. of C. E. standard section bent on a drop testing machine, the work done representing a dynamic force equal to 150,000 foot-pounds. *E* is a 90-pound A. S. of C. E. standard section bent on a drop testing machine and later bent into a U shape under the hammer. All of this bending, of course, was done cold.

The manganese rolled rails cannot be machined with ordinary appliances, but are readily bent to any desired curve with ordinary trackmen's curving tools. They are not magnetic, and the electrical resistance is about 3.4 times that of the ordinary Bessemer steel rails of the same section. The increased resistance, however, does not interfere with track signals in which the track forms part of the circuit.

THREE-FLUTED DRILLS

R S F

Three-fluted reaming drills have been manufactured for a long time by the tool makers of this country. Their common name is "three-fluted drill," and they are so termed in the various catalogues advertising them. The catalogues also note, generally in small type, that these drills will not drill the initial hole. Therefore extensive users have annexed the word "reaming," calling them "three-fluted reaming drills," which impresses upon the workman at once the purpose of the tool. The use of the tool to which the writer desires to draw particular attention is in structural steel work. Therefore, in order to more fully appreciate the class of material on which the tool is used, the reader should be acquainted with some of its irregularities. For instance, the so-called structural steel, such as shapes, plates, bars, etc., in most specifications call for 55,000 to 60,000 pounds tensile strength per square inch with 25 per cent elongation, and it is not only an occasional, but an everyday occurrence, for bars to test as low as 40,000, and as high as 90,000 pounds per square inch tensile strength, with elongations of only 15 per cent and as much as 40 per cent. In fact, in plain words, some material is as soft as iron and some as hard as tool steel.

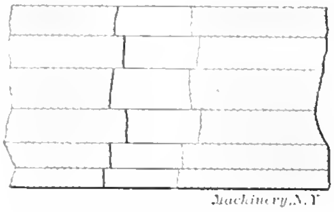


Fig. 1. Several Thicknesses of Structural Steel with Punched Holes, which the Reamer Drill "lines up"

The specifications also state that all material 5/8 inch thick and above shall be sub-punched 3/16 inch smaller in diameter than the finished hole and reamed to size. Material under 5/8 inch thick is punched full size, and when assembled, this work is easily reamed by the ordinary taper bridge reamer, as there is no material to remove, it merely being necessary to "straighten up the hole" produced by irregular punching.

On the other hand, the sub-punched work (as it is termed in structural shops) is built-up girders, chords, etc., and their thickness varies according to the number of plates, angles, etc., used, being generally from 2½ to 6½ or 7 inches thick, very few being much heavier. When assembled, the punched holes rarely "line up," but usually present an appearance similar to that in Fig. 1. A glance will show that the drill has difficulty in cutting its way through, though very few cases occur where the holes are not "trued up" or nearly so. The average number of reamed inches for high-speed drills for a year's run on this class of work with unskilled labor is 7,500 per drill, breakage being the cause of 75 per cent of the loss on account of the difficulties mentioned.

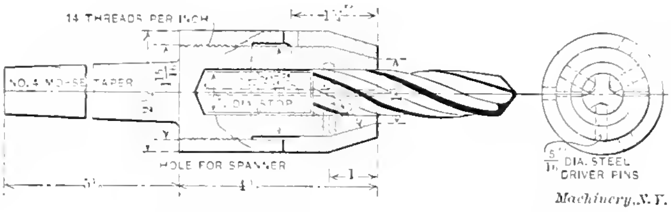


Fig. 2. Chuck for Holding Drills with Broken-off Shanks

The reader should not draw the conclusion at this point that faulty workmanship causes all bad punching; in some cases it does, but a large part is attributed to stretch in material. It is necessary to use the same templet on various thicknesses of material, and as each thickness has a corresponding amount of stretch, the drill must straighten up all inaccuracies.

The three-fluted reaming drills, when made of carbon steel, are practically useless in these days of "speed," the average life of a drill being less than 1,000 reamed inches. A chuck, as shown in Fig. 2, is well adapted for using drills after their shanks are broken off, in cases where the thickness of material will allow the use of a short drill.

The foregoing will give the reader a good idea why the high speed three-fluted reaming drill has been adopted, and the following costs of manufacture, compared with the best price for which they can be bought, will explain why some users make their own drills.

COST OF 15-16-INCH THREE-FLUTED REAMING DRILL

	Morse Taper Shank, Over-all Length, 12 inches		Graham Shank, Over-all Length, 10 inches
Turning	$0.18		$0.09
Fluting	0.063		0.063
Milling Tang	0.008	Groove Milling	0.012
Grinding	0.043		0.043
Total shop cost	$0.294		$0.208
Proportion of gen. shop expenses	0.277		0.182
	0.571		0.390
Hardening	0.065		0.065
Material	1.764		1.50
Total cost	$2.40		$1.955

Two inches less material is required for the Graham shank than the Morse taper shank, when both drills have standard length of flute.

The best price known to the writer, previous to the late business depression, for a 15/16 inch drill was $3.90 net. This has been reduced to about $3.15 within the past few months, still leaving a large saving for the user. The above costs are not caused by any special machinery whatever, with the exception of a device fitted to the table of a No. 4 Cincinnati universal milling machine for fluting and backing off.

The accompanying half-tone illustrations illustrate twelve milling cutters on one arbor, six fluting and six backing off. They are placed in pairs, with a separating bushing between, thereby milling six drills at one time. The cutters are all made of high-speed steel and are kept cool by numerous streams of oil supplied by a 1-inch Gould's rotary pump. It requires two 1-inch flexible steel hose to carry the used oil back to the pump. A feed of 0.016 inch per revolution is used. The shape of the cutters for milling a 7½-inch lead, with the table set at 27 degrees, and a half section of the finished 15/16 inch drill is shown in Fig. 3. As all are formed cutters, there are no variations in the flutes caused by the re-grinding. The depth of the backed-off part will be noticed. It is so milled that after hardening, the grinding is a simple operation, the drills being only ground to their exact size with a taper of 0.010 inch in six inches, the size decreasing toward the shank.

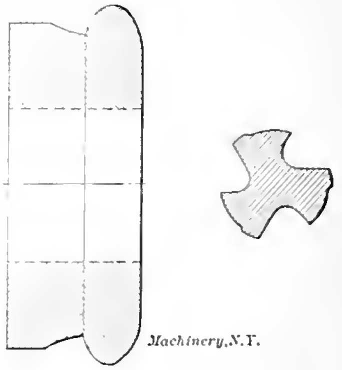


Fig. 3. Fluting Cutter and Section of 15-16-inch Reamer-drill

Ordinary methods of hardening have proved superior to all the fancy ones; the fluted part is heated to a bright yellow and permitted to cool in the open air, laid horizontally upon two suspended ½-inch thick square rods, thereby allowing the air to come in contact with all sides. Some makers claim success by cooling in air blast, then drawing in oil, and various other methods; but after having used all the principal makes, the writer has found the above mentioned method superior to them all, especially when performed in the winter months.

Evidence to substantiate the above statement has been acquired from tests made on a large number of various kinds of drills of different brands of high-speed steel. A recent prolonged test proved that drills made of "Blue Chip" steel by the above method out-class all other brands and even excel drills made of the same steel by a certain manufacturer of high-speed steel and small tools.

These tests serve to bring out another phase of the subject, namely: that the best cutting high-speed steel, that is, one that will carry off the greatest amount of heat, does not make the best drills. For example, "Novo" steel will stand a higher speed than any brand known to the writer, but when it is subjected to shocks, such as a twist drill is likely to receive, it generally breaks, and the drill is ruined. Only recently 1 9/16 and 1 7/8 inch diameter drills given to the

writer were split the entire length and yet showed no trace whatever of flaw or crack in the steel.

The "Blue Chip" steel drills are much tougher, and successfully accomplish a very large percentage of the work just described. A 15/16 inch diameter three-flute reaming drill made of this steel has made a record with us of 28,000 reamed inches, only 1½ inch of the drill being used up. Frequently these drills have been twisted a half turn backward in the flutes without breaking. The steel, in its annealed state, is easily worked, a reduction of only about 15 per cent of the speed of machine tools being required below that used on good carbon steel. It straightens easily either in the bar or drill length.

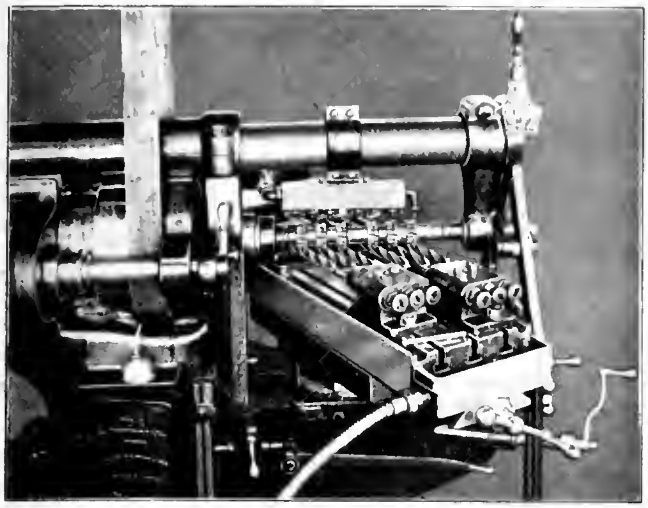


Fig. 4. Fluting and Relieving Six Drills simultaneously

A Warner & Swasey two-inch turret lathe is used for turning, and a maximum cutting speed cannot be obtained for one reason, viz.: the heat generated by the length of the bar against the back-rest is so great that the bar burns fast to the back-rest, despite the continuous flow of oil on that part, therefore the necessity for reducing speed. The roller back rest was brought out to overcome this difficulty, but it does not, for two reasons: First, the rake for the tool recommended by the makers turns a chip like a ribbon and this ribbon-like chip becomes tangled in the turret and among the other tools and thus is a great nuisance and time-consumer. Second, a tool ground to cut an ordinary curled chip works satisfactorily, except that the rollers pull the chips in between themselves and the work, resulting in numerous "digs" in the length of the cut. The Cincinnati No. 4 universal milling machine for fluting the drills works excellently, though taxed to its limit with twelve cutters working simultaneously. A Brown & Sharpe universal grinder, which has an automatic reversing feed, is used for grinding. This machine enables the operator to produce a large quantity of duplicate work at a low labor cost.

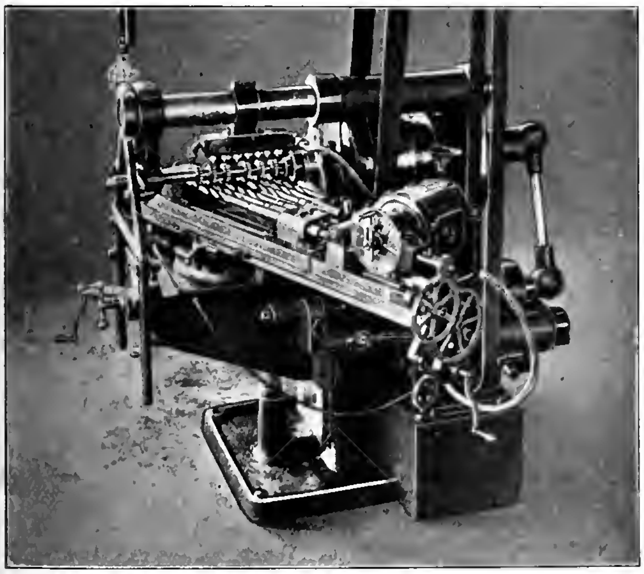


Fig. 5. Multiple Indexing Head used when Fluting and Relieving Drills

BEARING FOR HIGH-SPEED SHAFTS

In bearings for rapidly-rotating shafts such as are employed in steam turbines, high-speed engines, etc., the surface of the bearing structure is often not of sufficient extent to keep the bearing cool by the radiation therefrom of the heat generated by the friction of the bearing surfaces. In order to maintain the temperature of the bearing within safe and proper limits, cooling mediums are circulated over the radiating surfaces to absorb and remove the heat. A method of cooling such bearings by circulating the lubricant for the bearing surfaces through the body of the bearing was illustrated and described in a recent issue of the *Mechanical Engineer*. This bearing, which is the invention of the Vereinigte Dampfturbinen-Gesellschaft mit Beschränkter Haftung, of Friedrich Karl-Ufer 2—4, Berlin, results, it is claimed, in the effective control of the temperature and is attended with many other incidental advantages.

The shaft *A* rotates in a shell *B* which is supported by a seat *C* formed in the bearing frame *D*, and a cap *E* which is secured to the frame and holds the shell in place. The seat *C* is circular in cross-section, and the outer surface of the shell is of similar shape. The shell *B* is made in two parts by dividing it in a horizontal plane extending through the axis of the shaft, and it is provided with a number of external flanges *F* which support it on the seat *C* and assist in the radiation of of the heat imparted to the relatively thin body portion *G* of the shell by the friction between the shaft and its bearing surface. The outer edges of the circular flanges are in contact with the surface of the seat, thus forming a conduit between the flanges and the surface. By suitably arranging the flanges, this channel or conduit is made to follow a winding or tortuous path through or over the shell. The outline of this path may be that of a helix, or it may have a zig-zag shape or the form shown in the illustration, the object being merely to secure a circulation of the cooling medium over a sufficiently large radiating surface formed by the walls of the conduit so that the heat due to friction will be effectively removed. Lubricant is supplied to the conduit *J*, whence it flows back and forth over the radiating surfaces of the shell and is delivered by the passage *L* (Fig. 2) to the conduit *M* in the upper half of the shell. This conduit directs it back and forth over the radiating surface in the manner indicated, and delivers it to the passage *N* and to the bearing surfaces. Grooves, *O*, *P*, *Q*, assist in the distribution of the lubricant over the bearing surfaces, after which it escapes into chambers *R* and *S* and then flows downward into the chamber in the lower part of the frame. A conduit *U* drains it from the bearing and returns it to the source of supply for repeated use. Before the oil is delivered to the bearing surfaces, its temperature is raised by the heat which it removes from the bearing in the cooling operation. The lubricating effect of the oil is, it is claimed, increased by this pre-heating, warm oil being a better lubricant than cold oil, so that the friction of the bearing surface is decreased, resulting in a superior operation of the bearing and a reduction in the amount of heat removed by the oil. The result of the decrease in friction and amount of heat generated is that a given bearing may be made to carry a much heavier load without overheating.

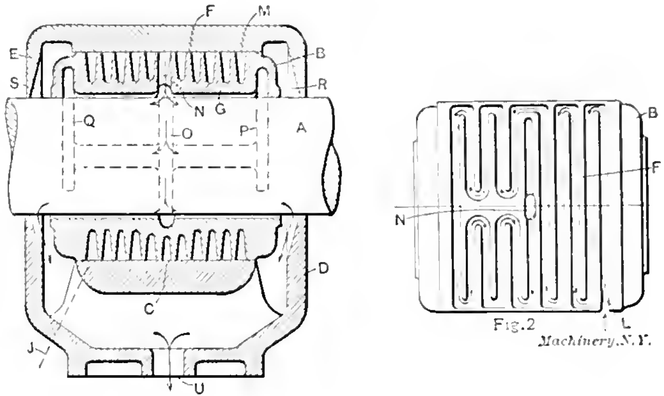


Fig. 1 Fig. 2

A High-speed Bearing in which the Lubricant is used as a Cooling Medium

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MACHINERY

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A FACTOR IN GRINDING

To those familiar with cylindrical grinding, it is well known that increasing the work speed increases the wheel wear. In case a wheel is too hard for the work, it is a common expedient to increase the work speed until the wheel cuts satisfactorily. An emery wheel cannot grind freely unless it wears itself away so as to present constantly new cutting points to the work; consequently, increasing the work speed causes the hard wheel to cut more freely because it wears away more rapidly.

The reason for increased wheel wear because of higher work speed is not clear to many who have studied the question, and the first deduction is likely to be that increase of wheel wear because of greater work speed is simply due to more work being done per minute. While this is a reason, it is not the only one, because experience has shown that increasing the work speed will increase the wheel wear *for the same amount of material removed*. Why is this so?

We believe the answer involves a matter of grinding wheel mechanics that apparently has not been given much attention by grinding machine authorities. A particle of emery embedded in the bond of a wheel is held quite insecurely. This can be demonstrated by attacking the face of the wheel, while stationary, with a metal tool. It is an easy matter to scrape off particles of emery, and under this test the wheel appears to be a fragile thing when we consider what it is capable of accomplishing. The common method of testing wheels for grade is to dig into them with a pointed tool, and experts can quickly determine the relative hardness of wheels, or rather the strength of bond in this manner.

Now, what enables the emery to cut when held so insecurely? Largely because of its kinetic energy. The condition is similar to that which gives a rifle bullet its power. A Spitzer bullet weighing 150 grains is projected from a modern Springfield rifle with such velocity that it has a striking energy of 2,400 foot-pounds, 50 feet from the muzzle. It is almost inconceiveable that so small a piece of metal can develop such great striking energy, and the fact gives one a vivid conception of the effect of velocity. In less degree, the cutting power of an emery wheel point depends on its velocity.

The standard velocity for grinding machine wheels is about 6,000 feet per minute or, say, 100 feet per second. A particle of emery weighing one grain, embedded in the circumference of a wheel running at the standard speed, has a kinetic energy of $E = Wv^2 \div 2g = 154$ foot-grains, nearly. That is, a particle of emery, because of its velocity, has a kinetic energy equal to 154 times its weight, falling one foot. This kinetic energy enables the point to plow its way through the opposing metal without throwing heavy stress on the bond holding it in place.

The contact of the grinding wheel with the work cylinder is theoretically on a line parallel with the axes, but actually on a surface. A particle of emery is in contact with the work for a period that depends on its speed and the work speed. Suppose that the work were standing still. It is obvious that the grinding wheel will instantly lose its contact with the work, as it will grind an arc into the metal and no longer touch it, but by the constant rotation of the work, new metal is brought into contact with the wheel and removed. During the period of contact the cutting points of emery plow narrow grooves through the metal, the length of each furrow depending on the work speed. If the work speed is doubled, obviously the length of the furrow is doubled. The possibility of an emery point cutting its way through the opposing metal depends upon how much material is opposed to it. The emery points do not act as a mass, but individually and as such have the weakness of scattered fighting units, which, as every soldier knows, can be easily defeated "in detail." There is a near balance existing between the force required to remove the opposing metal, the kinetic energy of the emery points and the centrifugal force tending to throw the loose particles on the wheel face off on a tangent. When the work speed is increased, this balance is lost and a new condition set up which causes the particles of emery to be more rapidly disrupted and new and fresh grinding points will be brought into action resulting in freer cutting.

* * *

BLIND ACCEPTANCE OF AUTHORITIES

It is important for a young engineer to avoid the blind acceptance of authorities, so common in the college-bred youth. The young man fresh from college usually enters practical life with but a vague understanding of many conditions that are deciding factors in constructive engineering work, and he is likely to believe that the formulas and rules laid down by the writers of his text-books may be relied on to give satisfactory results in all cases. He does not doubt the authority of those who wrote the text-books or deduced the formulas, and when he finds that the practical engineer sometimes accepts solutions which appear to be contrary to the rules laid down by his "authorities," he immediately concludes that the men under whom he is working are wrong. Someone has said, with a great deal of truth, that the college-bred engineer is really the best engineer in the long run, if he only is given time to unlearn what he has been taught in college. Of course, this expression must not be taken literally, but there is no doubt that there are many conceptions in the young college engineer, due to his education, which must be modified and sometimes discarded before he can make a success in practical engineering. This is not a reflection on college training and education, but merely implies that it is impossible to take into consideration in the limited scope of a technical college education all the practical factors, limitations and requirements, which enter into almost every engineering problem. In general, the training of the engineering school includes principles only, and the young man who enters into practical occupations must learn that while the principles always hold true, it is seldom that any one principle can be applied, by itself alone, to the solution of a problem. There may be a dozen fundamental principles, each of which enters into the problem; and it is impracticable to lay down a rule exactly determining to what extent each has an application to the problem.

The greatest asset of the engineer is *judgment* and *common sense*, guided by a fundamental knowledge of first principles; and the successful engineer is the man who fully realizes the value of his own judgment, and therefore dares to disregard, to a certain extent, the dictum of authorities, and rely upon his own investigations and experience.

ENTERTAINMENT FEATURES OF THE A. S. M. E. CONVENTIONS

A delightful feature of the semi-annual conventions of the American Society of Mechanical Engineers is the various excursions to points of interest in and about the cities where the conventions are held. The parties going on these excursions are given special attention, and unusual courtesies often are extended in honor of the society. To the ladies and other guests of the members such excursions are particularly enjoyable because of their novelty, and we fear that the majority of the members are more interested in them than in the regular proceedings.

Notwithstanding the popularity of such diversions, we are inclined to question the advisability of featuring them to the extent that has been the case in the last few years. It seems that the prestige of the society will suffer if the entertainment side of the convention is magnified so that it eclipses the technical side. We believe that the society will gain in prestige if less attention is given to pleasure, and more to the real business for which the conventions are intended. Let the Spring conventions be held in places where ample hotel accommodations are provided, but where the outside attractions are minimized. Then the attention of the visiting members will be centered on the papers and discussions. The chief value of the conventions lies in the oral and written discussion of the papers, and in the making of acquaintances and the renewal of friendly relations. If the discussions fail, there is comparatively little profit in traveling hundreds of miles to hear papers read, as every member receives the monthly journal of the society containing them. Let us continue to have entertainments, by all means; but let them be subordinate to the real business of the society.

* * *

THE SHOP OPERATION SHEET ON GRINDING DRILLS

We call special attention to the shop operations in another part of this number, describing the hand grinding of flat and twist drills. We believe they are of such a practical character as to command the attention of every machinist, foreman and superintendent of machine work, particularly if they are concerned with the instruction of apprentices and others.

The drill is the most used metal cutting tool, and receives the most abuse. Common laborers often are put to work on drill presses and required to keep their drills sharpened. When proper instruction in grinding is not given, the results are deplorable; power is wasted, drills are broken and rapidly worn out, and holes produced larger than the desired sizes, all of which could be avoided by giving practical lessons in drill grinding at the start. It is comparatively easy to grind a flat or twist drill by hand to a fair approximation of the correct shape if the proper shape is known to begin with, but that is just what many otherwise good mechanics do not know. A study of the operation sheet by those who *do* know, undoubtedly will give them a better understanding of the matter and better fit them for instructing those in their charge in the matter of upkeep, that is sadly neglected in many shops. A drill grinder is a tool whose value is not properly appreciated, and until it is a common part of machine equipment, hand grinding will be a matter for every machine man to understand.

* * *

THE MECHANICAL ENGINEER IN PUBLIC RELATIONS

An amendment to the constitution of the American Society of Mechanical Engineers was offered at the Washington meeting, which provides for a committee on public relations. It is the belief of a number of the members prominent in the society's affairs that the influence of the mechanical engineer on civic matters should be made much greater than it now is. In these days of machinery and great mechanical engineering works, the advice of the mechanical engineer on matters of public importance is not sought by the heads of municipalities and civic authorities as much as it should be. It is the aim of those standing sponsors to this movement for public relations to bring about a realizing sense of the value of the advice of the mechanical engineer in projects affecting the general welfare of communities. The paper "The Engineer and the People," read by Mr. Morris Llewellyn Cooke at the December, 1908, meeting of the society, called the society's attention to the importance of closer relationship between mechanical engineers and the national and municipal governments, and doubtless the proposed amendment to the constitution was inspired by it.

The movement is one that we heartily endorse; and any other movement that will tend to place the mechanical engineer and his worthy assistant, the machinist, in a position commanding greater respect of those benefited by their work, will receive our commendation. We feel that the mechanical work that has been largely instrumental in placing this country among the foremost nations of the world, has not been properly appreciated by the majority of those who have benefited thereby. The age of the politician is passing away, and following it is the age in which the achievements of the business man and the mechanical engineer will receive national recognition. Let us bring into prominence the work of our engineers, and stimulate in the minds of the younger generation the desire to emulate the constructive work of these men, which means so much more for the world's welfare than does politics, diplomacy or war.

* * *

THE NEWER HIGH-SPEED STEELS

O. M. BECKER[*]

After the metal cutting industries had taken breath, so to speak, following the advent of air-hardening or high-speed steels, and begun to adjust themselves to the new situation, the use of self-hardening or mushet steels rapidly decreased until very little call for it existed and most manufacturers ceased making it altogether, putting out instead a more or less excellent quality of the high-speed kind. This, however, was not for some little time after the Taylor-White discoveries became public. The self-hardening steels had come into rather general use in difficult jobs, and in progressively managed shops were used to a considerable extent on all sorts of jobs; and so, while the new steels with their wonderful possibilities were justifying themselves and establishing their place, very properly there was a disposition to hold fast to that which had already proved itself, rather than to take up something but little known or tried. Recently there has again come to be some demand for steels which, while possessing the qualities of high-speed steel to a moderate degree, enough to adapt them to a class of work not requiring its high cutting powers and red-hardness, could be bought at a price considerably below that of high-grade air-hardening steel; and a number of manufacturers have brought forward steels to fill this gap. There doubtless are many kinds of work wherein a steel of less endurance than the best high-speed varieties would answer every requirement and yield results equally as good—jobs where extremely high speeds or heavy cuts are in the nature of the case impracticable, or as in certain woodworking operations, where a cutter of higher endurance than one of the best carbon steel would have an almost indefinite life anyway. In such cases, it would seem, the high cost of air-hardening steel imposes an unnecessary expense in tool equipment.

Most such "new" steels are nothing more nor less than mushet or self-hardening, though some seem to be manganese rather than tungsten steels. A typical example of such a "special," "intermediate," or "semi-high-speed" steel, of excellent sustaining power and not exceptionally hard to treat, has the composition:

Carbon	1.190 per cent.
Tungsten	7.560 per cent.
Chromium	3.340 per cent.
Manganese	0.460 per cent.
Phosphorus	0.024 per cent.
Sulphur	0.025 per cent.
Silicon	0.200 per cent.

Another, corresponding still more closely in its composition to mushet steel, gave this analysis:

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[*] Address: Berwyn, Ill.

Carbon	0.94 per cent.
Tungsten	1.78 per cent.
Chromium	0.69 per cent.
Manganese	0.27 per cent.
Phosphorus	0.01 per cent.
Sulphur	0.01 per cent.
Silicon	0.11 per cent.

Both these steels, it will be observed, are rather lower in carbon than most mushet steels formerly were, and the first is rather higher in tungsten while the second is lower in chromium. A third, which scarcely falls within the mushet class, is thus composed:

Carbon	1.25 per cent.
Tungsten	2.25 per cent
Chromium	0.28 per cent.
Manganese	0.85 per cent.
Silicon	0.21 per cent.

The latter is advertised and sold specifically as a "finishing" steel; and it unquestionably gives excellent results in this particular kind of work. There are, besides, a number of other steels on the market, sold for tool use, whose tungsten content (or molybdenum equivalent) ranges anywhere below that essential to a high grade high-speed steel—say 17 per cent—and down to that indicated in the analyses above. Most of these are sold as high-speed steels, though usually at a lower price than is customary for those of highest grade, and to a greater or less extent are so, when the chromium content corresponds with the tungsten.

Still another steel very widely advertised as an "intermediate" steel, and certainly working exceedingly well in certain classes of work, including blanking and stamping as well as cutting wood and metals of moderate hardness, has this anomalous composition:

Carbon	1.03 per cent.
Tungsten	0.46 per cent.
Chromium	0.06 per cent.
Manganese	0.30 per cent.
Phosphorus	0.025 per cent.
Sulphur	0.009 per cent.
Silicon	0.008 per cent.

This is represented as a very dense steel requiring very slow and careful heating to a bright cherry red (800 to 850 degrees C. or about 1,500 to 1,550 degrees F.) for cutting tools, and somewhat lower for tools intended to withstand pressure or blows. It is water hardening, as might be supposed from its composition, and requires the temper to be drawn, as in the case of carbon steel tools. It is claimed to be at least 50 per cent tougher than carbon tool steel—though that is about what it seems really to be except for being high in manganese. Several other steels sold for about the same purposes also have about the same manganese, and some a good bit higher.

The most recent development in tool steels seems to be quite as startling as was the announcement of the Taylor-White process and the advent of high-speed steels. If the preliminary experiences with these remarkable steels can be maintained, as there seems to be no reason to doubt, another long step has been taken in tool steel development. For some time, perhaps as long as two years preceding this writing, it has been known to the informed that in certain steel works tools were in use very greatly superior to those made from steels regularly upon the market, tools capable of cutting at greatly superior speeds and maintaining themselves much longer in good cutting condition than is customary with ordinary high-speed tools. Experiments had been going on, apparently in a number of places at the same time, looking to the production of a superior steel which would free the makers from the limitations imposed by the Taylor-White patents, should the litigation relative to them terminate favorably to the holders of the patents. The results have been startling indeed.

It is possible, without any question, to cut at speeds double those possible with ordinary high-speed steels, and even much higher, the tools standing up to such astonishing speeds as five hundred feet per minute under good condition, it is reported. The greatest advantage, however, lies not so much in the increased cutting speeds as in the very greatly superior lasting quality. A tool of the new high-speed steel can be made to last as much longer than one of the best kind previously made, as that will outlast one of carbon steel. The most refractory metals can be cut with ease. Chilled iron, which could be cut with ordinary high-speed steel with difficulty, that is to say, at speeds near ten feet per minute and then only with very frequent grindings of the tool, can now be machined with comparative ease. Hard spots in skidded tires, to mention another example of the possibilities, which were likely to play havoc with the very best of tools, are cut through with little or no sign of their presence. Chilled rolls which the best tools previously available would scarcely touch, have been turned at 80 feet per minute. In hard material particularly do these newest steels show their powers to the best advantage. In softer metals, as in low carbon steels, there is a possible gain ranging from 25 to 60 per cent over ordinary high-speed tools, in regular work; though the makers seem to prefer to recommend in general that there be no distinctive increases in cutting speeds on this class of work.

The lasting qualities of these steels is astonishing, compared with ordinary high-speed steels even. Tools last from two to eight times as long before requiring re-grinding, depending upon conditions, the greatest advantage apparently being in the case of cutting very hard materials. The tool will cut without any diminution of its powers, apparently, while the nose is glowing at a bright red. Evidently the temperature points at which red-hardness or tempering begins is considerably higher than that of ordinary high-speed steels.

Following the first announcement of the new or superior high-speed steels, few details concerning them were obtainable, the makers preferring to keep their secret for the time being The steels are now sold upon the open market, and it can be stated that in details of working up into tools they do not differ in any essential particular from the ordinary high-speed steels. It is true they can be hardened in salt water; and it is reported that this has been done in the case of a particular tool a great many successive times without any cracks developing. Nevertheless even the makers admit that cracking is likely to take place, hardening in air or oil being the preferred and recommended method. For cutting exceedingly hard materials, like chilled iron, the water hardening is recommended, in spite of the possibility of cracking.

The new steels are easily forged, though the forging heat is best kept rather higher than is usual with the other high-speed steels, say at a yellow, or at the least at a bright red. The heat must on no account be lower than the latter, say not far from 950 degrees C. or 1,750 F. Annealing is done easily and simply, and it is declared that there is no possible danger from overheating in hardening.

The cost of the new steels is considerably higher than that of the ordinary high-speed kinds, so that its use in preference to the latter must be justified by exceptional conditions, such as especially difficult materials to cut, or the possibility of great economies. The latter arise, as already mentioned, less from increased speeds than from superior lasting qualities. The consumption of tool steel results from grinding the tools and the final rejection of the tool stock as too small for proper use. Evidently if a tool can run four to eight times as long without grinding (and give a superior finish at the same time) as the best previously available, this saving in steel and in time lost changing tools would go a long way toward justifying its use, even at double the cost.

* * *

If a delicate piece of machinery can not be adequately protected from rough handling by the operator, it is better to leave the parts exposed and let his own judgment dictate the usage to which the parts should be subjected. An example illustrating the idea is the method employed in packing high grade glassware, especially cut glass that is very costly A plan which has been followed with success is to pack it in barrels with excelsior, filling the barrel full and exposing a piece of the glass at the top. That exposed piece is the danger signal and a freight handler must have considerable hardihood who will treat that barrel disrespectfully. He knows that he cannot turn the barrel over on its side, and the exposed glass effectually prevents piling other freight on top.

NEW ENGLISH VERTICAL MILLING MACHINES

FRANK C. PERKINS*

The accompanying illustrations show the construction of four milling machines designed and constructed at the Manchester Works of Sir W. G. Armstrong Whitworth & Company. Fig. 1 shows a small, sensitive, vertical milling machine driven by an electric motor and designed chiefly for use on the breech mechanism of guns. The base plate, it will be seen, is arranged as a tank into which the lubricating oil runs and from which the oil is pumped through pipes to the milling tool. This machine is driven by a variable-speed motor and is suitable for high speed work. It will be noted that it consist of a box pattern frame with square slides to receive the knee. The machine is fitted with a steel spindle running in a tube having adjustment vertically by a hand-wheel, worm gear, and rack and pinion. The spindle is locked in any position by the lever seen just below and to the left of the hand-wheel, and it is arranged with conical bearings, the thrust being taken by ball bearings, while the upper end is supported in a bushing running in a bronze bearing. A variable-speed motor is used for driving, as mentioned; it is directly connected to the base of the upright and drives by belt over guide pulleys to the pulley on the top of the machine. The longitudinal traverse of the table is 10 inches, and the transverse movement 18 inches. The vertical adjustment of the table is 18 inches, and the vertical adjustment of the spindle, 2 inches.

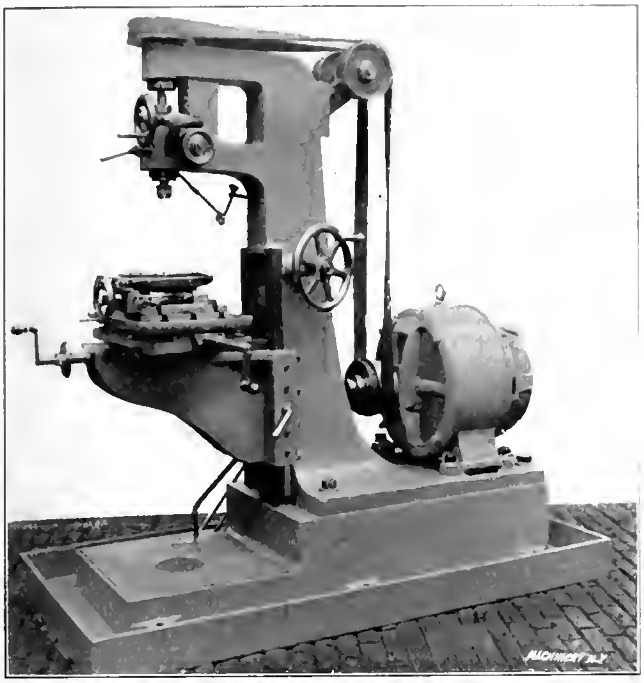

Fig. 1. Electrically-driven Sensitive, Vertical Milling Machine, built by Sir W. G. Armstrong-Whitworth & Co.

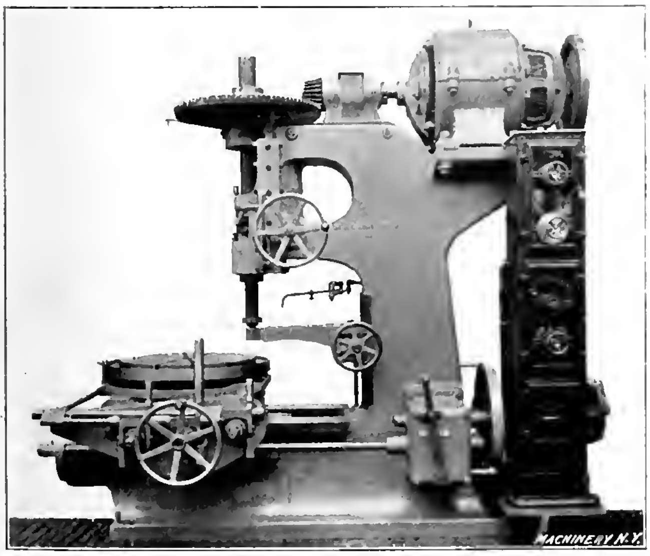

Fig. 2. Vertical Milling Machine with Two Motors—One for the Main Drive and the other for Operating the Feeds and Quick Traverse

The electrically driven vertical milling machine seen in Fig. 2 is operated by two electric motors. One of these is mounted on the top of the upright and is used for the main drive through bevel gears, while the other motor is fitted to the back of the upright at the base, for the feeds and quick traverse. The machine has longitudinal, transverse and circular feeds, all of which can be automatically tripped. The main motor on the top of the upright has a variable speed which gives the necessary spindle speeds. It may be stated that one of the features of this vertical milling machine is that the feeds can be thrown in or out of gear by means of clutches worked by levers, which are always in a convenient position, as they do not revolve with the feed-screws as do the handles of the machine shown in Fig. 3; consequently the feeds can be easily thrown in or out of gear. The electric controlling panel seen at the right in illustration Fig. 2 is of special interest. This panel contains a starting switch for the two motors, and a regulating switch for the main drive motor as well as a regulating switch for the feed motor,

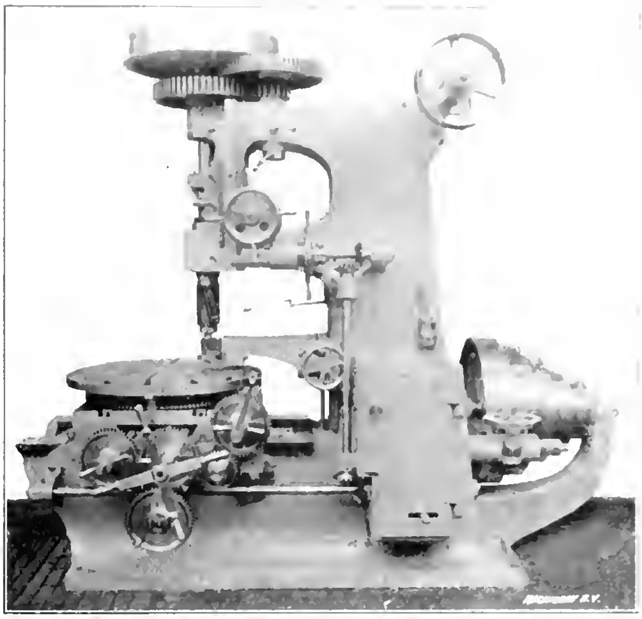

Fig. 3. Belt-driven Profiling and Vertical Milling Machine

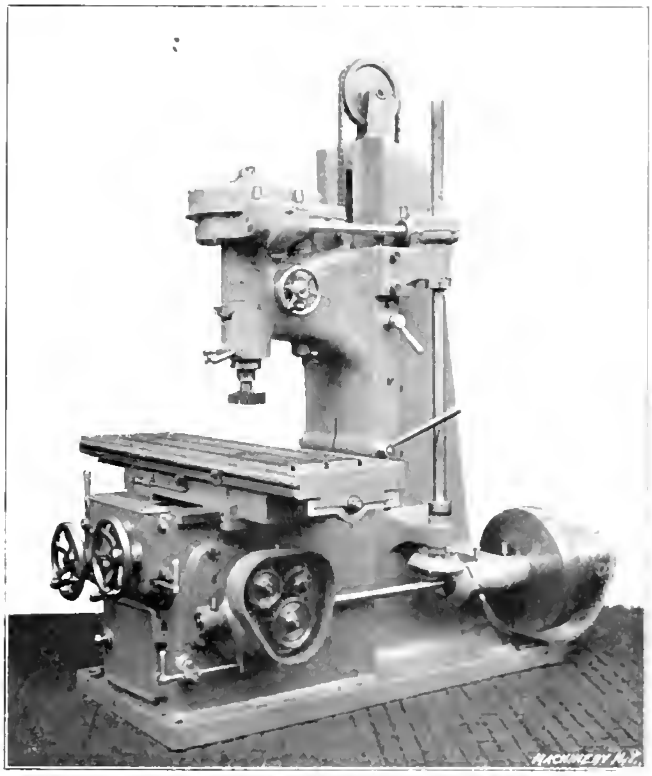

Fig. 4 Vertical Milling Machine designed for a Wide Range of Work

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* Address: Erie Co. Bank Building, Buffalo, N. Y.

It is also provided with electric circuit breakers, which are so arranged that it is not possible for one motor to run while the other is stopped. On this machine there is a vertical hand feed to the spindle for adjustment. The machine was designed for locomotive work and has a capacity for removing 6 cubic inches of material per minute.

The profiling and vertical milling machine seen in Fig. 3 is belt-driven from a counter-shaft, and is fitted with a cone pulley at the back and an endless belt which passes over the top of idler pulleys on the column. All the feed gear is contained in a box seen attached to the side of the column, and the various speeds can be connected by means of the hand wheel, rack, and pinion shown to the rear of the feed-box. The lever seen just above the box reverses all feeds. A machine which is adapted to a great variety of work and which is also constructed at the Manchester works, may be seen in Fig. 4. This machine has a solid base. The milling head is fitted with an adjustment for position, while the feed of the spindle is controlled by means of a small hand-wheel on the head. It will be noted that all of the motions of this machine are controlled by handles from the front, which is a great convenience.

* * *

WASHINGTON MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The regular Spring meeting of the American Society of Mechanical Engineers was held at Washington, May 4 to 7 inclusive, the New Willard hotel being the headquarters. Between 280 and 290 members were registered, and a large number of guests were in attendance. The meeting opened with an address of welcome delivered by Hon. Henry D. F. MacFarland, president of the Board of District Commissioners, and responded to by Jesse M. Smith, president of the society, following which was a reception and dancing in the large auditorium of the hotel on the tenth floor.

On Wednesday afternoon the members and guests attended a special exhibition drill of the United States Army troops at Fort Myer, where the Baldwin dirigible balloon and the Wright aeroplane tests were made last Summer and Fall. The balloon was on view at a remote point and was visited by a few of the members. On Wednesday evening Mr. F. H. Newell, director of the United States Reclamation Service, delivered an illustrated lecture "Home Making in the Arid Regions" which was a very interesting exposition of the great work being done by the United States government in the desert regions of the west.

On Thursday afternoon the members and guests were received by President Taft in the East Room of the White House. On Thursday evening, Rear Admiral George W. Melville, retired, addressed the society on the subject "The Engineer in the Navy." He was followed by Walter M. MacFarland of Pittsburg, Pa., who spoke on Rear Admiral Melville's service to the engineering profession and the nation, following which was the presentation to the National Gallery of a life-size portrait of Admiral Melville by Ivanowski.

On Friday afternoon a boat trip was made to Mount Vernon, the plan being to return to Fort Myer to witness an ascension of the Baldwin dirigible balloon under direction of Lieutenant Lahm. On account of a thunder storm, the ascension was not attempted.

Amendments to the constitution were proposed to section C10 regarding the qualification of associate members of the society, and C45 defining the standing committees, it being proposed that a public relations committee be added. According to the constitution all amendments to the constitution must be proposed at the Spring meeting and acted upon at the Fall meeting.

The following papers were presented:

"A Unique Belt Conveyor," by Ellis C. Soper, Detroit, Mich.

"Automatic Feeders for Handling Material in Bulk," by C. Kemble Baldwin, Chicago, Ill.

"A New Transmission Dynamometer," by Prof. William H. Kenerson, Providence, R. I.

"Polishing Metals for Examination with the Microscope," by Albert Kingsbury, Pittsburg, Pa.

"Marine Producer Gas Power," by C. L. Straub, New York.

"Operation of a Small Producer Gas Power Plant," by C. W. Obert, New York.

"A Method of Improving the Efficiency of Gas Engines," Thomas E. Butterfield, Philadelphia.

"Offsetting Cylinders in Single-Acting Engines," by Professor T. M. Phetteplace, Providence, R. I.

"Small Steam Turbines," by George A. Orrok, New York.

"Tests on Compressed Air Pumping Systems of Oil Wells," by Edmund N. Ivens, New Orleans.

"Safety Valves": Discussion continued from the February meeting in New York.

"Specific Volume of Saturated Steam," by Professor C. H. Peabody, Boston.

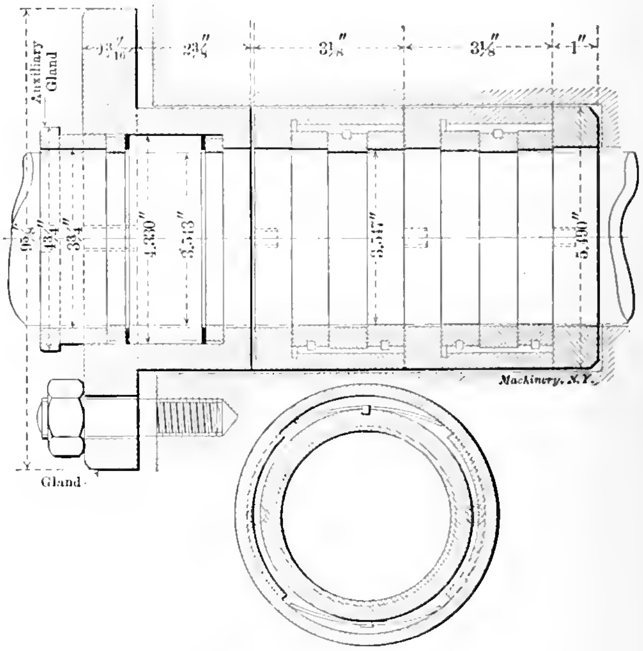
"Some Properties of Steam," by Professor R. C. H. Heck, New Brunswick, N. J.

"A New Departure in Flexible Staybolts," by H. B. Wille, Philadelphia.

* * *

FRENCH METALLIC PACKING CONSTRUCTION

The accompanying engraving shows a stuffing box made up of three rings whose bore is several tenths of a millimeter larger than the piston rod. The three rings are so arranged that two of them, one on each side, are pressed upward by means of springs, and the center one downward partly by its own weight and partly by a spring. By this arrangement, although the rings have play, the steam cannot escape. The rings do not suffer appreciable wear as the springs have a very slight tension. This stuffing box is the design of the Ateliers de Construction H. Bollinckx, Brussels, Belgium.



French Metallic Packing Construction

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Some interesting figures relating to the number of telephones in use in some of the largest cities in the world are given in a recent issue of *Teknisk Tidskrift*. The figures give the number of inhabitants per each telephone and are as follows: Stockholm, 6.6; Chicago, 11.2; New York, 12.5; Berlin, 20.6; Paris, 42.4; London, 46.1. The figures for Stockholm, however, only take account of the number of subscribers of the private telephone company of the city. If the state telephones, owned and operated by the government, are also included, the figure would be about one telephone for every four inhabitants. The reason why telephones are so commonly used in Stockholm is due to the fact that in no city in the world of similar size have the charges for telephone service been brought down to so low a level, making it possible for almost everyone to have a telephone installed in their home. Less than $10 a year pays for a telephone permitting of liberal use without any additional charge, and $22 a year provides for unlimited service within a radius of forty miles.

A NEW TRANSMISSION DYNAMOMETER*

WM. H. KENERSON†

The author has received from time to time many requests for a simple transmission dynamometer, and has himself often felt the need of one which would be more generally applicable than those now in use. These continued requests, together with the requirements of a definite problem whose solution demanded a rigid transmission dynamometer in the form of a coupling, led to the design and construction of the instrument described below. The accompanying illustrations show the construction of the dynamometer and its method of application and use. In Fig. 2 and Fig. 4 the corresponding parts of the dynamometer are given the same letters.

The couplings *A* and *B*, each keyed to its respective shaft, are held together loosely by the stud bolts *C*. The holes in the flange *A* are larger than the studs *C*, so that these studs have no part in transmitting power from one shaft to the other. The power is transmitted from *A* to *B* through the agency of the latches *L*, four of which are arranged around the circumference of the flange *B*. These latches are mounted and are free to turn on the studs *E*. The two fingers of the latches engage the studs *F* on the flange *A*. On the ends of each latch are knife-edges parallel to the stud about which the latch turns. For either direction of rotation of the flange *A* the latches *L*, which are in effect double bell-crank levers, will exert a pressure on the disk *G*, tending to force it axially along the hub of the coupling *B*, and this pressure, it will be seen, is proportional to the torque.

Between the end-thrust ball, or roller, bearings *M M*, is held the stationary ring *S*, which is the weighing member. *O* is a thrust-collar screwed on the hub of *B*, and *P* is its check nut, which is ordinarily pinned to the hub when in position. The stationary member *S*, in the form of a ring surrounding the shaft, is prevented from rotating by fastening to some fixed object the attached arm shown in the view (Fig. 1) of the assembled instrument. In this ring is an annular cavity covered by a thin, flexible copper diaphragm *D*, against which the ball-race of one of the thrust-bearings presses. The edge of this ball-race is slightly chamfered to allow some motion to the diaphragm. The cavity is filled with a fluid, such as oil, and connected by means of a tube to a gage. The oil pressure measured by the gage is proportional to the pressure between the thrust-bearings, which in turn is proportional to the torque.

The instrument may be calibrated in the torsion-testing machine or by means of a sensitive friction brake. Fig. 5 is an actual calibration curve for a small instrument, obtained by hanging standard weights at proper distances from the shaft on a horizontal lever attached to the shaft, and reading the pressures indicated by the gage for the various torques shown in the diagram. For ordinary purposes, however, it is not necessary to calibrate the instrument by actual trial, since computations of the oil pressures for the various torques from the lengths of the lever arms and diaphragm area check very closely those thus obtained.

It will be seen that the weighing means is similar to that employed in the Emery testing machine, which is recognized as being extremely accurate. It will be possible to employ the Emery flexible steel knife-edges on the levers, if desired, but this has been found in practice an unnecessary refinement.

The construction makes the coupling as nearly rigid as materials will permit, the movement of the diaphragm being extremely small. The only flow of oil through the copper connecting-pipe is that sufficient to alter the shape of the Bourdon tube, if that be the form of gage employed. As soon as the normal position of the gage is reached this flow ceases, hence there can be no fluid friction. It is possible, therefore, to use as long and as small a tube as desired, without introducing error. Where the gage is placed at a distance above or below the coupling, correction should of course be made for the static head.

Other means than the gage shown may be employed to measure the fluid pressure. Where extreme accuracy is desired it will be well to employ the weighing device used with the Emery testing machine. The manograph has been used in this connection to measure variations in torque too rapid for indication by the ordinary gage. For example, the variations in torque in a single revolution of the shaft of a 3-cylinder gasoline engine have been recorded with its aid.

Where the rate of rotation of the shaft is variable and it is desired to indicate the horse-power direct, the combination of gage and tachometer shown in Fig. 6 is employed. The hydraulic gage is connected to the coupling described, its pointer therefore indicating torque. The pointer of the tachometer shows the number of revolutions per minute. Being a function of the revolutions per minute and the torque, the horse-power will be indicated by the intersection of the two pointers and suitable curves on the dial as shown. Arrangements for recording or integrating the work done may also be attached to the coupling.

A summary of some of the more important characteristics of the instrument follows:

a. The instrument is compact. The example shown in Fig. 2 and Fig. 3, which is designed to transmit 30 horse-power at

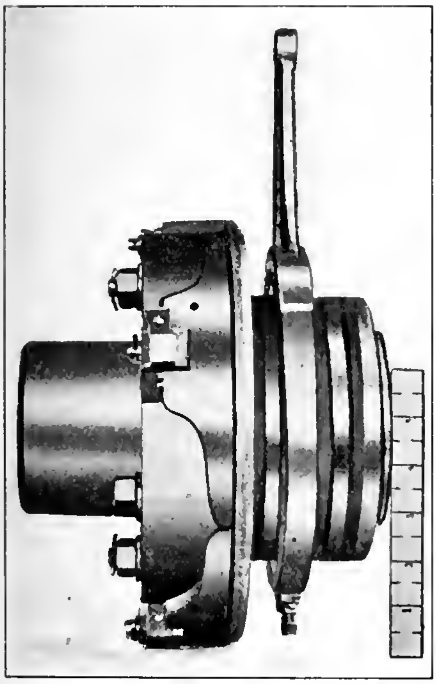

Fig. 1. Dynamometer for 2-inch Shaft, Weight 60 pounds

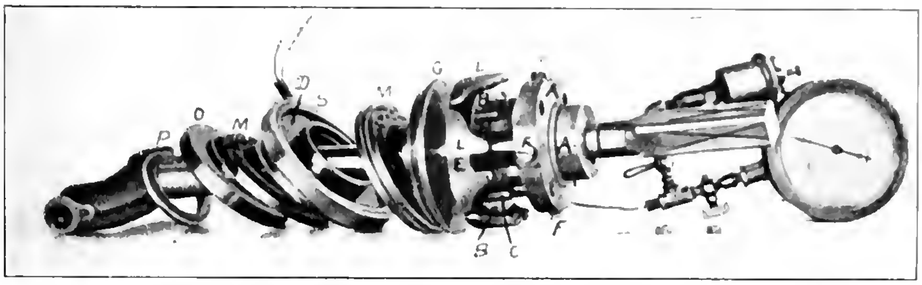

Fig. 2. Transmission Dynamometer taken apart to show Construction

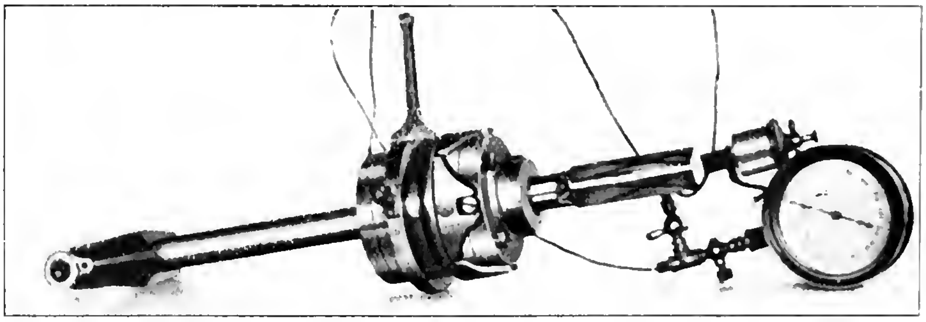

Fig. 3. Transmission Dynamometer in Automobile Propellor Shaft, 30 H.P. at 500 R. P. M., Weight 25 pounds

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* Abstract of paper presented at the Washington meeting (May, 1909) of the American Society of Mechanical Engineers.

† Associate professor of mechanical engineering, Brown University, Providence, R. I.

500 R. P. M., is about 5⅜ inches diameter and weighs about 25 pounds.

b. It is as rigid as an ordinary flange coupling.

c. It may be made in the form of a coupling, and will then occupy about the same space as the usual flange coupling, or it may be made in the form of a quill on which a pulley is mounted. This form may be made in halves for application to a continuous shaft.

d. It will indicate for either direction of rotation of the shaft.

e. The torque may be read and recorded or the work integrated at a considerable distance from the coupling.

f. The readings do not require correction for different speeds of rotation. All parts containing oil are stationary, hence are unaffected by variation in speed. Other parts are likewise unaffected by centrifugal action.

g. It may be made very sensitive and accurate. The construction lends itself very easily to variation of range of application and to varying degrees of sensitiveness, since the oil pressure, and hence the sensitiveness of the instrument, depends upon the area of the diaphragm, the relative lengths of the arms of the latches *L*, and the diameter of flanges. Its accuracy is dependent mainly on the degree of accuracy of the means employed to measure the fluid pressure, of which a number of forms, other than the usual pressure-gage, are available.

h. The only power absorbed is the small amount due to the friction of the ball, or roller, bearings, and this can be determined from the pull of the retaining arm. It is unnecessary to make correction for this, however, since the amount is so small as to be negligible.

i. Since the only wearing parts are the ball, or roller, bearings, which may be lightly loaded, the instrument should not be deranged easily. Because of the very small volume of oil contained in the weighing chamber, ordinary temperature changes do not affect the calibration. All parts containing oil are stationary, hence all joints may be soldered and leakage entirely prevented.

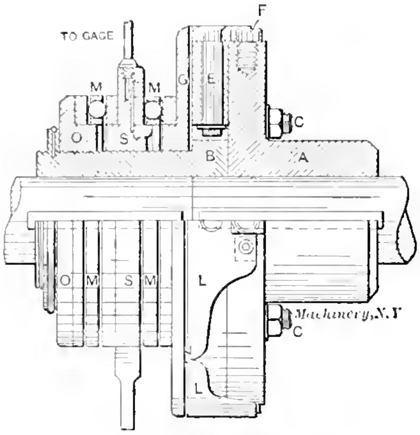


Fig. 4. Dynamometer Shown in Section

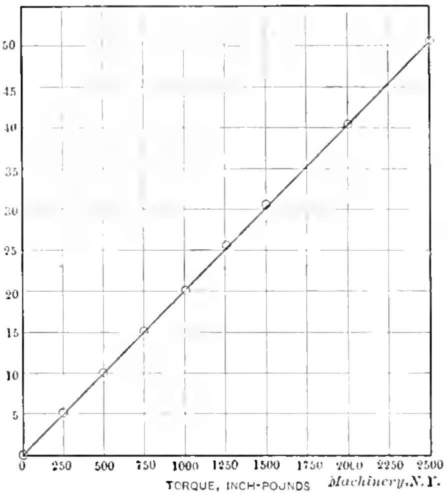


Fig. 5. Calibration Curve for Transmission Dynamometer

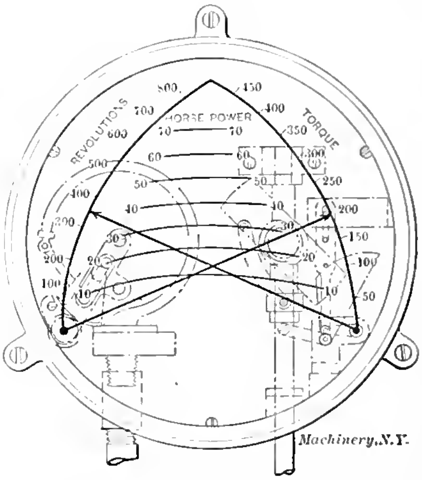


Fig. 6. Combination Pressure Gage and Tachometer, indicating Torque, Revolutions per Minute, and Horse-power

* * *

A curious condition exists regarding the penetration of high power rifle bullets, the penetration actually being greater at 100 yards than at 50 feet from the muzzle. The official data on the penetration of the Springfield army rifle, model 1903, using the cartridge loaded with 48 to 50 grains of pyrocellulose and the 150-grain Spitzer bullet is 33.5 inches of white pine boards 1 inch thick placed 1 inch apart at 50 feet from the muzzle; 46.7 inches, at 100 yards, and 24.3 inches at 500 yards. The difference is even more marked with thoroughly seasoned oak, the penetration being 12.2 inches at 50 feet and 33.6 inches at 100 yards. This condition of greater penetration at long ranges and reduced velocity is what caused the failure of the so-called bullet-proof cloth invented in Europe several years ago. The cloth or padding did actually arrest high speed bullets fired at close range, but at 300 to 500 yards, it was readily penetrated.

RECLAIMING ARID REGIONS IN THE WEST

The illustrated lecture by F. H. Newell of the Government Reclamation Service, delivered the evening of May 5, at the Washington convention of the American Society of Mechanical Engineers, was one of the most interesting and instructive entertainments provided. The extent of the government's work in reclaiming the arid regions of the West is but dimly appreciated by the majority of people in the east. The work is of vast extent and is being pushed with vigor in Arizona, New Mexico, Colorado, California, Idaho, North Dakota, Washington, Oregon, and other states. The colored views thrown on the screen of the results already realized from this work, vividly impressed all with the wonderful work accomplished which will mean more for future generations than for the present. The fruit produced on irrigated ground surpasses that of any other part of the world, especially the products of the land in the Northwest where the long summer days and fertile soil are extremely favorable to the best development and coloring. The extent of the work from the engineer's point of view, staggers the imagination, even of engineers accustomed to think of big projects. Dams, ditches, sluices, and other hydraulic works have been constructed under conditions of greatest difficulty. In many places special roadways, miles in extent, and along the sides of cliffs and in other trying situations, were necessarily bulit before the work could be done. The highest dam in the world will be on the Soshone river, in Idaho, its height being 328 feet. In this case the vast body of water impounded will irrigate not only the land below the natural water level, but will also be used to irrigate land considerably above it; the power developed by the dam will be employed in part for pumping water to the higher levels. The development of electric transmission of power enables modern irrigation engineers to accomplish wonders that were impossible before. The power developed by the dams is in many cases large, and through long distance transmission the water from canals or ditches can be elevated at far distant points to levels considerably above the general level of the country and thus new areas are brought under the magic effect of water. A feature of the Western arid lands now under irrigation, not generally appreciated, is its great fertility. Not having been rain soaked for centuries, the mineral constituents of the soil have been retained and when watered, the luxuriant vegetation produced is marvelous.

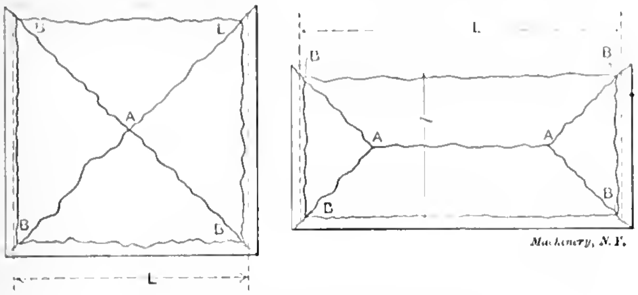
* * *

An airship of large dimensions is now being built at the Siemens-Schuckert Works in Berlin, Germany. The length of the airship is 426 feet, and the diameter of the supporting balloon is 42½ feet, the volume being about 460,000 cubic feet. The balloon space will be divided up into sections, so that if one part of the balloon is injured, it will still remain in the air. The airship is provided with four 125 H. P. motors, and it is expected that it will have a speed of at least 38 miles (60 kilometers) an hour.

FORMULAS FOR STRENGTH OF FLAT PLATES*

WILLIAM F. FISCHER†

The machine designer is often called upon to carry out designs consisting in part of flat surfaces, such as plates supported or fixed at the edges, with or without intermediate supports or ribs. Exact formulas for finding the bending moments of flat plates, and their resistance to the stresses created by pressures normal to their surface, have not, to the writer's knowledge, been determined. The formulas given by different authorities are founded on assumptions, and should be considered as probable approximations only; they should be used with caution, as the results obtained are not likely to be very accurate. In devising such formulas, all the assumptions should be made to err on the safe side.



Figs. 1 and 2. Probable Manner of Rupture of Flat Square and Rectangular Plates, held securely at the Edges

Square Plates

A square cast iron plate fixed or rigidly held at the edges and loaded with a uniformly distributed load, or a load concentrated at its center, would be likely to fail, as shown in Fig. 1. It would first fracture along the diagonal lines from *A* to *B*, and then fail at or near the fixed edges along lines *B B*. The plate, of course, might also shear off along the edges *B B*, depending upon the method of loading the span *L* between supports, and the thickness of the plate. If the plate were merely supported along all the four edges, it would be likely to fail by breaking along the diagonal lines *A B* only.

In the accompanying Supplement are given two tables of formulas for square flat plates. In Table I the plates are supported at all four edges and the load is uniformly distributed over the unsupported surface of the plate. Formulas given by different authorities are reproduced and the various values for total load, unit stress, etc., as obtained from the original formulas given by each authority, are given. A formula deduced by the author of the present article is also included.

In Table II in the Supplement are given formulas for square flat plates secured along all four edges with the load uniformly distributed over the unsupported surface. In the same table formulas are also given for square flat plates loaded at the center.

Rectangular Plates

In Fig. 2 is illustrated the probable manner of failure of a flat rectangular plate of cast iron loaded with a uniformly distributed load. The plate, if uniformly loaded and secured along all the four edges would probably fail by fracturing along the center line *A A* of the longer axis of the plate, and along the diagonal lines *A B*, and then fail at or near the edge of the support along the lines *B B*. If the plate were merely supported along all four edges, it would fail simply by fracturing along center line *A A* and the diagonal lines *A B*. As may be readily seen, the plate firmly secured at the edges offers a much greater resistance to the stress created by the load than does the plate merely supported at the edges.

In Table III in the accompanying Supplement, a number of formulas for flat rectangular plates supported at all four edges and loaded with a uniformly distributed load are given. Among these are also included formulas deduced by the writer. In Table IV are given formulas for flat rectangular plates firmly secured at all four edges and loaded with a uniformly distributed load. The fact that various authorities differ considerably, indicates the approximate nature of investigations along these lines. It is, however, important that formulas be deduced and used for designs of this character, because, while the formulas are only approximately correct, they indicate, in a general way, the dimensions required in flat plates, and the factor of safety assumed will always be taken large enough so that, practically, the difference between the various formulas is of small moment. It would be advisable, however, to use the formulas which give the greatest dimensions, indicating that they are on the safe side. Accompanying the present article will be found a table

RECTANGULAR FLAT PLATES SUPPORTED AT ALL FOUR EDGES AND LOADED WITH A CENTER LOAD W

Author and Reference	Formulas as Given by Author	Safe Load at Center of Plate $W =$	Unit Stress in Extreme Fiber of Material $f =$	Thickness of Plate in Inches $t =$
Grashof, Trautwines, C. E. Pocket Book, page 493	$f = \frac{3\,C\,W\,L\,l}{2\,t^2\,(L^2 + l^2)}$ $C = 2$	$0.34\,\frac{f\,t^2\,(L^2 + l^2)}{L\,l}$	$3.\,\frac{W\,L\,l}{t^2\,(L^2 + l^2)}$	$1.73\,\sqrt{\frac{W\,L\,l}{f\,(L^2 + l^2)}}$
Rankine, Civil Engineering, page 543	$M = \frac{3\,W\,L^4\,l}{8\,(L^4 + l^4)}$ where l is less than 1.19 l	$0.45\,\frac{f\,t^2\,(L^4 + l^4)}{L^3\,l}$	$2.25\,\frac{W\,L^3\,l}{t^2\,(L^4 + l^4)}$	$1.5\,\sqrt{\frac{W\,L^3\,l}{f\,(L^4 + l^4)}}$
Rankine, Civil Engineering, page 543	$M = \frac{W\,l}{4}$ being the same as for a plate supported at side edges only	$0.67\,\frac{f\,L\,t^2}{l}$	$1.5\,\frac{W\,l}{L\,t^2}$	$1.225\,\sqrt{\frac{W\,l}{f\,L}}$

RECTANGULAR FLAT PLATES, FIRMLY SECURED ALONG ALL FOUR EDGES AND LOADED WITH A CENTER LOAD W

Grashof, Trautwines C. E. Pocket Book, page 493	$f = \frac{2\,C\,W\,L\,l}{2\,t^2\,(L^2 + l^2)}$ $C = 1.75$	$0.38\,\frac{f\,t^2(L^2 + l^2)}{L\,l}$	$2.62\,\frac{W\,L\,l}{t^2\,(L^2 + l^2)}$	$1.6\,\sqrt{\frac{W\,L\,l}{f\,(L^2 + l^2)}}$

M = maximum bending moment, inch-pounds
L = long span between supports
l = short span between supports
W, f and t as given above.

Note: Rankine gives bending moment M only as given in second line.

Writer assumes resisting moment M_1 as $M_1 = \frac{f\,l\,t^2}{6}$

Then $M = M_1$ or $\frac{3\,W\,L^4\,l}{8\,(L^4 + l^4)} = \frac{f\,L\,l^2}{6}$; also $\frac{W\,l}{4} = \frac{f\,L\,t^2}{6}$

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* With Data Sheet Supplement.
† Address: 220 W. 149th St., New York City.

for rectangular flat plates supported or secured at all the four edges and loaded in the center; in the tables where only one set of formulas is given, it indicates that the authorities quoted in the other tables do not give formulas for the case in question. As the formulas here collected usually are found only by diligent search in a number of different hand-books, and as these hand-books may not always be easily procurable, the author hopes that the collection will prove useful to many readers of MACHINERY who, at some time or other, may be called upon to lay out a design involving square or rectangular flat plates.

* * *

OIL TESTING MACHINE

An interesting machine for testing the durability of the lubricating qualities of oils has been designed by Mr. Paul Wendt, Kottbus, Germany. The machine, as shown in the accompanying engraving Fig. 1, reproduced from the *Zeitschrift des Vereines deutscher Ingenieure*, is mounted on a frame, and a slide *A* is moved forth and back by means of a crank motion. On top of the slide *A* is placed another slide *B* which rests freely on the lower slide, and is carried forth and back with it by friction only. When the contact surfaces of *A* and *B* are well lubricated, the inertia of the part *B* and the resistance offered by the mechanism will tend to make it move but little, but when the friction between the two surfaces becomes greater, the part *B* will have a tendency to follow the part *A* forth and back for the whole stroke. On the end of the rod passed through and secured to *B*, a ratchet pawl is mounted, which engages with the ratchet wheel *C*, provided with teeth of very fine pitch. When the motion of *B* becomes sufficient to turn the ratchet *C* one tooth space, the ratchet will stay in the position to which it had been moved by the engagement of the pawl *D*. On the same spindle on which the ratchet wheel is mounted is also mounted a cylinder around which is wound a sheet of paper, and under this cylinder is placed a scriber which is given a motion sideways, by a screw driven by bevel and spur gearing from the same crank-shaft which gives the motion to the slide *A*. On the end of the shaft, passing through the ratchet gear and recording cylinder, a lever is placed, on the end of which an adjustable weight *E* is attached. The lever hangs in a perpendicular position at the beginning of the test, but as the ratchet *C* is moved around, the lever and the weight will follow, moving to the right. By this means resistance to motion of the slide *B* and ratchet *C* is increased automatically, so that as the experiment proceeds, and the oil deteriorates, the frictional resistance between *A* and *B* becomes greater, and a greater force is required to move the ratchet *C* one tooth space.

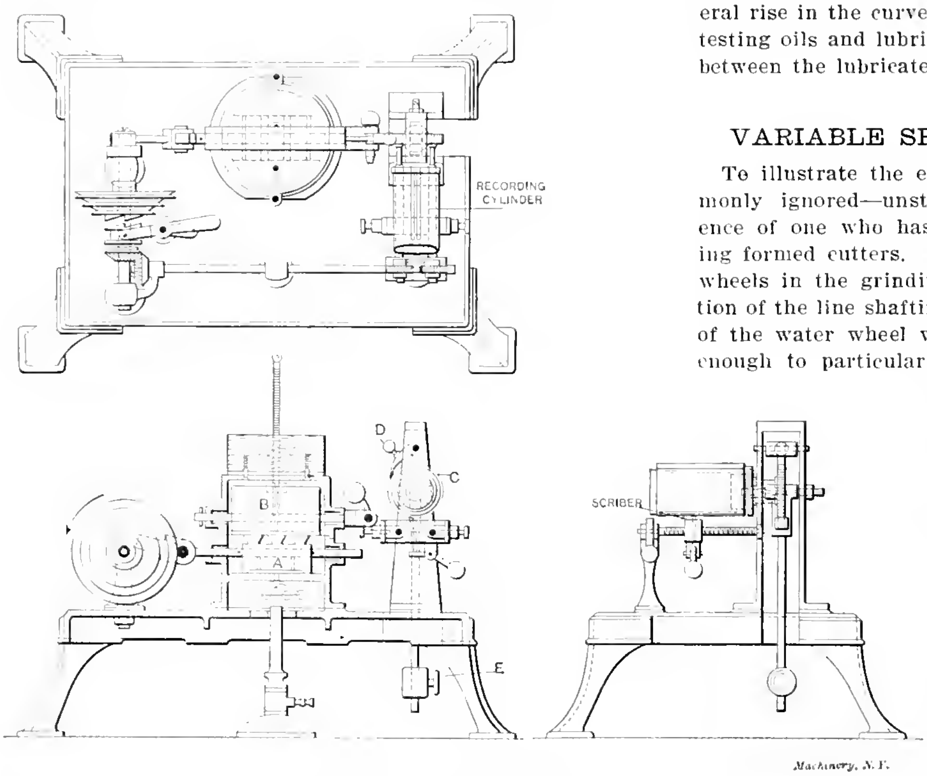

Fig. 1. Wendt Oil Testing Machine

The apparatus is of value for comparing the qualities of different oils. In the two examples shown in Fig. 2, the diagrams indicate that in one case the oil retained its lubricating qualities practically unimpaired for fifty-four minutes, but then, having become heated, it very quickly became impaired in quality. In the other case shown, another oil retained its lubricating quality only twenty-one minutes. By testing the oils by this machine, therefore, it was found that it would be likely that of the latter oil, more than twice the quantity would be required for equally good lubrication that would be required of the first kind of oil. The uneven character of the line recorded on the cylinder depends upon the fact that the slide constantly moves slightly forth and back and thereby gives a vibrating motion to the recording cylinder. But until the motions forth and back become large enough to move the ratchet one tooth space, there is no general rise in the curve produced. The machine is intended for testing oils and lubricants which are used in small quantities between the lubricated surfaces.

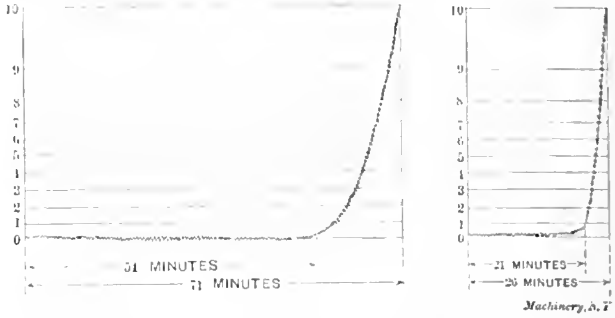

Fig. 2. Records produced on the Oil Testing Machine, showing Comparison between two different kinds of Oil

* * *

VARIABLE SPEED FACTOR IN GRINDING

To illustrate the effect of a factor in grinding quite commonly ignored—unsteadiness of speed—we cite the experience of one who has developed special apparatus for grinding formed cutters. When this work was first developed, the wheels in the grinding department were connected to a section of the line shafting driven by a water wheel. The motion of the water wheel was subject to some fluctuation, but not enough to particularly affect the grinding so far as casual inspection would show. There was trouble, however, from constant breakage of emery wheels, these having to be of very thin section to do the work required. A few years later, a steam turbine was substituted for the water wheel and at once a great reduction in the breakage of the wheels was noted. The steam turbine operated with more steadiness than the water wheel and to this fact alone is attributed the reduction in the breakage of the grinding wheels. It is not clear why the fluctuation of the water wheel should affect the grinding wheels in this manner. The amount of material removed in the grinding operation is small and the side-pressure on the wheels is low. The difference in operation due to the fluctuations of the water wheel should not account for the breakage, but the fact remains that the breakage has been greatly reduced with steadier motion. Who can give the best explanation?

* * *

According to *Page's Weekly* the results of the trials with the White Star liner *Laurentic*, which is equipped with a combined system of reciprocating and turbine engines, have been so satisfactory that it is probable that the same system will be used in the two giant steamers, *Olympic* and *Titanic*, which are now being constructed by Harland & Wolff in Belfast.

MAKING AN ENGRAVING BLOCK

ETHAN VIALL*

The old-time ball-vise or "sow-block," as it is known among die-sinkers, is scarcely recognizable in the beautifully finished engraving block of today, with all of its numerous adjustments and attachments; yet the rough old device with its rough-cast hemispherical-base and wooden pillow, was without a doubt the granddaddy of the present form. The engraving-block described in this article, was, as its name indicates, intended primarily for engravers' use only, but its usefulness to the tool- and die-maker will be at once recognized by those not already familiar with it, for while it will hold delicate articles without crushing them, it will also hold anything within the capacity of its jaws, as firmly as any vise made, and in any workable position. There is nothing weak or fragile about the tool even if it is a beautiful piece of workmanship.

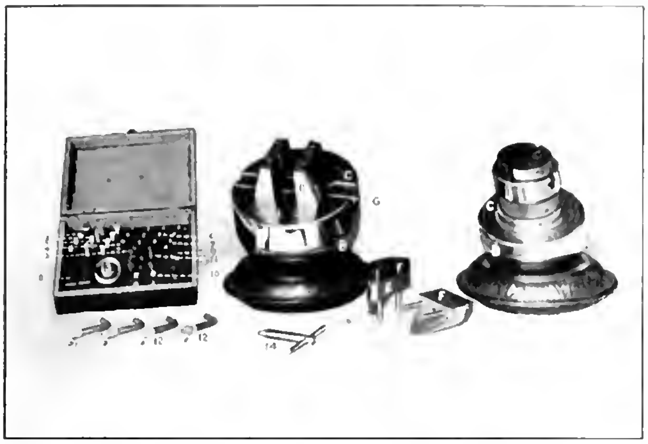
Fig. 1. Regular and Keylsss Engraving Blocks and Attachments


Fig. 2. Partly finished Castings for the Spherical Base

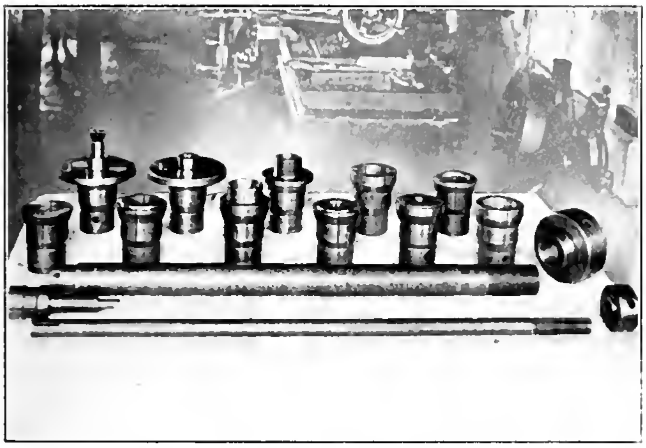
Fig. 3. Set of Split Chucks for Jones & Lamson Lathe

Fig. 4. Centering the Spherical Base

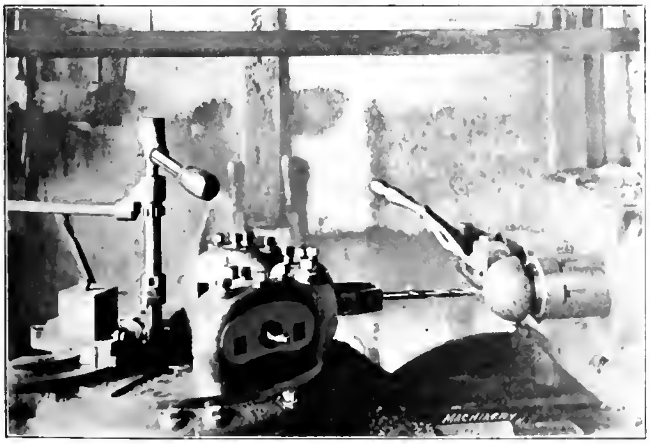

Fig. 5. Drilling the Hole in the Base

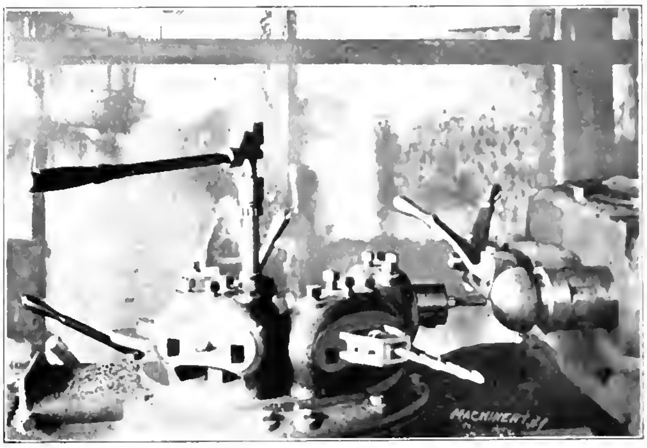

Fig. 6. Tapping the Hole in the Base

There are two things that must be kept in mind by anyone making goods for jewelers' or engravers' use; first, such articles must be well made, and, second, they must be well finished. The block here shown certainly fills these requirements in every way. This block was originally designed by L. W. Géry, an engraver of New Orleans, and it is manufactured by Adolph Muehlmatt of Cincinnati, Ohio. Mr. Muehlmatt is a practical engraver and toolmaker of more than local reputation, who has from time to time added improvements as the demands of the trade or his own originality suggested them, and it is through his courtesy that we are enabled to publish the following article.

Mr. Muehlmatt manufactures two styles of engraving blocks. The regular and the keyless form, both of which with their attachments are shown in Fig. 1. The jaws of the keyless block, which is shown at the right, are operated by a knurled ring in a manner similar to an ordinary scroll chuck. The regular block is, when shorn of its special attachments, simply a two-jawed universal chuck mounted on a turntable and "ball," the whole thing being set into a ring. This article will deal principally with the regular style, which is shown in detail in Fig. 7.

By examining Figs. 1 and 7 it will be seen that besides the two chuck-jaws *D*, there are two removable false jaws *E*, upon the top of which are placed two semi-circular pieces of

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* Associate Editor of MACHINERY.

steel *F*, one of which is stationary and the other swiveled. These top pieces have holes drilled about three-quarters of the way through them for the insertion of the various attachments shown in the box and on the table at the left in Fig. 1. The numbers given to the parts correspond to those of similar parts which are shown in the line engraving, Fig. 8, except that 13 and 14 are omitted in the latter, as they are simply a key with a knurled head for light work, and a key with a cross handle for heavier duty. The way these attachments for the top pieces or third set of jaws, are used by the engraver for holding different shapes, is partially shown in Fig. 9. The method of holding a fancy pencil-case is shown at *A*; *B* shows the bowl of a spoon clamped to the block; *C* a spoon handle, and *D* a small locket or pendant. The large rubber-covered hooks shown at 12, Fig. 1, are intended to hold large metal plates, and they are usually used directly in the jaws *D*. The length of the two pins in the false-jaws *E* is such that the jaws will stand, as shown in the engraving. This is often a desirable feature when special attachments are used and the work is interrupted and must be removed for a few minutes on account of other and perhaps heavier work. The pillows *A* shown in the halftone are leather rings which are filled with sand. These rings are far more "clinging" and satisfactory than wood or metal ones.

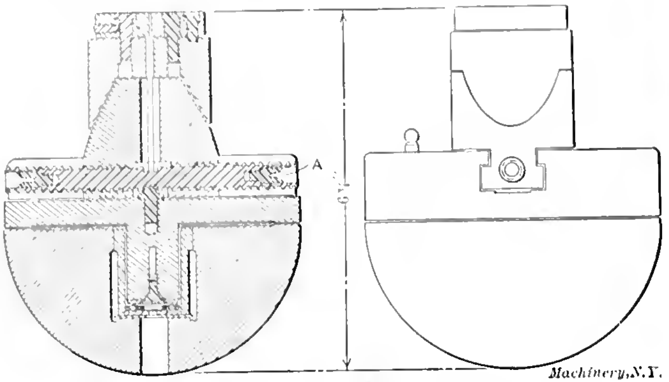

Fig. 7. Elevation and Section of the Engraving Block

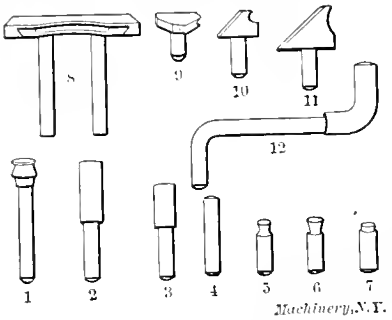

Fig. 8. Auxiliary Attachments for the Block

Making the Bases

The hemispherical, or "ball" bases *B*, are made of cast iron and are cored out to make them light and convenient to handle. In machining these bases they are first placed in an ordinary three-jawed chuck; the "flat" part is then turned and the hole bored as shown by the barrel of castings in Fig. 2. The bases are next held in a Jones & Lamson flat turret lathe, by means of the bored holes which fit over an expanding chuck.

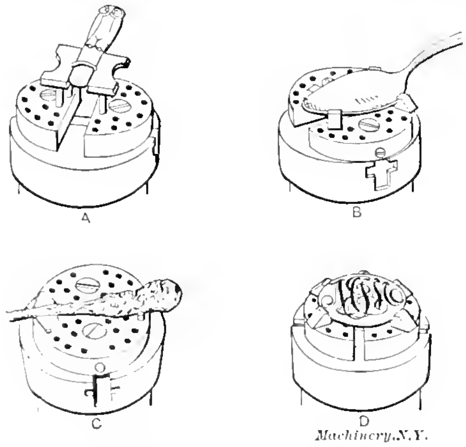

Fig. 9. The Way in which Irregularly Shaped Pieces are held by the Auxiliary Attachments

Most men who have worked in the big watch factories have a strong liking for split chucks, and Mr. Muehlmatt is no exception, as will be evident by examining Fig. 3. This complete set of spring chucks, both expanding and contracting, types, together with the quill and rod shown, were made for use on the Jones & Lamson lathe, to do this special work. It

Fig. 10. Attachment for Turning the Spherical Surface of the Base

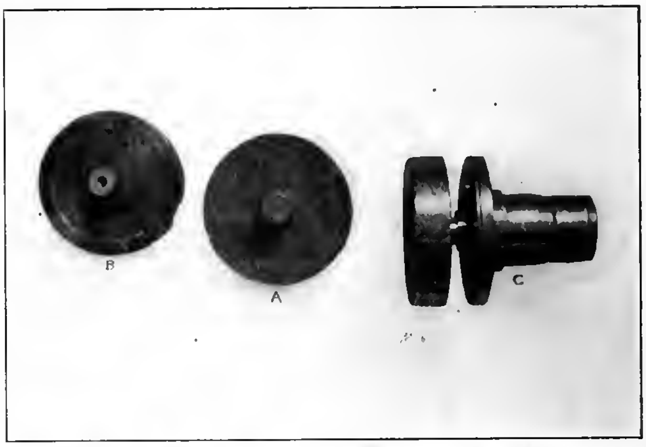

Fig. 11. Turntable of the Block with Jig and Chuck for Machining it

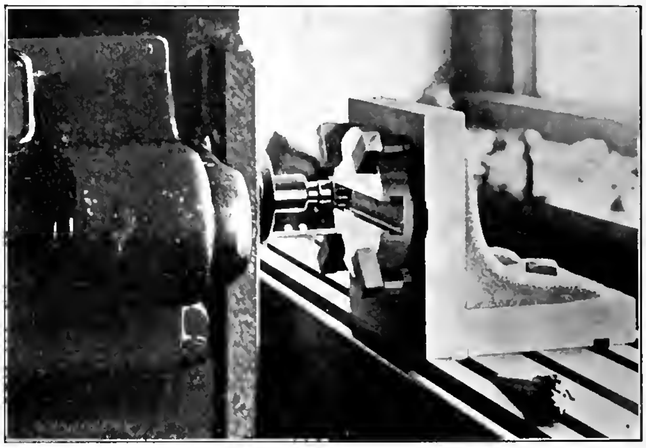

Fig. 12. Finishing the T-slot in the Turntable

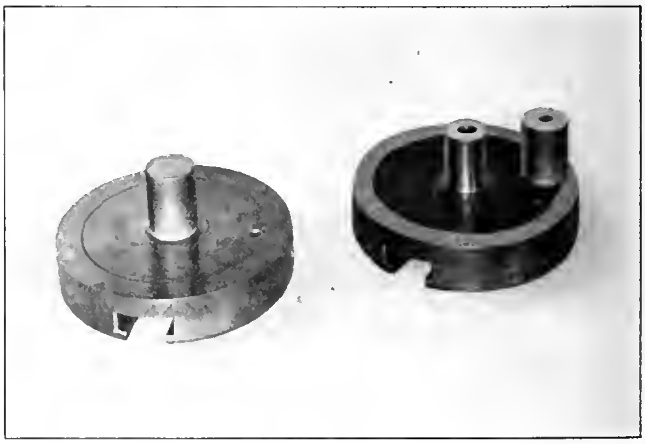

Fig. 13. Method of Protecting Turntable Bearings from Plating Solutions

is seldom that work of this kind is done on a lathe of this type, so that it is worthy of more than passing notice.

Centering, Drilling and Tapping

After placing the base on the expanding chuck, the first operation is to center it for starting the drill, as shown in Fig. 4, using the usual form of flat centering tool. The hole is then drilled, and tapped as shown in Figs. 5 and 6.

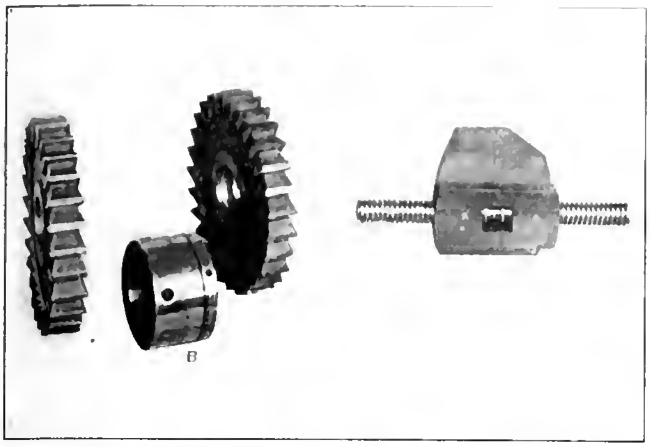

Fig. 14. Micrometer Spacing Collar—Jaws ready to be Machined

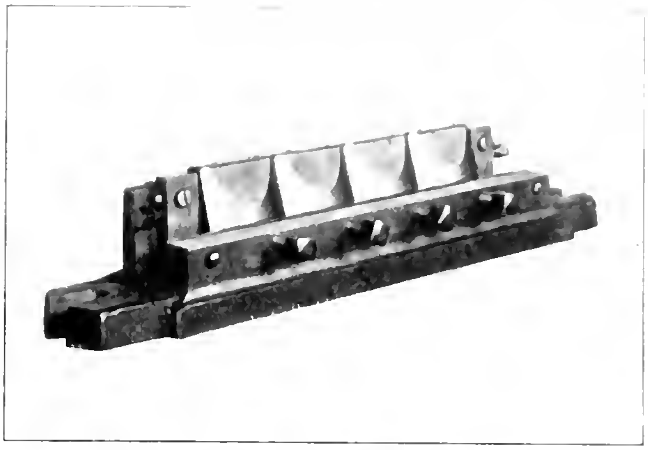

Fig. 15 Fixture for Holding Jaws while Milling the Bevel

Fig. 16. Channelling out the Turntable for the T-slot

Fig. 17. Damaskeening the Turntable Top in a Drill Press

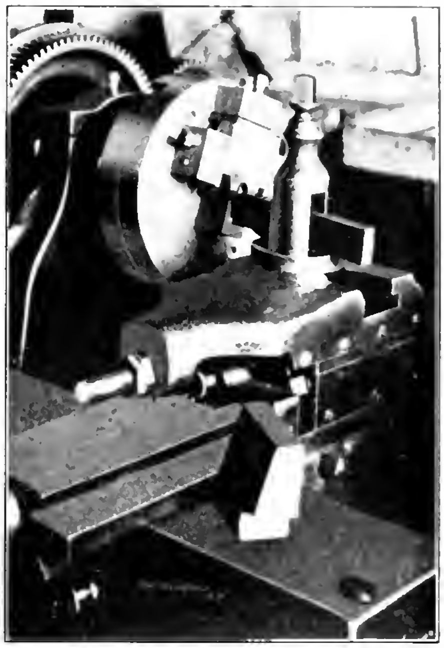

Fig 18. Boring, Threading and Facing Jaws in a Lathe

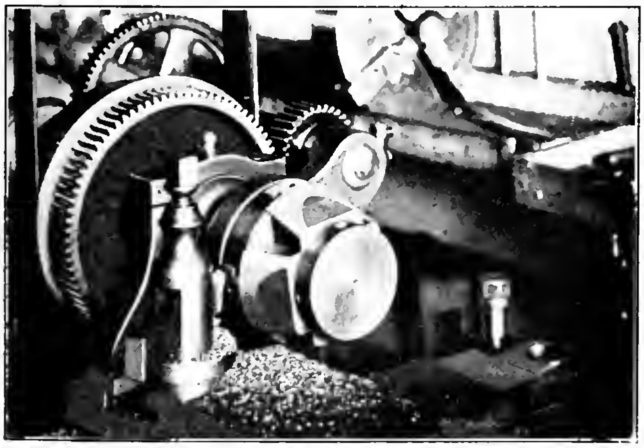

Fig. 19. Turning the Outside of the Jaws in the Lathe

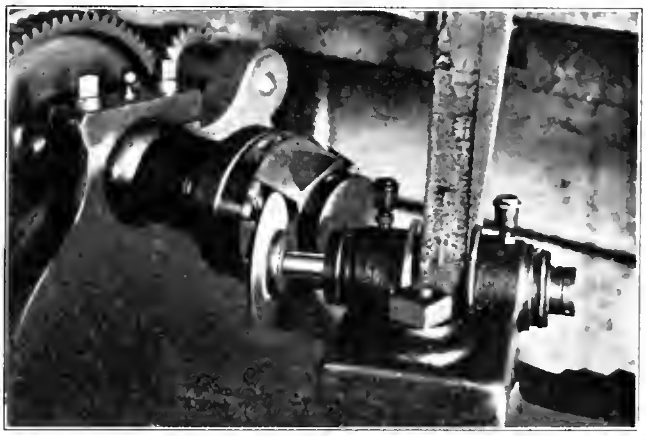

Fig 20 Grinding the Outside of the Jaws

Turning the Hemisphere

The next operation consists of turning the spherical surface, using the device shown in Fig. 10, which was designed by Mr. Muehlmatt. As will be seen, the device consists mainly of a circular-shaped rack or gear-segment carrying a tool-post and tool, which is turned by means of a small pinion, meshing with the gear teeth. This pinion is fastened to an upright shaft having two ratchet hand levers on the upper end. These ratchets are very convenient as they not only allow the levers to be in any position while they are being used, but also allow them to be swung out of the way during the other operations.

After the bases are removed from the lathe they have a small hole drilled in the flat or top part for a stop-pin that locks the turntable and base together when the swiveling motion is not desired. They are then ground and polished ready for the nickelplater.

Machining the Turntables

The turntables C, Fig. 1, a rough casting of which is shown at A, Fig. 11, are first held in a regular chuck, the bottom and stem turned and the small hole for the screw that holds the hardened washer drilled and tapped. The stop-pin hole

is next drilled, using the jig shown at *B*, which slips over the turned stem. This jig is also used to drill the hole in the base just referred to, a collar on one side just fitting the large hole in the base. In this way the stop-pin holes in the two parts are sure to line up. Two small bushed holes are in the jig shown because it is used for two different sizes of engraving blocks. The partly machined turntable is next held in the split chuck *C*, which fits the Jones and Lamson lathe, and the face and outside diameter is turned. The chuck *C* has a face-plate attached to it which has a pin in it fitting the stop-pin hole of the turntable; this pin acts as a driver.

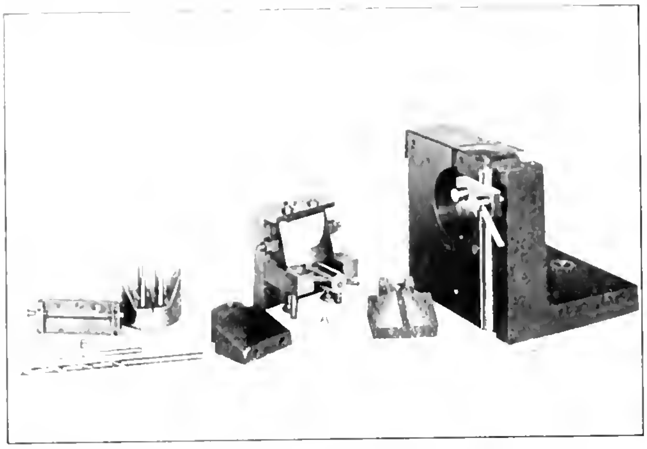
Fig 21. Two Jigs and a Fixture used in the Construction of the Block

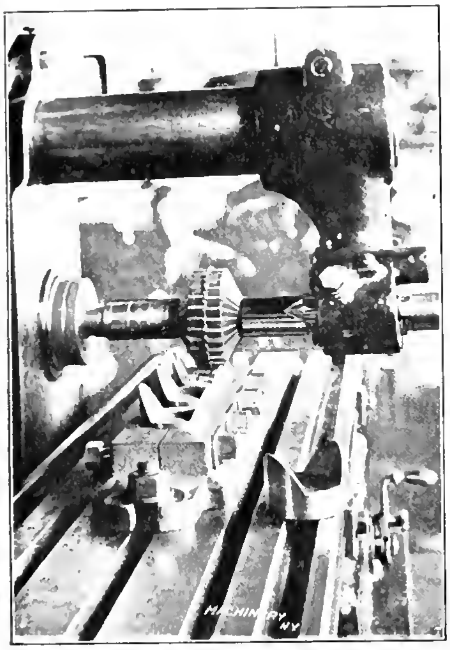

Fig 23. Milling the False Jaw Blanks

Milling the T-slot for the Chuck Jaws

When the turntables go to the milling machine to have the T-slots for the chuck jaws cut in them, they are placed in the fixture shown in Fig. 16 and channelled out. They are then transferred to the angle-plate jig, Fig. 12, and the T-slot finished. The edges of the slot are next rounded with the milling cutter lying on the table; the parts are then ready for the final grinding and plating.

In plating, it is undesirable to have nickel or copper deposited on the stem as it is a bearing, so small metal caps, Fig. 13, are placed over the stems to keep off the solutions.

Fig 25. Tools for Laying Out Holes in Jaws F, Fig. 1

Damaskeening the Turntables

The fancy spotting or damaskeening of the turntable tops is done on a small drill press (Fig. 17), the turntable being revolved on its own stem, which is set into a socket in the special base. The spotting tool used is simply a piece of steel rod, to the end of which is cemented a disk of leather. In doing the work the top of the turntable is smeared with fine emery and oil and it is turned with the left hand while the right works the rapidly revolving tool up and down by means of the hand lever.

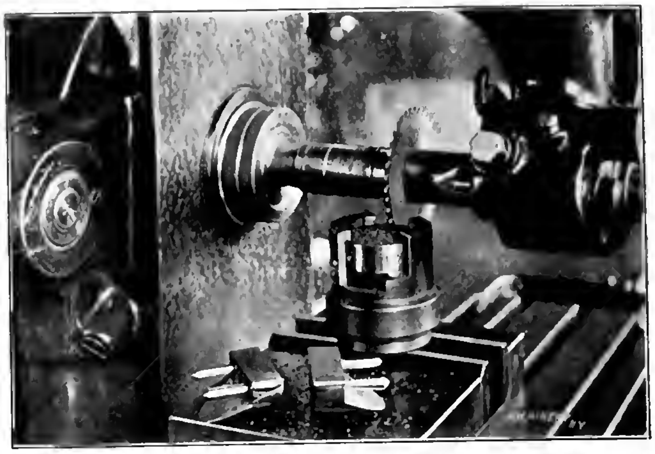

Fig. 22. Splitting the False Jaws in the Milling Machine

Machining the Jaws

Most of the ordinary straight milling on the chuck-jaws, such as facing off the top and sides, is done by holding the piece in the regular vise, but for truing the face of the jaw and boring and threading the clamping screw hole, they are held in the lathe by the fixture shown in Fig. 18. After a pair of jaws have been screwed together, as at *A*, Fig. 14, they are "squared" all over and stamped as mates. In the final fitting to the turntable the idea is kept in mind that while the fit must be good, the parts must work freely and easily with no bind anywhere.

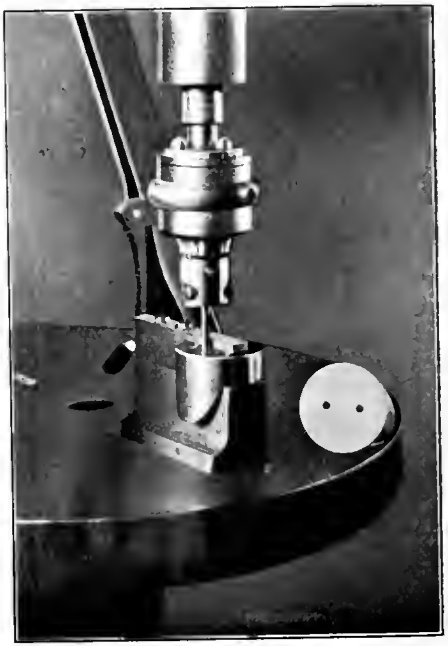
Fig. 24. Jig and Tapping Head for the False Jaws

A micrometer-adjustment spacing-collar is shown at *B* in Fig. 14, which is very convenient for straddle-mill work.

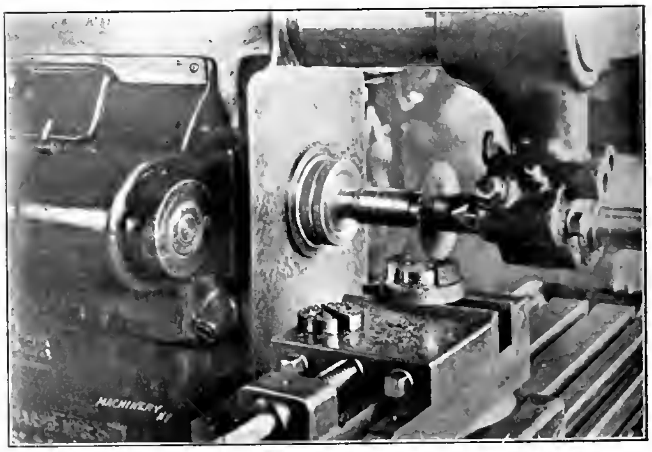

Fig. 26. Splitting the Jaws F, Fig. 1

In Fig. 15 is shown the fixture used for holding the jaws while milling the bevel on them, which is done with a bevel side-mill. Fig. 19 shows the way four of the jaws are held in the lathe while turning them, and Fig. 20 shows how the same fixture is used to hold them while they are being ground.

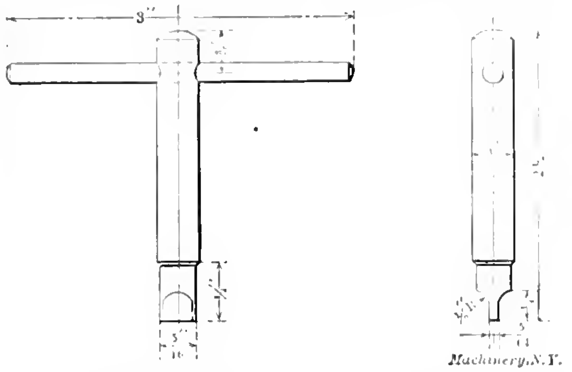

Fig. 27. Key used for Tightening the Jaws

When drilling the holes for the pins which hold the false-jaws in place, the chuck-jaws are placed in the jig shown at *A*, Fig. 21.

The False Jaws

The false jaws are both cast in one piece with a pin or stem on them similar to the one on the turntable, which is used to facilitate handling. The false-jaws are chucked by this stem, the outside turned and the stem is then cut off and the piece faced off at the same time. The blanks are next placed in the fixture, Fig. 23, and milled as shown. The slot which is sawed down the middle is put there to act as a guide for the drilling jig *B*, Fig. 21, used to drill the pin holes and the holes for the upper jaw screws, the jig having a tongue which exactly fits this slot.

The jig and geometric tapping head shown in Fig. 24 are used while tapping the screw holes in the false-jaws. The jaws are then placed in a fixture and split in the milling machine as shown in Fig. 22.

The upper or swivel jaws *F*, Fig. 1, are at first only flat pieces of steel, which are placed, one at a time, into the box-like piece *A*, Fig. 25. The part *B* is then placed on top and a blow given it under the hammer, with the result that all the holes to be drilled in the piece are "spotted" at one stroke by the blunt punches in the bottom; the piece then appears as shown at *C*, while at *d* its appearance is shown after all the holes have been drilled and the piece split. This splitting is done as shown in Fig. 26.

By referring back to Fig. 7 it will be seen that the screw that clamps the jaws together has a rather peculiar arrangement in the ends for the key. Instead of having a square hole, drifted out as usual, it has a piece, *A*, pressed into it.

The way the screw-blank is held while the ends are drilled for this piece is shown at *C*, Fig. 21. After the holes are drilled the small pieces are forced in with a hand-press as shown in Fig. 28, the holder and shape of the punch used being shown in Fig. 29. The style and shape of the end of the key used is shown in Fig. 27. The way these small key-pieces are held while being slotted is shown in Fig. 30. Three other gang jigs are also shown on the table in this halftone. The forcing in of the slotted key-pieces necessarily swells the ends of the screw-blanks to some extent, but as the thread is cut afterward no harm is done. This thread is cut with a Rivett-Dock threading tool. One-half the screw is held in a split chuck with the outer end steadied by the tail-stock center, as

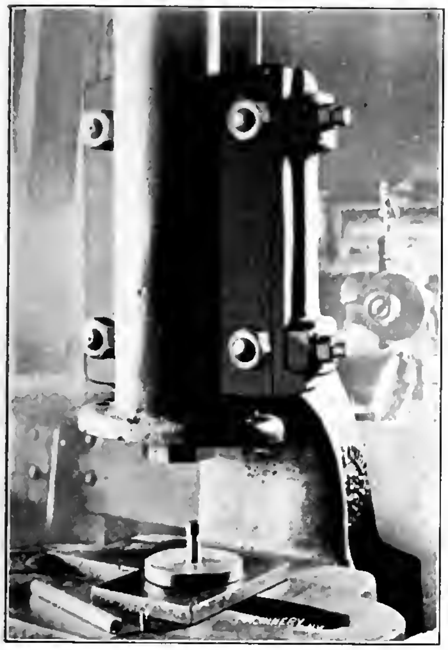

Fig. 28. Forcing the Piece A, Fig. 7, into Place

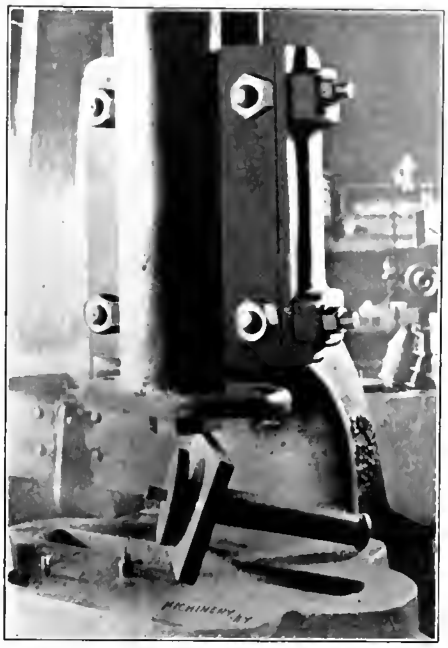

Fig. 29 View showing Holder and Shape of Punch

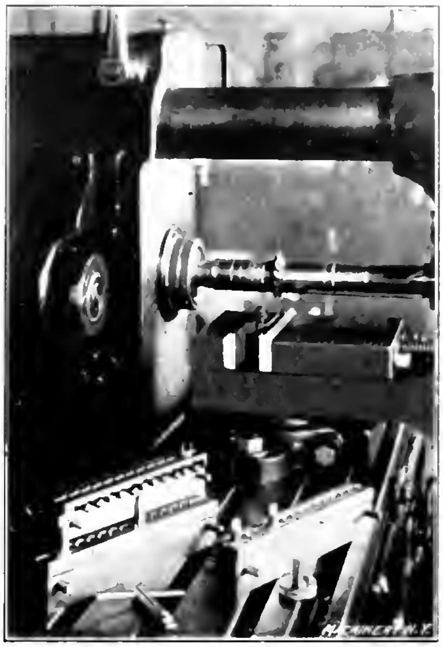

Fig. 30. Milling the Slots in the Pieces A, Fig 7

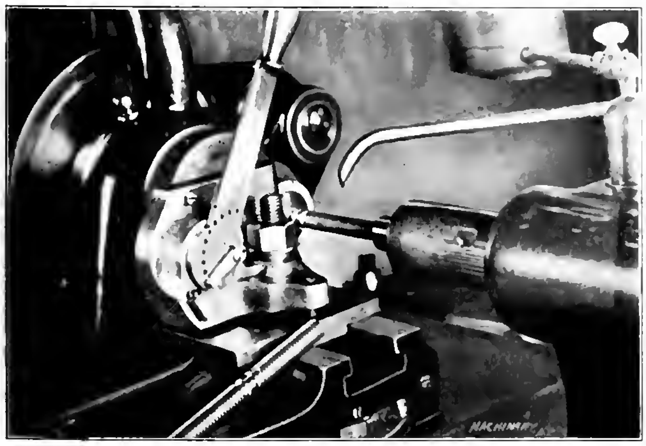

Fig. 31. Threading the Clamping Screws

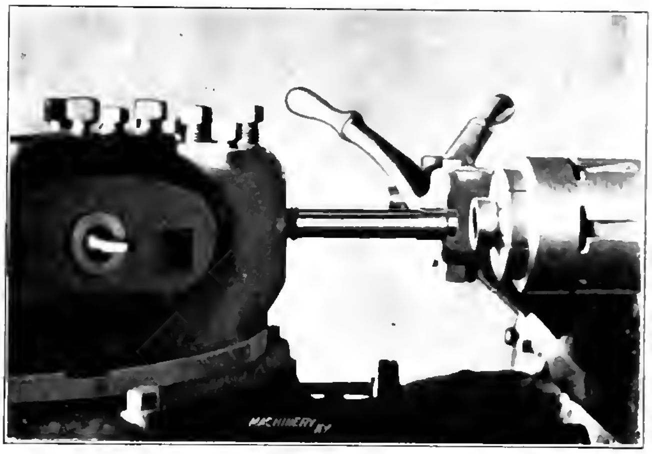

Fig 32. Boring the Turntable Bushings

shown in Fig. 31, the blank having, of course, been previously turned to size.

Bronze bushings are set into the base of the engraving-machine, as a bearing for the stem of the turntable. In machining the inside of these bushings they are held in a draw-in chuck in the Jones and Lamson turret lathe, rough bored, and then finished to size with a Schellenbach-Hunt adjustable boring-bar, as shown in Fig. 32. The use of a boring-bar seems to be the best way to secure accurately bored bushings in this case, as any attempt to finish bore with a tool depending on a carriage stop will not give uniform results.

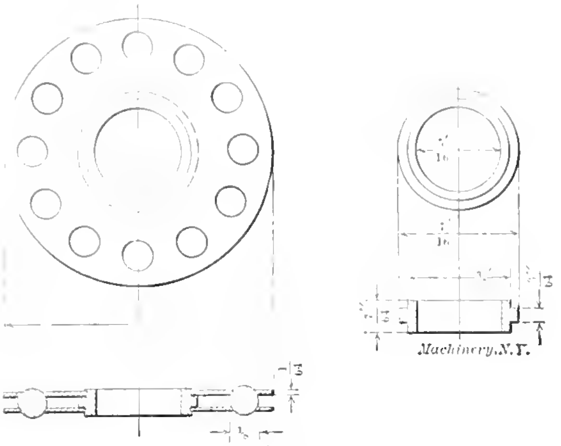

Fig. 33. Detail of the Ball Bearing for the Turntable

At the bottom of this bronze bushing as it rests in place in the base, is a special form of ball bearing which is shown in detail in Fig. 33. The cage consists of two punched disks held together by a hub onto which they are pressed and riveted fast. The manner in which this cage works between two hardened steel disks may be seen by referring to Fig. 7.

* * *

Reinforced concrete is rapidly coming into use as a building material and for making engineering structures of all kinds. It is a material admirably adapted for permanent structures, being practicably indestructible and gaining strength with age. It is not a material easy to handle, however, and special apparatus and experience are required to make a concrete structure secure. Some who are of the idealistic type, are dreaming of an ideal building material which can be molded into form without the difficulties and drawbacks of concrete, and one of the great developments of the future may be a partial realization of these dreams. It is possible that water will be the principal part of the new building material. Suppose that the normal temperature were at or below zero. Water would then make an ideal building material, provided, of course, that it could be readily obtained and that the interior temperature of the building would never rise above the melting point. Ice blocks would then be as good as concrete blocks, and finely divided ice could be used for the bond or mortar at the joints; or water-tight forms could be used to give the desired shape, the water being poured in, and allowed to freeze. Ice structures have been built in northern countries, and used for a variety of purposes, including exposition buildings of large size. The dreamers of an ideal building material have thought of the possibility of discovering a material which added in small proportions to water would cause it to crystallize and take permanent form having strength and heat-resisting qualities equal to cement. When we consider how little solid matter is required to make a firm jelly, it does not seem inherently impossible that the dream may be realized. Granting realization, then, monolithic construction would be reduced to the simplest terms, and the cost of transportation of the greater bulk of the material in cities would be eliminated, save that the charge for water is partly due to the cost of piping to the spot.

* * *

A great many women students are, at the present time, studying at the German engineering schools. According to a consular report, 1 230 female students are enrolled at the nine leading German engineering schools.

PATENT LAWS AND THE COST OF MANUFACTURE

In the new British patent act a clause is inserted requiring that articles patented in Great Britain shall be manufactured in that country to "an adequate extent." The United States Consul J. M. McCunn of Glasgow, states that he has been informed that under this law parts of patented machines and devices could be manufactured in the United States and then simply assembled in Great Britain. The ground on which this view is taken is that each part of a machine considered separately is not a patented article, and that the patent merely applies to the machine as a whole. As no test case has been brought into the courts, the Consul states that the previous opinion is the generally accepted reading of the law until a test case has been brought. Should this be a sound opinion it would mean that the new British patent act would be valueless in bringing about the results for which it was framed, and the construction of the law along the lines indicated would be entirely out of harmony with ordinary common sense. From an engineer's point of view assembling in itself cannot be considered manufacturing. A manufacturer of patented articles would at least be expected to make the majority of the integral parts. It is admitted, of course, that it is difficult to draw a distinct line between actual manufacturing and assembling. Many automobile firms, for instance, buy a large proportion of the parts ready-made from manufacturers of specialties in that line, yet, these manufacturers are generally and properly considered makers of automobiles. When assembling pure and simple is referred to, however, it is clear that no engineer would refer to the process as manufacturing, and the British lawyers who would interpret the new law to that effect are likely to find it rather difficult to convince an intelligent court, and even more difficult to secure expert testimony to support their view of this matter.

Taking larger views of the question, however, and considering from the productive engineer's point of view the benefit derived fom a law requiring patented articles to be manufactured in every country where the patent is granted for the article, there is considerable chance for difference of opinion with the framers of the new British patent act. While it is reasonable to require that every inventor or firm owning an invention should make use of it if a monopoly in the manufacture of the article in question is expected, it is not so clear that it is reasonable to require that every patented article should be manufactured in every country where the patent is in force. Such a requirement is simply an indication of the narrow sphere of thought from which mankind is slowly emerging, and is distinctly uneconomical from the productive engineer's point of view. It requires a duplication of plant and special machinery at great expense; in the end no actual benefit is derived by anybody, and the productive capacity of a great number of people is merely turned into wrong and useless channels. The engineer is concerned primarily with the reduction of the cost of production, and to him the question of prime importance should be to what extent any special law reduces this cost. From the engineer's point of view it would evidently be best that the whole world's supply of a certain article be manufactured in one or a few places where the cost of production of that certain article is the lowest. Of course, the economic gain from centralized manufacture would be lost in cases of exceptionally bulky or heavy manufactures, where increased freight charges would become a serious item. In this connection tariff duties between different countries ought to be considered, but as these are artificial and not natural barriers, the engineer may disregard them for the moment when he endeavors to arrive at a law governing the most economical methods of production. In the final analysis, of course, the results of tariffs between different countries must also be considered, as they increase the cost of production of the world's total supply of any one article, and consequently work in opposition to the constant aim of the engineer of decreasing the cost of production and devising means for producing the largest amount of goods at the smallest expenditure of labor.

MACHINE SHOP PRACTICE*

TWIST DRILL GRINDING

The drill is one of the most common tools used by the machinist and it is also the tool which, perhaps, receives the most all-round maltreatment, as will be evident by examining the supply in the average shop. Broken drills and poorly ground points are very closely related, as one is often the effect of the other. An improperly ground drill also means that the quantity and quality of the work is affected; hence, the mechanic should know what the requirements for a correctly formed drill point are, for while it is impracticable to grind a drill theoretically correct by hand, such knowledge will enable one to more closely approach the true form. A machine especially designed for this purpose is, however, to be recommended. The requirements, briefly stated, are as follows: The two cutting edges should be equi-angular with the axis, and of the same length; the angle of clearance for each cutting edge should be the same, and the clearance should increase toward the center of the drill.

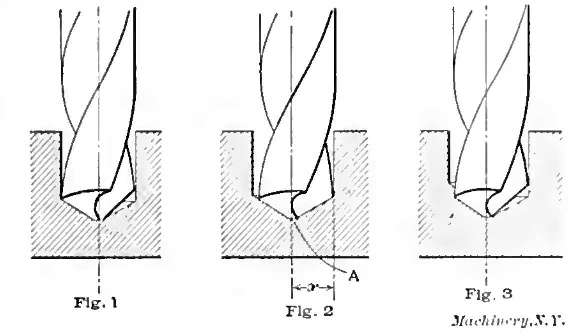

Fig. 1 Fig. 2 Fig. 3

Figs. 1, 2 and 3, illustrating the Effects produced by Drill Points improperly ground

In Fig. 1 is shown the relation of the drill point to the hole bored, when the cutting edges are not at the same angle with the axis. As will be seen, one side will do all, or at least a greater part of the work, thus subjecting the drill to an unbalanced torsional or twisting strain, which does not occur when each cutting edge is in action, as then the tendency of each side to spring away from the cut is counterbalanced by the opposite side. The drill will also be forced against the side of the hole, resulting in an enlargement of the latter.

The effect produced when the lengths of the cutting edges are unequal is illustrated in Fig. 2. As the drill, when it is fed into the metal, revolves about the center *A*, the horizontal distance *x*, from this point to the longest side, will be equal to the radius of the hole, which will, of course, be larger than the drill diameter if the point *A* is not central; hence, if holes of the correct diameter are to be drilled, each cutting edge must be exactly the same length. In Fig. 3 is shown a drill point having cutting edges inclined at different angles to the axis, and of different lengths, thus combining the disadvantages mentioned in the foregoing.

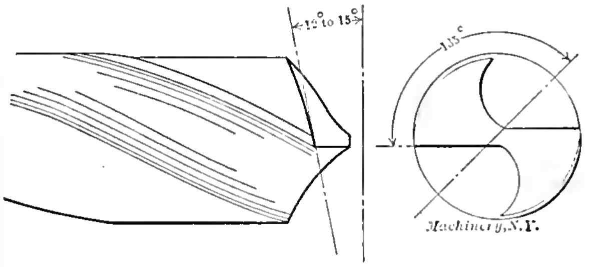

Fig. 4. Clearance Angle at the Periphery and Angle that the Point should make with the Cutting Edges

The clearance for the cutting edge is a very important feature of drill grinding. Drills split through the web are usually an indication of improper clearance or excessive feed. If the end of the drill conformed exactly to the shape of the bottom of the hole, obviously it would not cut, as the lack of clearance would make it impossible to sink the cutting edges into the metal; consequently, when there is insufficient clearance for a given feed, the drill binds back of the cutting edges, thus subjecting it to an excessive torsional strain. Theoretically, the clearance should be just enough to permit the drill to cut freely, in order to give the cutting edges the maximum amount of support. The Cleveland Twist Drill Co. advocates a clearance angle of 12 degrees at the periphery of the drill, with a gradual increase toward the center until the point or line joining the two cutting edges is at an angle of 135 degrees, as shown in Fig. 4. When soft material is to be drilled and heavier feeds are used, the angle of clearance may be increased to 15 degrees, while for hard material such as tool steel, for example, the amount of clearance can be diminished as the feed must necessarily be light, and a strong cutting edge is required.

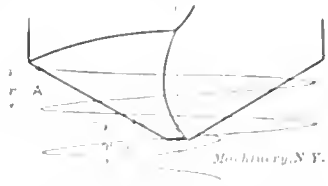

Fig. 5. The Angles of the Helical Paths described by the Points A and B show why the Angle of Clearance should increase toward the Drill Point

As previously stated, the clearance should gradually increase toward the drill point. The reason for this will be apparent by considering the movement of two points *A* and *B* (Fig. 5) on the cutting edge, as the drill is fed downward, one point being much nearer the center than the other. Assuming that the feed is constant, the path described by each of these points will correspond to that indicated by the helical lines shown. As the vertical distance *x* that each point moves per revolution of the drill will be the same, the angle of the smaller helix or spiral will be greater than that of the larger one. The angle of the helix, in each case, indicates the minimum clearance necessary at that particular point, for a feed per revolution equivalent to the distance *x*. The amount of feed indicated has been greatly exaggerated in order to make the comparison clearer.

There is a difference of opinion concerning the exact shape of a drill point, both in regard to the form of the end and the angle between the cutting edges. The Sellers grinder (the operation of which is described in the Shop Operation Sheet accompanying this issue) so controls the drill in relation with the grinding wheel that the surface of each lip conforms to the segment or part surface of a cone, as shown in Fig. 6. The axis *a-a* of the cone is inclined to the axis *b-b* of the drill, and also lies in a different plane, as shown in the view to the right, thus giving the cutting edge the required clearance which, obviously, increases toward the drill point. If we assume this hollow cone to be a grinding wheel revolving about the axis *a-a* with the drill point held against it as shown, the surface of one lip will evidently be ground to the desired conical form. It is not necessary, however, in order to grind each lip to this form, to resort to such a method. In the drill grinding machine referred to, this same surface is produced by turning the drill, which is held in a suitable chuck, around the axis *a-a* of the cone, while an emery wheel having a flat surface tangent to the surface of the cone, grinds the point.

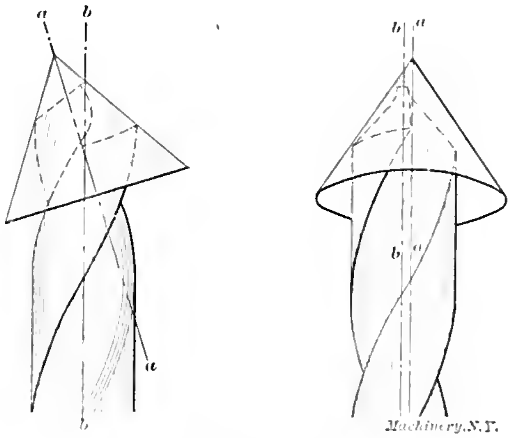

Fig. 6. Form given to the Lip of a Drill by the Sellers Drill-grinding Machine

As to the angle of the point, recent tests (the results of which are given in this and the May issue) have demonstrated that an included angle of 118 or 120 degrees is about right. The pressure required to force a drill through the metal be-

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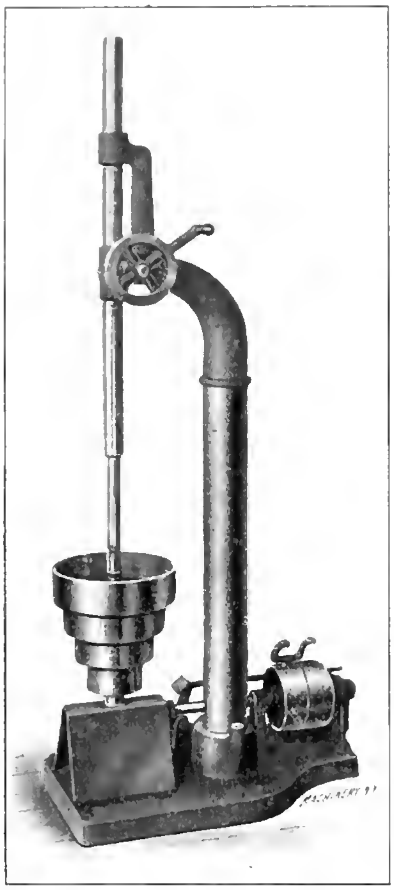
* With Shop Operation Sheet Supplement.

comes less as the angle of the point is diminished, but the power required to turn it increases; therefore it is not advisable to have the angle of the point too acute, as then the power consumption will be too great, and, on the other hand, the point should not be too blunt, owing to the excessive end-thrust and the resulting strain on the machine.

* * *

REAMING MACHINE FOR CHAMBERED HOLES IN PULLEYS AND SPINDLE SLEEVES

The difficulty of obtaining a true hole when reaming in a lathe or drill press, particularly when the parts to be reamed have chambered or relieved holes, is well known; in the latter case it is almost impossible to get the two ends of the hole to line up, even though floating reamers be used for this purpose. In order to overcome these difficulties the Hoefer Mfg. Co., of Freeport, Ill., has built, for use in its own shop, the reaming machine shown in the accompanying illustration.


Machine for Accurate Reaming of Long Holes in Pulleys, Sleeves, etc.

The base and column are the same as used for the company's regular 16-inch drills. The metal cover fastened to the base encloses a bracket carrying a bevel gear and pinion transmitting the power from the pulleys shown, to the spindle of the device. The key or drift hole of this spindle is shown just below the cone pulley. The end of the spindle which points upward, fits a No. 3 Morse taper and holds the shank of the reamer arbor. On this arbor an adjustable shell reamer is placed, and at the upper end of the arbor, just above the reamer, a small pilot is provided which enters into the guiding arbor above it. This guiding arbor is, in turn, held in the non-rotating spindle carried by the column. As shown in the illustration, a rack is attached to this spindle by means of which it can be raised and lowered by the wheel and lever shown.

The device is used for reaming spindle sleeves, pulleys and the holes in various gears. These holes are first bored in a drill press by means of a special boring bar extending through the cored hole of the sleeve into a revolving bushing in the base of the jig. The boring bar is provided with two double-ended cutters placed about one inch apart, one cutter being used for roughing, and the other for finishing the hole about 0.010 inch under the standard size. The guide bar of the reaming machine (held in the upper non-rotating spindle) is ground to a sliding fit for the bored pulley or sleeve.

In operating the reaming machine, the upper non-rotating spindle with its guiding arbor is raised, and the pulley is slid onto the arbor. The spindle is then lowered until the guiding arbor engages the pilot on the end of the reamer bar, and the operator starts up the machine, meanwhile holding the cone pulley with both hands on opposite sides of the rim. As the lower spindle rotates, he exerts a slight pressure on the pulley, thereby feeding it over the reamer until the latter comes through at the top. Since the guiding bar above and the shank of the reamer arbor below quite closely fit the hole before and after reaming, respectively, any error in the alignment of the hole is hardly possible. The upper and lower corners of the reamers are stoned off by a small oil stone, and a very smooth hole results in the work. The reaming is done by the drill press operator, who performs the reaming operation while a hole is being bored in the drill press, the two machines being placed near together. In the illustration a pulley is shown finish reamed, the reamer being visible at the upper end of the pulley, which is supported by the shank of the reamer arbor.

* * *

OFFSETTING CYLINDERS IN SINGLE-ACTING ENGINES*

A great deal has been said recently about the offsetting of cylinders in single-acting engines and many claims of superiority are made by those who employ this form of construction. About twenty-five manufacturing establishments in the United States are building engines in which the cylinders are offset, chiefly those of the automobile type, and one company is formed for the purpose of making engines in which the offset is equal to the crank radius and the connecting rod length is about 3¾ times the crank radius. Among the claims made by manufacturers for offset engines are: greater power, less side-pressure of the piston on the walls of the cylinder, better turning effort, less vibration, smoother running qualities and when one cam shaft is used, a more convenient mechanical arrangement.

The author of this paper gives a complete mathematical analysis of the effect on the length of stroke, turning force, side-pressure of piston on cylinder, etc., under various conditions of ratio of length of crank to length of connecting-rod and amount of offset, the latter ranging from zero to an amount equal to the length of the crank. The mathematical expressions by which these conditions are investigated take into account the length of the crank, the length of the connecting-rod, the amount of offset, the area of the piston head, the weight of the reciprocating parts and the revolutions per minute. The engines of various manufacturers are made by means of these mathematical expressions, and the effects on side-pressure, vibrations, etc., are all tabulated. In brief, the results of these investigations may be summarized as follows:

Offsetting increases slightly the length of stroke and the crank angle passed over during the stroke toward the crank shaft.

The maximum value for the side-pressure of the piston on the cylinder walls decreases as the offset increases up to the value of one-half the crank radius for any ratio of $L \div R$.

The work lost in friction due to the side-pressure of the piston on the cylinder walls decreases as the offset increases up to a value of 75 per cent of the crank radius.

Both the maximum value of the side-pressure and the work lost in friction increase as the value of the ratio $L \div R$ decreases.

Offsetting decreases the height and weight of the engine.

Offsetting increases the life of the cylinder and piston.

Offsetting improves the thermal cycle.

The author makes the following comparison of the importance of these various considerations:

Improvements due to offsetting, (1) in the thermal cycle, (2) in the mechanical arrangement, (3) in the turning effort curve, and (4) in lubrication, are very slight and may be neglected. The real advantages are:

a. A reduction of the frictional losses due to the pressure of the piston on the walls of the cylinder, resulting in a slight increase in mechanical efficiency and less wear of the piston, piston rings, and cylinders, and consequently longer life.

b. A reduction of the maximum value of the side-pressure of the piston on the walls of the cylinder allowing the use of shorter connecting rods, shorter pistons, and shorter cylinders, resulting in a shorter and lighter engine and in lower inertia-forces due to the reciprocating parts.

The most important of these advantages would be a considerable saving in weight.

The disadvantage of offsetting lies in the fact that the reduction in average side-pressure and maximum side-pressure grows less as the speed and inertia-force increase, so that for a speed of 1,400 to 1,500 R. P. M. there is either no reduction at all or an increase.

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* Abstract of paper presented by Prof. Thurston M. Phetteplace before the Washington meeting (May, 1909) of the American Society of Mechanical Engineers.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

BORING MILL GAGE AND A SWAGE HOLDER

A short time ago B. W. Cooper, general manager of the Danville Foundry & Machine Co., showed me a handy little attachment used on their big boring mills for sizing large pulleys and fly-wheels. The device (shown in Fig. 1) consists of a bar of one-inch cold-rolled steel about three feet long, fastened by cast-iron brackets to the inside of the housing of the mill and back far enough to clear the cross-rail nicely. On this bar is a sliding cast-iron bracket carrying a measuring rod, as shown in Fig. 1. Rods of suitable length for sizing every standard-size pulley or fly-wheel made in this shop are kept in a rack close to the mill, and when a job is put on, a rod numbered to correspond to the number of the casting to be turned is put into the socket in the bracket and shoved in as far as it will go. It is then locked in place by turning the little hand-wheel screw shown. With this device, work can be brought to size with the mill running at full speed, as the right diameter has been obtained when the point of the measuring rod will just swing past the piece. When the gage is used with the machine revolving it should be swung against the work from the rear side or against the direction of rotation to prevent it from being forced past and bent. This tool may be used effectively on any large circular work, the outside of which is turned on a boring mill, as anyone who has had to use calipers on such work will understand.

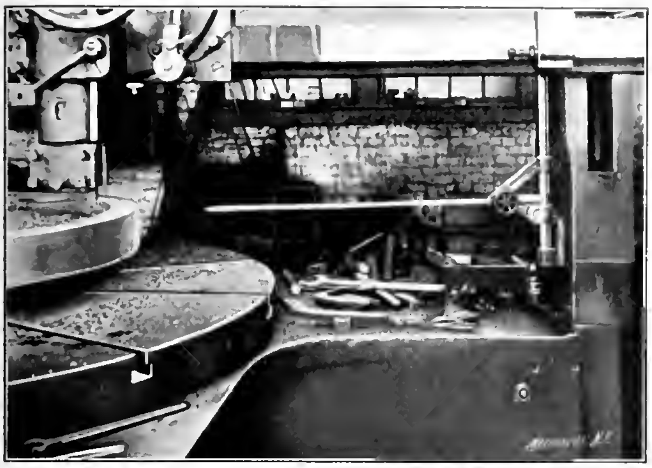


Fig. 1. Device for Measuring Circular Work on the Boring Mill

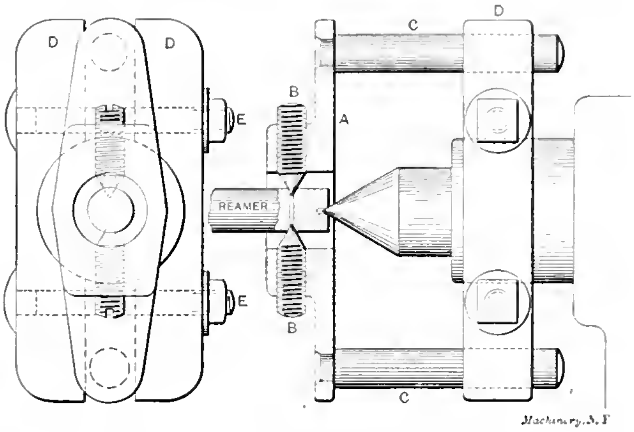
Fig. 2. A Steam-hammer Swage-holder or "Deadman"

Another very good thing that I saw in this shop is the "deadman," or swage-holder for the steam hammer, shown in Fig. 2. For the blacksmith, with only one helper who must be used to operate the hammer, this tool is extremely useful. As will be seen, the holder is made to take almost any style of spring-swage and is adjustable for height by means of staggered holes in the upright piece and a pin in the socket on the base-strap. The base-strap can also be moved around the block by loosening the clamping bolt, which allows the swage to be placed in different position on the anvil. E. V.

AN IMPROVED REAMER HOLDER

When reaming in the lathe the tendency for a reamer to slip off the center is not due to any inclination of the reamer itself to draw into the hole faster than it is fed in, but due rather to the fact that there is very little stock being removed, and that the reamer is usually held from rotating by a dog or holder of some kind which acts on one side only, thereby tending to pry the reamer off the center. When a reamer is held in this way there is also a liability of its reaming different size holes owing to the fact that sometimes it may have a little more stock to remove than at others, and that it may be fed faster in one hole than another; which in either case would tend to spring the reamer a little more out of line in one hole than another, thereby causing the holes to vary in size. This is especially true with small reamers with long shanks.

To overcome these difficulties the writer devised the holder shown in the accompanying illustration. The idea in part was borrowed from Prof. John E. Sweet's double-tailed dog. Referring to the sketch, *A* was made from a piece of machinery steel about ⅞ inch x 1½ inch x 5 inches. The clearance hole for the reamer shank is 1 inch and it will take reamers up to 1⅛ inch in diameter and some larger ones, this depending, of course, on the size of the shank. The holes for the pivot screws *B* should be drilled and tapped clear through from one way before the clearance hole for the reamer is drilled, so as to bring them nicely in line. The pivot screws are made from tool steel and hardened; the included angle of the points is 60 degrees. The studs *C* are ½ inch cold rolled steel. The driver *D* which is clamped on the tailstock spindle, is made from hard maple, which answers the purpose just as well as though it were made of cast iron or steel. A good way to make it is to bore a hole in a block of wood to fit the tailstock spindle, and drill the holes for the carriage bolts *E;* then cut enough out through the center of the block so that the studs *C* will be a loose fit in the slots when the driver is clamped in place as shown.



Machinery,N.Y.

Holder which prevents a Reamer from Sliding off the Center

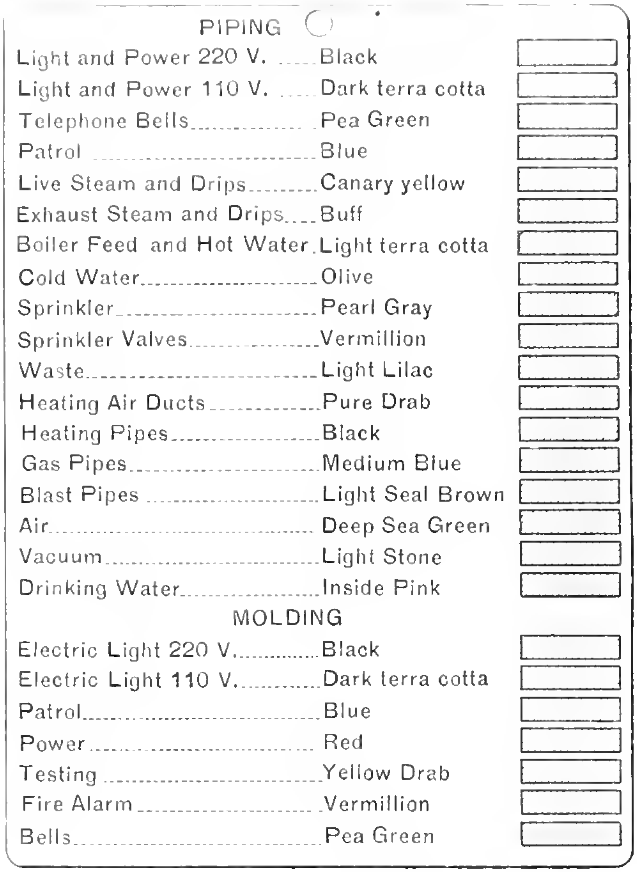
To get the female centers in the reamer shank approximately in line to receive the pivot screws, drill a small hole through the shank of the reamer and countersink with a center reamer. It is not necessary that the hole should pass exactly through the center of the shank. The shanks of most reamers will be found soft enough so that they may be drilled readily. The studs *C* fit loosely in the blocks *D*, but when the reamer tries to rotate they come against these blocks, and being on opposite sides of the reamer and self-adjusting, the reamer will be held without any cramp, and there will not be any tendency for it to lift off the center. In using this holder all that is necessary for safety is to pass a string or belt lace around the holder and driver and hold it with one

hand, well out of the way, while feeding with the other. Another point of advantage is that the shanks of the reamers will not become marred or bent.

Syracuse, N. Y. **George G. Porter.**

DISTINCTIVE COLORS FOR PIPING IN A MANUFACTURING PLANT

The question of using distinctive colors for the various lines of piping in a manufacturing plant is one that has scarcely received the consideration that it deserves. The fact that a pipe is a pipe and that the line gives no trouble is enough for a great many superintendents and works managers. If there be any trouble there are the plumbers and pipe fitters who put up the job; let them look after it. They have made all of the changes and put in the new connections and know practically the exact location of every valve and union in the system. The thing that the superintendent does not stop to consider is this: There is the possibility that the men who did the work may leave the employ of the compuany before new men have been on the job long enough to have learned all of the details of the system, the result of which might be, should an accident occur to, say a water line, considerable damage before anyone unfamiliar with the system could trace the line through a network of piping to a valve controlling the supply. With the different lines of piping painted distinctive colors, it would be a comparatively easy matter for anyone to trace the particular line to a valve, shut the valve and stop the flow of water before any great amount of damage had been done.



PIPING		
Light and Power 220 V.	Black	☐
Light and Power 110 V.	Dark terra cotta	☐
Telephone Bells	Pea Green	☐
Patrol	Blue	☐
Live Steam and Drips	Canary yellow	☐
Exhaust Steam and Drips	Buff	☐
Boiler Feed and Hot Water	Light terra cotta	☐
Cold Water	Olive	☐
Sprinkler	Pearl Gray	☐
Sprinkler Valves	Vermillion	☐
Waste	Light Lilac	☐
Heating Air Ducts	Pure Drab	☐
Heating Pipes	Black	☐
Gas Pipes	Medium Blue	☐
Blast Pipes	Light Seal Brown	☐
Air	Deep Sea Green	☐
Vacuum	Light Stone	☐
Drinking Water	Inside Pink	☐
MOLDING		
Electric Light 220 V.	Black	☐
Electric Light 110 V.	Dark terra cotta	☐
Patrol	Blue	☐
Power	Red	☐
Testing	Yellow Drab	☐
Fire Alarm	Vermillion	☐
Bells	Pea Green	☐

Machinery,N.Y.

Color Board giving List of Pipes and Wire Moldings with Name and Sample of Color

The best example of a color scheme for piping that has come under my notice, is the one in use at the Hawthorne plant of the Western Electric Co. They not only use distinctive colors for the different pipe lines throughout the plant, but they have extended the use of the color scheme to the moldings of the wiring system. Moreover, I noticed that there were "color-boards" upon the walls of the different buildings. The boards were about six or eight inches wide and probably eighteen inches long, and had a list of the lines of piping and moldings, the name of the color distinctive of each line of pipe or molding, and a small rectangle painted with the particular color, as indicated in the accompanying illustration. Thus there was no possibility of a workman mistaking the line unless he was unable to read or was color-blind.

This color scheme is not standardized by any means, but it has the advantage of covering a wide range—more than most shops would need—and it was carefully worked out, the idea being to get colors that would "hold" and still not be so near alike in shade as to be confusing to the workmen.

Columbus, Ohio. **C. E. Bliven.**

LUBRICANT FOR LATHE CENTERS

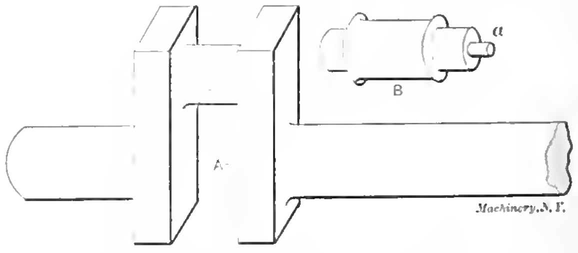
Until recently I have had considerable trouble with lathe centers, especially on small work when using high speed steel, as the work is revolved so fast that it is almost impossible to keep the centers from cutting. White lead is used by many to remedy this trouble, but I do not know what advantage white lead has over ordinary machine oil, unless it is the odor that is given off when the centers become heated, as this acts as a sort of warning. It may not be generally known that dry or powdered red-lead, mixed with a good grade of machine oil to about the consistency of cream, is an excellent lubricant for lathe centers. Since using this mixture I have never had a center cut, though they get very hot sometimes.

In order to test the efficiency of this lubricant as compared with a mixture of graphite and white lead composed of equal parts of these materials mixed with the best grade of machine oil, a piece of machinery steel 7/16 inch in diameter was placed between the lathe centers (which were lubricated with the graphite mixture) and revolved at a speed of 490 revolutions per minute for five minutes without stopping. After the piece had been revolving about two and a half minutes I could not bear my hand on it, and it was necessary to loosen the tail-stock spindle in order to give the lubricant a chance to work in between the bearing and center. At the end of four minutes the lubricant was smoking badly, and at the end of five the piece was taken out of the lathe, and the center examined. There was a slight burr thrown out around the hole, and by the aid of a glass it could be seen that considerable cutting action had taken place. The red lead and machine oil mixture was then used for lubricating the centers, with the result that when the piece was removed from the lathe at the end of five minutes, the hole did not show any cutting action whatever, but instead was very highly polished.

Geneva, N. Y. **Roy B. Demino.**

REPAIRING A LARGE CRANK-SHAFT

Some time ago I was called upon to repair the crank-shaft of a large pumping engine, which had a crank-pin broken as indicated in the engraving. This shaft was 18 feet long, 14 9/16 inches in diameter and had two cranks with pins 10¼ inches in diameter by 10 inches long. It was a solid forging and weighed 10,880 pounds. The broken ends of the pin, attached to each web, were first drilled and planed off smooth. Each piece was then placed in a horizontal boring mill and roughly bored for the new pin which was to be fitted. The two faces *A* were then bolted together with the webs exactly in line, and placed in the mill a second time and bored, thus bringing the two holes absolutely in line. The webs, still bolted together, were next put on the planer and key-seated, and in this way both key-seats were also kept in perfect alignment. The pin was then forged and turned to the required



Large, Solid Crank-shaft which was broken as indicated, and repaired by Forcing a Pin into the Webs

size, as shown at *B*. After it was finished in the lathe it was placed between the centers of the milling machine, and key-seats were cut into each end. A small part *a* was left on one end as shown, so that the pin could be turned in the lathe, and key-seated, without changing its position on the centers, thus keeping both key-seats and fittings in perfect alignment. Ninety tons was decided to be the proper pressure for forcing the pin into place, so, for an experiment, I used the formula and factor curve in the Data Sheet of August, 1903, by Stanley H. Moore, and found it to be correct. The formula given in this Data Sheet for determining the required pressure in tons is:

$$P = \frac{A\,D\,(P\,F)}{2}$$

where *P* equals pressure in tons, *A* equals area of fitting in square inches, *D* equals difference in diameter between plug and bore, *PF* equals pressure factor taken from the Data Sheet chart. The required pressure or the value of *P* was 90 tons, so transposing the formula and solving for *D* it became:

$$D = \frac{2\,P}{A\,(P\,F)}$$

The holes in the webs for the new pin are 8 inches in diameter and 7 inches long, and by referring to the curve in the Data Sheet the value of *PF* for an 8-inch fitting was found to be 55, so, substituting the known values:

$$D = \frac{2 \times 90}{8 \times 3.1416 \times 7 \times 55} = 0.0186 \text{ inch.}$$

As the hole was counter-bored a short distance, thus cutting down the area, I increased the allowance for the fit to .019 inch, with the result that the pressure required to force the pin into place was approximately 90 tons. A hydraulic press was used for this purpose and the pin was forced into the lightest half of the crank first. After the shaft was tested in the lathe and found true, the ends of the pin, which were made 3/16 inch longer than the web thickness and hollowed out on the end, were riveted over into the countersink in the web. The bearings were then turned true, and the job was finished.

J. S. Van Pelt.

Augusta, Ga.

SUB-PRESS DIE FOR SPECIAL SPRINGS

The die described in this article was designed and made for the manufacture of a special spring used in connection with a heat regulator. This spring is of an irregular shape, and it was conceded that the only proper way to obtain these springs at a reasonable cost was through the medium of a punch and die. The first set of dies for this work was made in the ordinary way, without applying the sub-press principle, but these tools were soon found to be of little value, as the steel used in the springs was a special grade, hard to punch, and it was essential that the blanks must come from the press straight. The tools just mentioned would not leave the blank straight, and only a few could be punched before the die would be sheared and thereby rendered useless. The sub-press die described in the following was then designed, and, after being made and put in commission, proved satisfactory. A large number of blanks have already been punched, and the die is still in good condition. The spring shown in Fig. 1 is 18¼ inches long × 1⅜ inch wide on central part of the spring, and ⅞ inch wide on the wings; two ½-inch holes are pierced in the central portion, and a ¼ inch hole in each wing. The thickness of the stock used in the spring is 0.055 inch. The width of the stock is equal to the length of the spring. The springs are cut from the end of the sheet to allow the stock to be fed through the die from front to back.

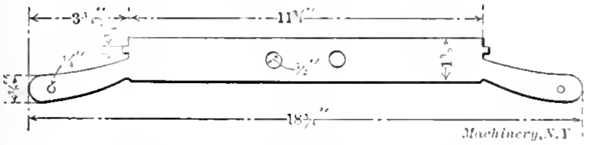


Fig. 1 Spring to be made in Sub-press Die in Fig. 2

The die holder *A* shown in Fig. 2 is made of cast iron, finished on the top and bottom and on all bosses. The top is recessed to fit the die, which is 1 inch thick × 6¾ inches wide. More will be said about the die holder subsequently. The die is a sectional die, consisting of four pieces; the two pieces *C* and *D* are 1 inch thick × 3¾ inches wide × 10¼ inches long; the two pieces *E* and *F* are 1 inch thick × 3½ inches wide × 10¼ inches long. The four pieces are finished on all sides, and are then placed in position on a surface plate, and the form of the spring is scribed on the surface. The stock is then removed to within 1/16 inch of the scribed line. The screw and dowel holes *G* are next drilled, there being three screw and two dowel holes in each of the four pieces. Each of the sections is next fitted tightly into its proper position in the die holder. The die holder is then placed under a drill press, and the holes are transferred into it from the sections. The screws used are ½-inch filister head cap screws; the dowels are made from ⅜-inch drill rod. With the die still in position, the four square key slots shown are laid out, one-half of the slot, which is ⅜ inch square, being in each section of the die. These keys serve to keep the four sections of the die in an accurate position, and thus prolong its life.

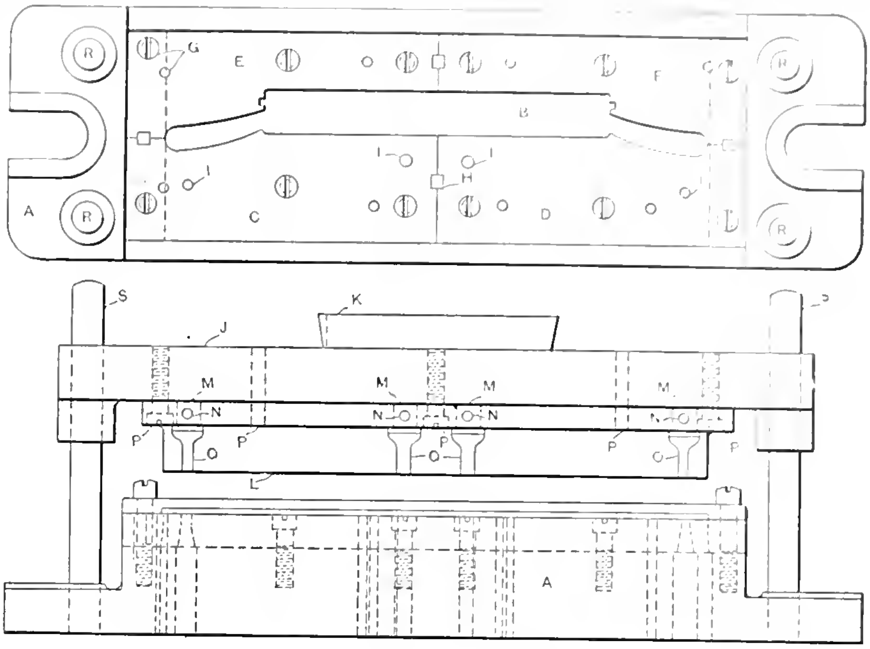


Fig. 2. Plan and Elevation of Sub-press Die for Making Spring shown in Fig. 1

Before removing the sections, the templet of the spring is laid on the top surface of the die, and with a scriber the outline of the templet is scratched on the die. The sections are now removed and the keyways *H* are machined accurately to the lines, and the form of the spring, which has already been roughed out, is finished. The holes *I* to be pierced in the blank are now laid out, drilled, and reamed. This work finishes the machine work, and the sections are now ready to be hardened and tempered in the usual manner.

The reason for making this die in four sections was that the die, being 20½ inches long over all and the hole for the blank 18¼ inches × ⅞ inch, it was impossible to harden the die successfully in one piece. The sections being hardened, and the temper drawn, the edges of the sections are ground to a true surface, a very small amount of stock being removed.

When the bottoms of the sections have been ground, they are again placed in position in the die holder. With a scriber the hole for the blanking punch, as well as the four holes for the piercing punches, are scratched through the die on the die holder. The sections are then removed, and the stock in the die holder machined out to allow the blank and piercings to fall through. The sections of the die are then

replaced and fastened in place by the screws. The dowels are fitted and driven in place, as well as the square keys. The die is now ready to receive the punch shown in elevation in Fig. 2. This is made as follows: The punch holder *J* is of cast iron, machined on the top, bottom, and on the bosses. The dove-tail *K* is fitted to the ram of the press. The punch *L* is of tool steel 2½ inches thick, 6¾ inches wide, and 19½ inches long. This piece of steel is machined on all sides, and the punch fitted to the die. The holes for the piercing punches *M* are now transferred through the die into the base of the punch; after these holes are drilled and reamed, the punch is removed from the die. The set-screw holes *N* are drilled and tapped. The punches *O* are turned and fitted into the base of the blanking punch.

The punch is now ready to be fastened to the punch holder. In order to do this, the punch is placed in its working position in the die; the holder is then placed on top of the punch, and the bosses for the guide pins lined up in position. With a scriber the outline of the base of the punch is scratched on the punch holder; the punch is then removed and the screw and dowel holes *P* drilled and counter-bored in its base. The punch holder is then placed in position to receive the punch, which is placed on the holder between the lines already scratched, and the screw and dowel holes *P* are transferred through the punch to the holder. The holes are then tapped, and the punch holder is now ready to receive the punch, which, after being fastened by the screws, has the dowels fitted, and driven in place. This punch is not hardened, but left in its soft state, to allow for staking and cutting in the die in case it wears small.

The piercing punches *O* are now fitted; the shank is fitted to the punch base, and the opposite end to holes in the die. These punches are then hardened and tempered, after which they are placed in position in the blanking punch, and fastened by set-screws *N*. The punch is now complete, and placed in working position.

The punch and die is then fastened on a horizontal boring mill, and the four guide pin holes *R* are bored, great care being taken to have these holes exactly in line. After boring, the holes are reamed, using a lining reamer, which insures perfect alignment. The guide pins *S* are next turned to 1.015 inch diameter, and 11¾ inches long. After turning, the pins are hardened and tempered, and then ground the entire length. The ends fitting the die holder are a driving fit, the remaining part being a sliding fit in the holes in the punch holder. The punch and die are then ground on the cutting surfaces, and, after driving the guide pins in position, the punch is placed on the pins and gently lowered to the face of the die, to test the accuracy of the tools. If the punch enters the die equally free on all sides, and the piercing punches are found to be in line with the holes in the die, the punch and die are pronounced ready for use.

This tool proved satisfactory from the start, and nearly 25,000 springs have been blanked to date, the blanking punch having been staked and cut in once, which operation required about one hour's time. NOTROH.

ISOMETRIC PERSPECTIVE

I must take exception to one or two statements of Mr. Honey in MACHINERY for August, 1907, as regards isometric perspective. In the first place, "perspective" is not in this connection "an erroneous expression." According to the first definition in the Standard dictionary, perspective is "the art or theory of representing, by a drawing made on a flat surface, solid objects or surfaces seen as not lying in that surface; delineation of objects as they appear to the eye; specifically, in mathematics, a branch of projective geometry."

Isometric projection certainly fills this bill as far as the first part of the definition is concerned; and if we consider objects as they appear to the eye, their appearance depends entirely on the point of view. In the so-called "painter's" or "diminishing" perspective, the object appears to no two observers the same. It just happens that in isometric perspective or projection, the point of view is an unusual one—namely, one in a line passing through the object at an equal angle to all three co-ordinate axes; an angle best expressed in familiar language by saying that it corresponds to that of the greatest diagonal of a cube. If a cube be so tilted that the line of sight passes through this greatest diagonal, the outline presented will be a regular hexagon, with the nearest corner of the cube in the center of the circumscribed circle. This is the exact isometric projection of the cube. A photograph taken of a cube with this greatest diagonal in the axial line of the camera lenses would exactly coincide with an isometric perspective of the same cube, care being taken that the scale was the same.

The isometric representation is by no means "distorted." The fact that such a body as a cube, which is symmetrical with regard to every axis, is reproduced isometrically as a perfectly symmetrical drawing, whereas the "diminishing" or "artistic" perspective or projection of the same cube may have no two sides or angles alike, shows that the isometric projection is in fact the only one which is *not* distorted.

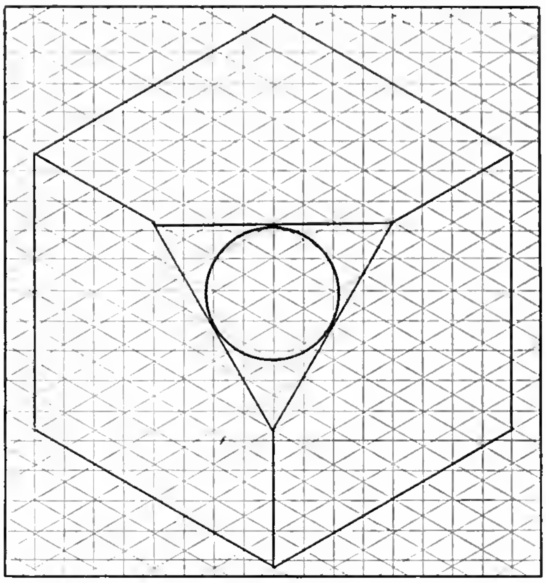
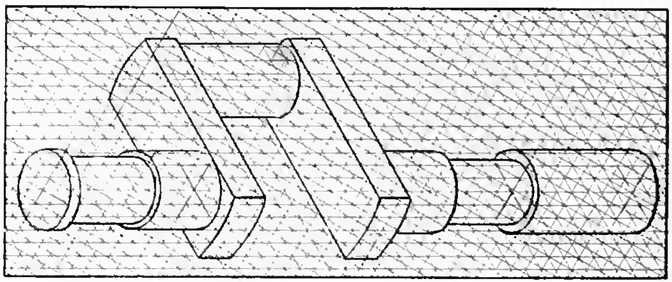


Fig. 1. Example showing that Objects are not distorted when drawn in Isometric Projection

It is also not strictly correct to say that "whenever it is necessary to represent circles in this kind of projection, the drawing of ellipses is unavoidable in whatever position the object is placed." It depends entirely on the object. If its shape be such that every circular outline therein lies in one of the co-ordinate planes, ellipses will be necessary whenever the object is supposed to be viewed along the line of sight above referred to—namely, at equal angles to all the co-ordinate axes; and the major and minor axes of such ellipses will bear to each other the proportion of 1 to $\sqrt{3} = 1 : 1.732$; that is, considering 1 as the diameter of any circle, the major and minor axes of the corresponding ellipse, projected isometrically in the same manner, are respectively 1.225 and 0.707. Most other circles, not lying in these co-ordinate planes, as, for instance, in the faces of a cube, will also be ellipses. But if we have a circle lying in a plane at right angles to the greatest diagonal of the cube, and view it along this diagonal, not only will it appear as a circle; but it can appear as nothing else. Further, the isometrical projection of a sphere cannot be anything else than a circular outline, no matter from what point of view, in what plane projected, or from what distance viewed.



Machinery,N.Y.

Fig. 2. A Crank-shaft shown in Isometric Projection

It is also not true that "this distortion increases with the increase of the dimensions of the object"; because in the first

place there is no distortion; in the second, the isometric projection being supposed to be taken with rays of light that are parallel to each other, that is, taken at an infinite distance from the object, dimensions have nothing to do with the case; it is a matter of proportion only.

Fig. 1 shows an isometrical projection of a cube projected at right angles to its greatest diagonal, and with a circle inscribed in the triangle produced by this section.

In this connection allow me to say that the popularization of isometric drawing in Germany and America is due to me, it having been facilitated by the isometrically-ruled paper patented by me in Germany in 1902, and a sheet of which was sent, for the purpose of patenting it, to the American publishers who are now pushing the system. As far as I know, no patent was applied for, but some of the material used in an American pamphlet on the subject is taken, without credit, from my "*Leitfaden für die Isometrische Projektion*," published by Gebr. Jänecke, Hanover, in 1902. One of the illustrations (shown in Fig. 2) used by the American publishers for advertising purposes, over some such inscription as "Can you draw this?" is Fig. 132 of my German book. I send you my original drawing. Although nothing has been paid me for the use of my material, I like to have the satisfaction of being properly credited. ROBERT GRIMSHAW.

Dresden, Germany.

FORMULA FOR MILLING V-SHAPED GROOVES WITH INCLINED TOP AND BOTTOM

The accompanying formula and table will be found very useful in making patterns and broaches for brackets, such as are used on bicycle lamps, automobile speed indicators, etc. These brackets, in order to fit into each other, must have the top and bottom of the teeth inclined at the same angle, as shown by the lines KA and KG in the engraving.

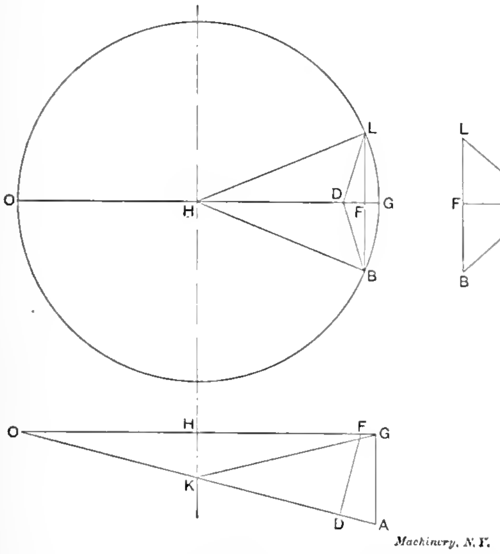


Diagram for Deriving Formula for Setting Index-head for Cutting V-shaped Groovee

Assume that the number of teeth is N, that the cutter angle LDB is given, and that the radius HG equals 1. The angle LHB, which is the angle of one tooth, is bisected by the radius HG. Draw LF perpendicular to OG. The line KA represents the bottom of the tooth; the plane in which the angle of the cutter for milling the tooth must be measured is perpendicular to KA. Assume, therefore, that the angle is measured in a plane FD. (See lower view of engraving.)

$$\text{Angle } LHB = \frac{360 \text{ degrees}}{N}$$

Since HG bisects angle LHB,

$$\text{Angle } LHG = \frac{360 \text{ degrees}}{2N} \text{ and } LF = \sin\frac{360^\circ}{2N}.$$

The triangle LFD shown at the right in the engraving is in a plane perpendicular to OA. In this triangle

$$FD = LF \cdot \cot LDF = \sin\frac{360}{2N} \cdot \cot LDF$$

But FD also lies in the plane containing the right triangle ODF.

$$OF = OH + HF = 1 + HF;\ \text{but } HF = \cos\frac{360}{2N}.$$

consequently

$$OF = 1 + \cos\frac{360}{2N}$$

and

$$\cos OFD = \frac{FD}{OF} = \frac{\sin\frac{360}{2N} \times \cot LDF}{1 + \cos\frac{360}{2N}}.$$

The angle OFD equals the angle OAG, or the angle to which to set the index head.

TABLE OF ANGLES FOR SETTING INDEX HEAD WHEN MILLING V-SHAPED GROOVES

No. of Teeth	Included Angle of Cutter		No. of Teeth	Included Angle of Cutter	
	60°	90°		60°	90°
10	74 5'	80 53'	31	84 57	87° 5
11	75 35	81 53	32	85 6	87 11
12	76 50	82 26	33	85 16	87 16
13	77 52	83 2	34	85 25	87 21
14	78 45	83 32	35	85 32	87 26
15	79 31	83 58	36	85 40	87 30
16	80 11	84 21	37	85 47	87 34
17	80 46	84 41	38	85 54	87 38
18	81 17	84 59	39	86 0	87 42
19	81 45	85 15	40	86 6	87 45
20	82 10	85 29	41	86 12	87 48
21	82 34	85 42	42	86 17	87 51
22	82 53	85 54	43	86 22	87 54
23	83 12	86 5	44	86 27	87 57
24	83 29	86 15	45	86 32	88 0
25	83 45	86 24	46	86 37	88 3
26	84 1	86 32	47	86 41	88 5
27	84 13	86 39	48	86 45	88 8
28	84 25	86 46	49	86 49	88 10
29	84 37	86 53	50	86 53	88 12
30	84 47	86 59	.	.. ..	..

The formula above expressed in words would be:

The cosine of the angle to which to set the index head equals the sine of one-half of the tooth angle, multiplied by the cotangent of one-half of the cutter angle; this product divided by 1 plus the cosine of one-half the tooth angle.

Belvidere, Ill. IRVING BANWELL.

CAM-OPERATED PRINTING PRESS MECHANISM

It was desired, on a printing press, to remove the printed sheets from the cylinder at the rate of fifty a minute. The cylinder was 6 inches in diameter and rolled back and forth over the type bed. The type bed also moved back and forth the same distance as the cylinder, one moving forward while the other moved backward. The sheets extended two-thirds around the cylinder and were held by grippers at the front edge. When the cylinder reach a position in which the front edge of the sheet was at the top—after having made one complete revolution—the sheet was to be taken off the cylinder and carried 23 inches horizontally. The object of this article is to describe the means by which this was accomplished.

The movement of the press will be understood from Fig. 1. The crank A drives the carriage or type bed by means of pitman B acting on bracket C. Bracket D is bolted to the under side of the carriage, and at its lower end engages with lever E. This lever is pivoted at its center F, and its upper end engages the cylinder, thus securing the same movement of type bed and cylinder, but, as stated above, in opposite directions. The sheet is fed to the cylinder in position G and is gripped for removal at the take-off position H. J represents the extreme throw of the cylinder forward.

An interesting point to be noted here is the surface speed of this cylinder. When near the take-off position the cylin-

der center moves approximately one inch for each 10-degrees revolution of the crank. If it had simply a rolling motion, the same as a cart wheel, a point on the top of the cylinder would move 2 inches in this time. Being geared to the carriage and the carriage moving backward an inch—the same distance as the cylinder center moves forward—causes the point on the top of the cylinder to move another inch, or 3 inches in all. The paper is therefore unwound from the cylinder at this rate of speed or about 9 feet per second, and mechanism had to be designed to take it as fast.

The figures 1, 2 and 3 represent the position of parts of the mechanism after a 10-, 20- and 30-degree revolution of the crank from the take-off position 0. The movement of the take-off is as follows: *K* represents a pair of racks which slide in ways and mesh with gears *L*. These racks are connected by rods which carry the grippers *M*. The pinions *N* are fastened to the same shaft as *L* and mesh with the stationary racks *O*. This shaft is journaled and has a horizontal movement of 7¼ inches by means of the connections *P* and lever *Q*. Lever *Q* is reciprocated by means of the cam on the crank shaft through connection *R*. The driving of rack *K* is another variation of the cart-wheel principle. The distance the rack *K* will move for each inch of movement of the center of the gear and pinion, equals the ratio of the radius of the pinion to the sum of the radii of the pinion and gear. The pinion and gear are 2¼ and 5 inches respectively. The ratio is therefore 1⅛ to 3⅝.

Since most draftsmen do not have proportional dividers, and as it often happens that they cannot be adjusted fine enough even when the draftsman does have them, a convenient way in which to find proportional dimensions is shown in Fig. 2. Make a right-angled triangle having the base equal to one member of the proportion and the altitude equal to the other and draw the hypothenuse. A proportional to any given dimension may be found by laying off the given dimension from 0 on the horizontal and erecting a perpendicular to the hypothenuse, which will be the required dimension.

Scraps of tracing cloth are very useful in plotting out movements on the drawing board. The laying out of cams is made easy by having the cam shape on the cloth in pencil; the cam may then be given the same motion as in the machine, and the shape altered to produce the required movement. This, of course, only applies to face cams.

The points 1, 2 and 3 were the most essential in the design of the cam, and were laid off along the center line of the connection *R* at 1′, 2′ and 3′. This was done by means of the strip of cloth as explained above. It is evident that as connection *R* moved out, its end *S* would drop, thus raising the roller slightly at each ten degrees of revolution of the cam. The exact positions of the roller are indicated by short lines at 1″, 2″ and 3″.

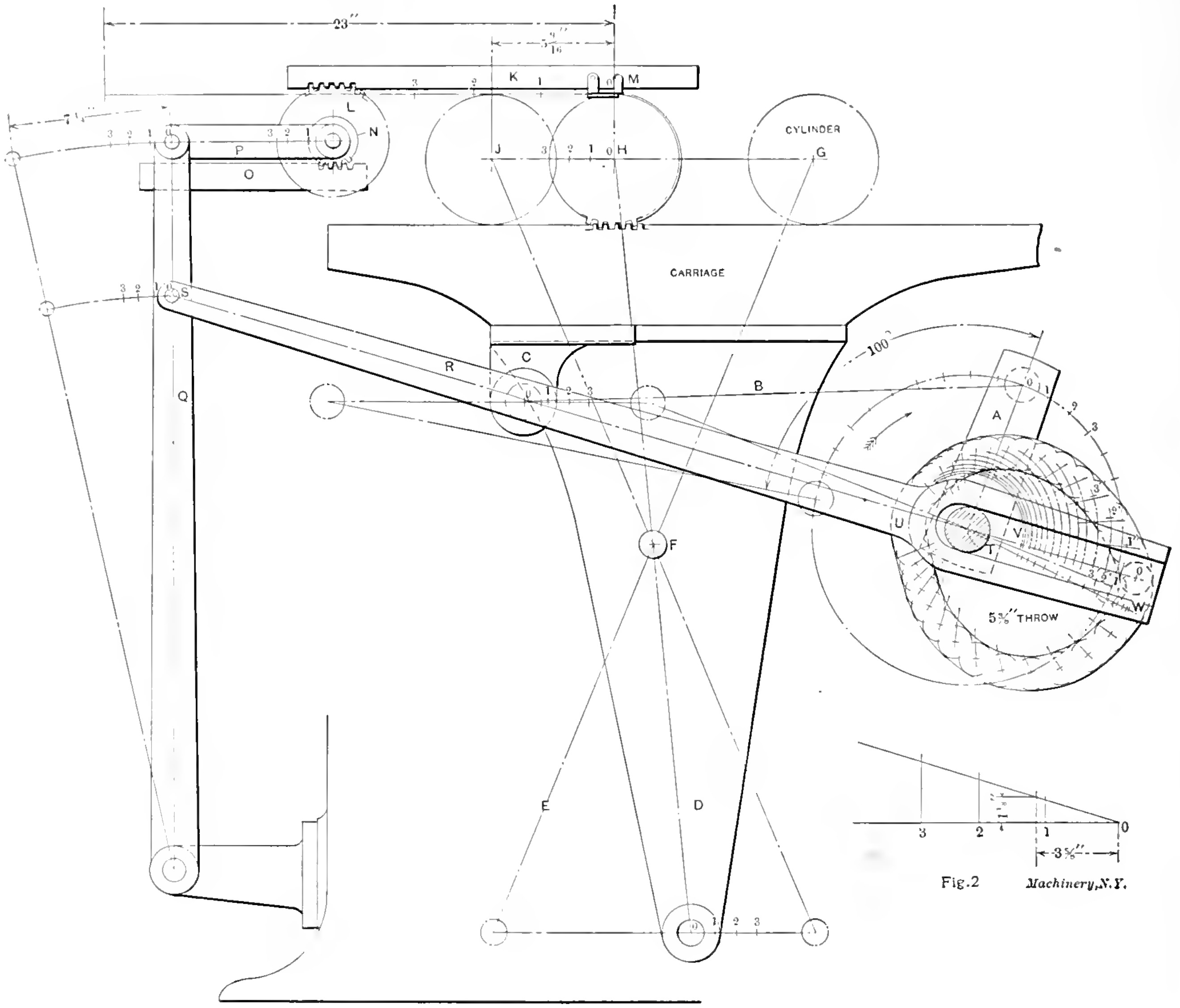


Fig.2

Fig.1

Figs. 1 and 2. Lay-out of Cam and Cam Motions for Printing Press

Spaces of ten degrees were laid off about the center *T* either side of the center line *T*0, with the exception of 70 degrees "dead" time at *U*. Circles from the points 1′, 2′ and 3′ were scribed about the center *T* to their respective radial lines, allowing for the increments at 1″, 2″ and 3″. Circles were drawn with these centers the size of the cam roller, and curves were drawn tangent, thus giving the contour of the cam walls.

When this most important part of the cam was determined, the remaining ten degrees spaces on the upper half of the cam were twelve in number. The space along the center line from 3′ to *V* was divided into twelve parts decreasing in

size so as to produce a gradual movement down to the "dead" part of the cam. When these points were described about the center T onto their respective ten degree radial lines, the cam walls were drawn in.

The lower half of the cam from U to W was simply to produce a return movement. On the center line TW the movements for this part of the cam are shown. The 5⅜ inch of throw from V to W was divided into thirteen parts—the number of ten degree spaces—which were graduated so as to start the roller slowly from the inactive portion of the cam, increasing to obtain the greatest movement at the center, and slowing down again for the reversal of motion. The ten degrees from W to 0 was to allow an opportunity for a better curve to reverse the motion. The movement of the cam from 0 to W gives ¼ inch movement along the center line. This causes the take-off at the cylinder to run by and reverse its motion and be on the return stroke when it grasps the paper. In the portion of the cam from 3" to U the slight variation due to the dropping of the connection at S was neglected as being of no importance. The same was true regarding the lower part of the cam from U to 0. Both these portions of the cam might have been laid out according to either the gravity, simple harmonic or elliptic formulas. The eye proved to be a sufficient guide in this case. It is good practice to lay off the increments along the center line as shown in the diagram. The relative movement or time of the cam may then be seen at a glance.

This cam was cut in the lathe, a former having first been filed up. By putting the cam and former on an arbor, removing the screw from the cross slide and putting a weight on the slide to keep the tool against the former, the cam was roughed out. A roller of slightly smaller diameter than the finished size was fitted to the tool to bear on the former. The cutting edge of the tool was kept even with this roller. A finishing cut was taken with a rather odd tool. It consisted of a piece of tool steel the same diameter as the roller to be used, squared on one end to fit the tool-post. This piece was left round for a sufficient length to bear on the former. At the end, teeth were cut in it the same as a file, and the tool, when hardened, was ground to size. After taking a finishing cut with this tool the cam and roller were a fine fit.

New York City. DAVID J. WALSH.

EFFICIENT TYPE OF BLANKING AND FORMING DIE

A novel design of die which will appeal to progressive manufacturers, as well as die-makers, is shown in the accompanying illustration. Ordinarily the blank is punched out and then put through the successive bending operations until it is completed. The type of die shown herewith, which can be employed on most classes of work, does not cut out the blank, but trims off the metal on the outside, leaving the blank attached to the strip until the last bending operation is completed, when it is cut off. All these operations are successive. While the bending operation is taking place, piercing and blanking punches are preparing another blank. The die proper, which is shown in Fig. 1, does not look familiar to the average die-maker, as he is accustomed to dies having holes cut through corresponding to the shape of the piece to be blanked. In this case, the outside of the die is used as a cutting edge for shearing the stock to the required shape.

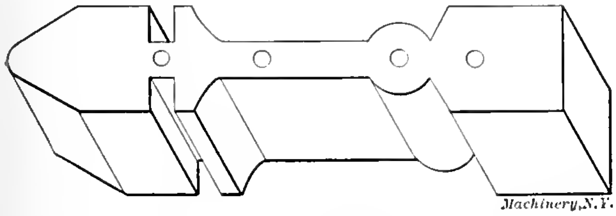
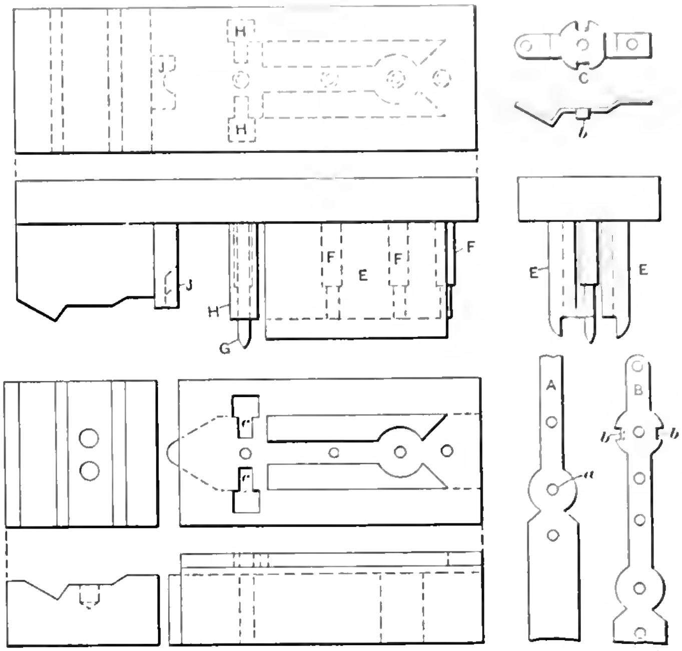

Machinery,N.Y.

Fig. 1. A Die in which the Outer Edges are used for Shearing the Metal when Blanking

The first thing to be done when constructing such a die would be to develop or determine the shape of the blank before it is bent to shape. The best and surest way known to the writer is to carefully ascertain the shape as near as possible and then cut out two blanks, by hand, exactly alike, marking each with the same symbol. One of these blanks is then bent to the required shape, and if the piece is too long or too short after all the bends are made, the duplicate can be referred to when making another pair of blanks with the required changes. By following this method of always making two blanks, then bending one and retaining the other to refer to until the desired shape is obtained, we have, finally, a straight blank which is useful for laying out the blanking die. The bending die should almost invariably be made before the blanking die, as it is much easier to change the shape of the templet, than to change the blanking die. After the bending dies are completed so that the finished blank is correct, the duplicate templet can be used to lay out the blanking die. This is almost universally made by cutting a hole the shape of the templet, through the die and filing it to size. This method means that we must make a blanking die and punch and two or three bending dies and punches, which also means that there are to be two or three presses in use. Compare, mentally, the cost of producing 1,000 blanks made under such conditions, with the cost of producing the same number made with one die and with one press that produces a finished blank at each stroke. When the nature of the work will allow slight variations on the outside of the blank, there is no comparison whatever between this type and the older style of die.



Machinery,N.Y.

Fig. 2. Diagrammatical View of Blanking and Forming Die for Producing the Piece shown at C

Referring to Fig. 2, A and B show the stock after the first and second blanking and piercing operations, respectively, and the finished piece is shown at C. During the first operation the piece is blanked by the punches E and pierced by the three punches F. As the blank is moved along for the second operation, it is located by the pilot-pin G which enters the hole a. The lugs b are formed by the punches H on either side, after which the piece is ejected by spring-pins located at c, so that it may be fed along. The blank is then cut off by the punch J.

It might be well to add that with clever designing, this die might be advantageously used for work requiring more accuracy than that here illustrated.

Pittsfield, Mass. F. E. SHAILOR.

* * *

The *Mechanical World* gives an account of the amount of money expended on aerial navigation by various governments during 1908. In Germany, the amount of public money spent was about $660,000. The French government spent $235,000, and Austria Hungary $27,000; Great Britain expended about $25,000. Besides the large public expenditure in Germany, over $1,300,000 was privately subscribed in that country in connection with the Count Zeppelin fund.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

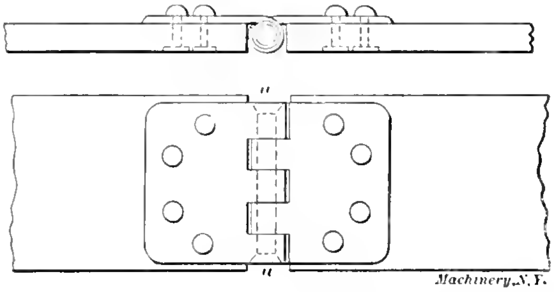
TO TURN SOFT RUBBER

Mount the rubber roll on a wooden mandrel, if the size of the hole will permit, or on an iron mandrel if the hole is of small dimension. Drive the work at about the same speed as for finishing brass. For a turning tool use a worn-out half-round file, without drawing the temper. Grind out nearly all the teeth but leave a sharp burr on the cutting edge. This saw-tooth edge is what does the work. Give the tool plenty of clearance. **E. B. Gafkey.**

Lakewood, Ohio.

BELT FASTENER

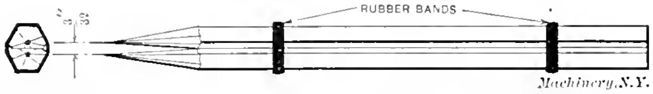
The accompanying sketch shows a belt fastener, attached to a 3-inch double belt, that will more than equal the strength of the belt itself, and last as long. It is made of a common T-hinge of the proper width, which is secured to the belt by eight 3/16-inch copper rivets, as shown. The pin hole should be countersunk in the ends as at *a*, and the edges of the hinge nicely rounded. A brass pin should be inserted in place of the steel one and riveted over on the ends. As will be seen, the knuckle part of the hinge comes between the ends of the belt. On wide belts, two or three hinges may be used. **A. I. Linsley.**



Cleveland, Ohio.

SPACER FOR LETTERING

A spacer for giving the proper height to the lettering on the body of a drawing is shown in the engraving. As will be seen it is made by fastening together, with rubber bands, two flattened pencils. As a rule these letters are about 3/32 inch high, but if higher or lower spaces are desired, a set of two or three spacers could easily be made which would answer all the requirements of a drafting-room. The leads are easily sharpened by simply removing the bands.



Three Rivers, Mich. **E. G. Peterson.**

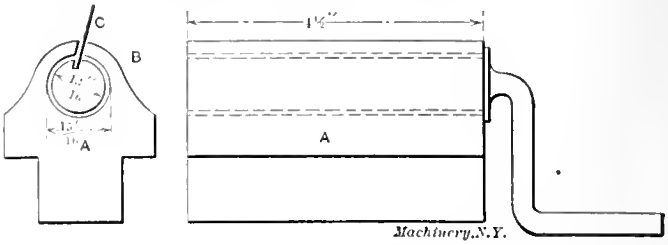
TO PREVENT THE BREAKAGE OF INCANDESCENT LIGHT GLOBES

Many readers of Machinery have doubtless been annoyed by the continual breakage of incandescent light globes hung near some rapidly moving belt. Of all the electrical phenomena whose exact nature we really know so little about, none manifests itself to us more frequently than the static charge residing on the surface of a moving belt. An observing person will notice that the filament of a lamp in proximity to a charged belt is distorted until it touches the glass, even though no spark is visible. Now, when the current is turned on, as soon as the filament becomes incandescent the glass cracks and the lamp is on the retired list. Here is a simple preventative: Attach to the lamp, in the ordinary manner, any one of the numerous wire protectors on the market. To this protector fasten a fine wire, say number 16 bell wire, and run it to an overhead I-beam, water pipe, or other metal body that is grounded. Through this path the static charge passes away without affecting the lamp. It is understood, of course, that the protector is insulated from the lamp circuit by being fastened to the insulated socket. **Donald A. Hampson.**

Middletown, N. Y.

DEVICE FOR ROLLING TIN-PLATE TUBES

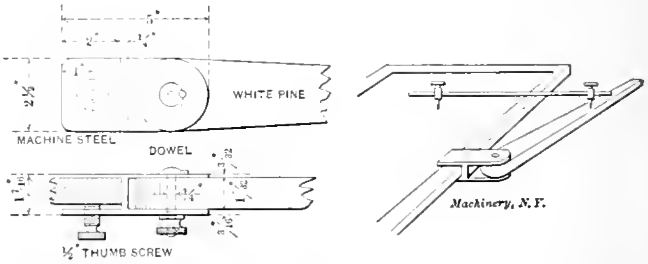
A rush order came to my department for several thousand tin-plate steam heater floor tubes. The shop rollers were too large in diameter for the job, and the usual method of manufacture, that is, bending the pieces of tin-plate around an iron rod in a groove in the creasing stake, was too slow. Consequently, I made an appliance similar to the one shown in the illustration. The device consists of a cast iron block *A*, which is bored to receive the roller *B*, having a slot throughout its length, as shown, which holds the metal plate when the crank is turned and the roll is being formed. When one edge of the plate *C* is inserted in the slot in the roller, the crank is turned two or three times, when the roller and tube can be withdrawn. With this simple tool, the output was increased to 500 per hour, as against 50 per hour with the creasing stake.



Manchester, England. **T. Iles.**

ATTACHMENT FOR THE DRAWING-BOARD

In laying out work, it is often necessary to locate a center or some other point beyond the scope of the average sized drafting-board. The accompanying sketch illustrates a simple device that has been found to meet the requirements when such occasion arises. If the attachment is made according to the dimensions given, it will fit any board up to 1⅛ inch in thickness. **W. L. Van Ness.**



Toledo, Ohio.

TWO TYPES OF BACK TOOL REST

Fig. 1 illustrates a very poor back tool rest which may be seen on some new screw machines. The tool lacks support, breakages are frequent, and the efficiency is thereby greatly diminished. Fig. 2 shows what these machines need —a rigid tool rest. **F. Rattek.**

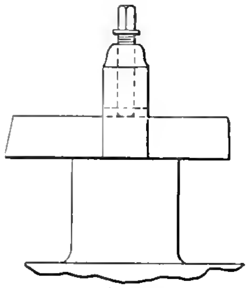


Fig. 1

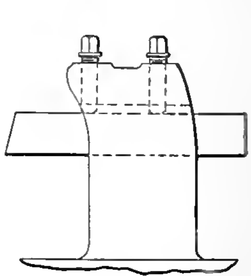


Fig. 2

Machinery,N.Y.

Brighton, Mass.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

CHAMPION DOUBLE BACK-GEARED LATHE AND IMPROVED GEAR BOX

In Fig. 1 is shown the head-stock end of an engine lathe built by the Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, O. The special feature of the design lies in the use of a three-step cone for a high power belt, which may be connected with the spindle either directly or through double back gears. The throwing in of the back gears or the changing from one back gear ratio to the other may be effected from the front of the machine by the use of conveniently placed levers and handles. The drive will be understood from a study of the half-tone engravings, Figs. 1 and 2, and the line engraving, Fig. 3, which shows the mechanism.

The cone pulley *A* has driven into it a sleeve *B*, having pinion teeth cut in its outer end. A second gear, *C*, is driven onto a seat turned just behind the flange. Gears *B* and *C* mesh with corresponding gears *D* and *E*, which are normally free to revolve on back gear quill *F*. The latter is supported by shaft *G*, which passes through the length of the head-stock and bears at opposite ends in the eccentric hubs of levers *H*, which are journaled in bearings in the head-stock casting. The outer ends of levers *H* are connected by bar *J*, which may be reached from the front of the machine. By swinging this bar *J*, the eccentric hubs of levers *H* throw the back gear quill forward or backward, so that gears *D* and *E* are thrown in mesh with gears *B* and *C*, while the pinion formed on quill *F* is thrown into engagement with driving gear *K*, keyed fast to the spindle.

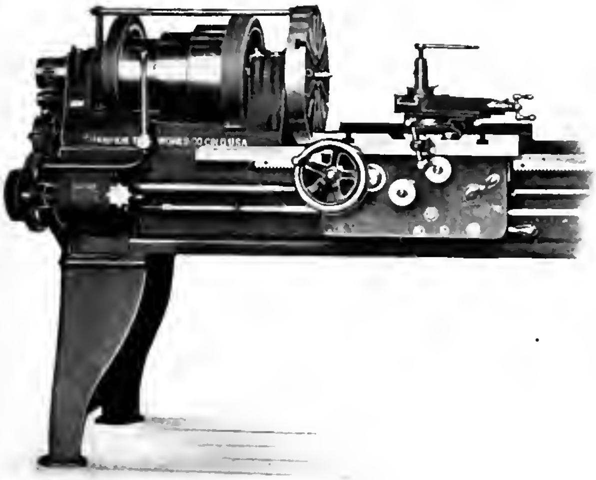


Fig. 1. Double Back-geared Head-stock for Champion Lathe

As stated, gears *D* and *E* normally revolve freely on quill *F*. The hubs of these gears have key slots cut in them, and are recessed on their inner hubs to furnish a clearance space for key *L*, which may be shifted axially in a cross slot in *G* by means of a bar *M* pinned to the external sliding collar *N*. In the central position, when *L* is resting in the recesses of the hubs of *D* and *E*, both these gears are disconnected from the shaft. When sleeve *N*, and with it *M* and *L*, is moved to the right or left, the key is forced into one of the opposing pairs of slots in the hubs of the gears *D* or *E*. By this means the two back gear speeds are obtained. Sliding collar *N* is operated by a yoke and rock-shaft provided with a handle, shown at the front of the head-stock in Fig 1.

Great belt power is obtained by this drive. The smallest step is 8¼ inches in diameter for a 3½-inch belt, and the largest is 11½ inches in diameter. The operator has perfect control of the back gears without moving from his position, and may make changes from single back gear to double back gear, or *vice versa*, without stopping the counter-shaft. This double back gear does not interfere with the driving of work in which the spindle is directly connected with the cone. The speeds are positive, and no friction or other connections are used, clutches being relied on for the various changes. This double back-geared drive is an invention of Mr. John C. Pflanzer, superintendent of the shops of the makers. It is applicable to 16-inch lathes and larger.

The new feed box is shown applied to the lathe in Fig. 4. The gearing connecting the spindle and the gear box is exceptionally well guarded, as shown, standing comparison in this particular with the lathe of any other American maker. The guard has a spring catch which may be released to swing it back for oiling the gear bearings. If desired, it may be easily lifted off the machine entirely. The use of a substantial guard is made possible by the fact that a large number of screw cutting and feed changes are provided by the gear box, without requiring the removal or replacing of any change gears. The quick-change gear mechanism gives forty different threads or feeds in all.

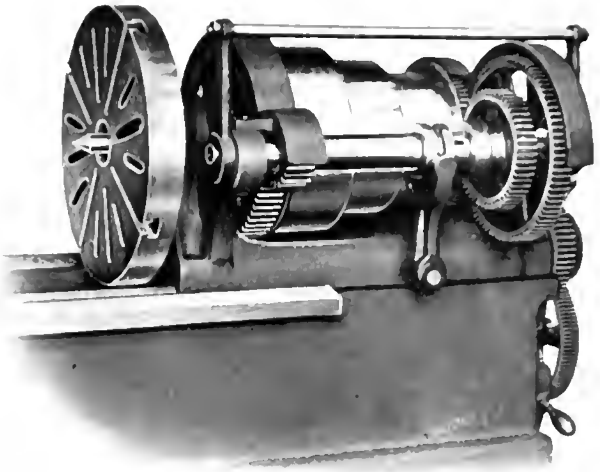


Fig. 2. Rear View of Head-stock, showing Arrangement of Double Gearing

Provision is made for reversing the feed by the lever at the end of the head-stock in the usual way. A double train of gearing is provided between the spindle and the gear box, either side of which may be thrown into action by a push pin, thus giving two rates of speed to the driving shaft of the feed mechanism. This driving shaft has formed on it a pinion extending the full length of the feed box, meshing with an idler carried on a swinging arm, so that it may be adjusted to engage with either one of a cone of eight gears on the variable speed shaft above it. This construction is, of course, a familiar one. The variable speed shaft is in turn geared to an intermediate shaft, which is connected with the lead-screw by a cone of three gears. A sliding key operated by the vertical knob shown at the right-hand end of the feed box, throws either one of these three sets of gears into action. These have ratios of 2 to 1, 1 to 1, and 1 to 2 respectively. The knob for making these changes is retained in each position by a ball forced by a spring into a depression placed opposite

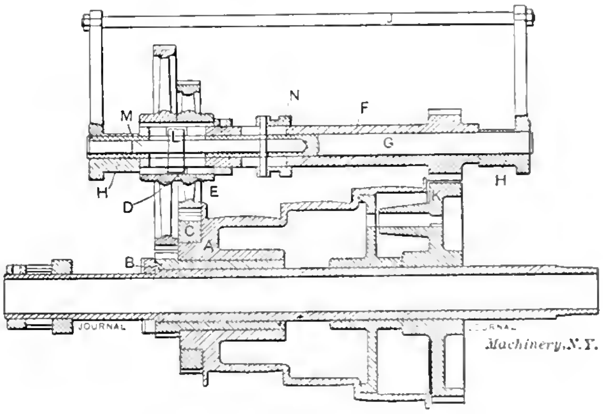


Fig. 3. Plan View of Driving Mechanism

each one of the three stopping points. This prevents the shifting key from working out of position except when the knob is turned by the operator.

There are thus forty-eight combinations possible, derived from the two changes controlled by the pull pin in the outside gearing connections, the eight changes furnished by the swinging idler and the main cone of gears, and the three changes controlled by the vertical knob. Of these forty-eight combinations, forty are non-duplicates, giving that number of separate thread pitches without change of gearing. Provision is made in the connection between the head-stock and gear box for change gears for odd or fractional pitches as required. The forty threads available range from 2 to 56 per inch, including 11½. The forty non-duplicating feeds give 3½ times the number of turns per inch for the corresponding thread.

The lead-screw is driven from the lead-screw shaft in the gear box by a clutch, which may be thrown out if desired when the rod feed is in use. The latter is connected with the feed-screw shaft by gearing inside the box. The splined feed rod has a provision for axial movement against the pressure of springs in either direction. These springs hold it normally in central position, where suitable clutch teeth engage with corresponding internal teeth on the loose gear by which it is driven from the lead-screw shaft. Stop collars are provided as shown, on each side of the carriage. When the automatic feed forces the carriage against either of the stop collars in either direction, the feed rod is thereby shifted longitudinally and the clutch is thrown out of engagement, stopping the feed. When the carriage is returned by hand to the starting point again, after releasing the friction in the apron, the spring automatically throws the splined rod back to the central position, so that the feed rod clutch is again in engagement.

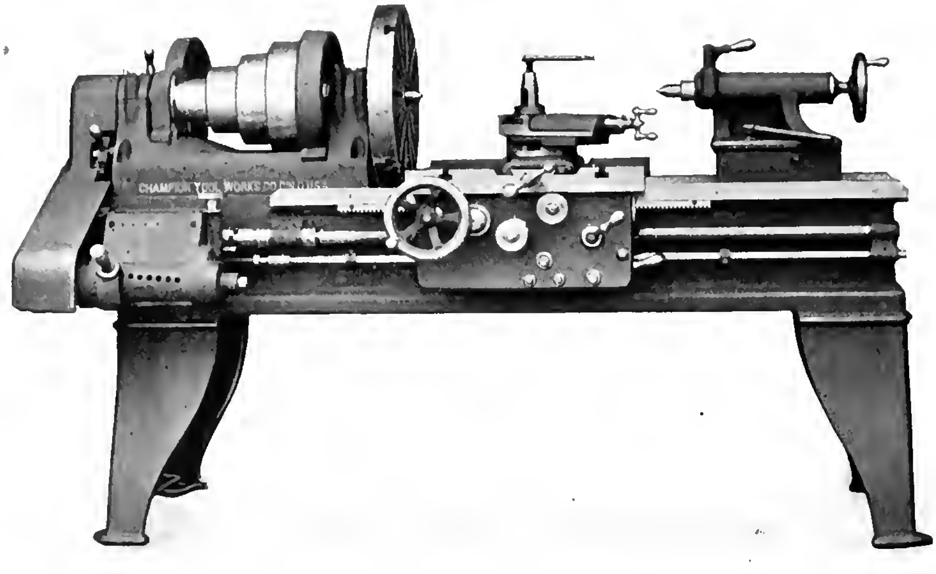


Fig. 4. Sixteen-inch Champion Lathe with Gear Box Mechanism giving Forty Changes

The pinion in the apron may be withdrawn when chasing threads, and provision is made in the apron feed reverse for interlocking with the lead-screw half-nut, so that the rod and screw feeds cannot be engaged at the same time. The rack pinion has an inside bearing, so that the apron is virtually of the double construction so far as this vital feature is concerned. The gears and longitudinal feeds are controlled by independent frictions.

The compound rest slides have taper gibs, and the swivel is graduated in degrees. Both compound rest and cross feed screws have dials graduated in thousandths. The carriage has a chasing dial connected with the lead-screw, which permits the cutting of threads without reversing the spindle. By its use the operator is informed of the proper time to throw in the half-nut. This permits using the two belts of the counter-shaft for giving two speeds in one direction, so that with the single back-geared four-step cone drive, sixteen spindle speeds are obtainable or, similarly, eighteen speeds are obtainable with the head-stock mechanism shown in Figs. 1, 2, and 3.

The quick change gear device is applicable to the 12, 14, 16 and 18-inch lathes manufactured by the Champion Tool Works Co. It is the invention of Mr. William Donaldson, secretary and designer of the firm. The lathe shown in Fig. 1 has a simpler feed gearing, which will be furnished if desired by the customer. With it three changes of pitch or feed are obtainable without altering the change gears.

BROWN & SHARPE NO. 12 PLAIN GRINDING MACHINE

The plain grinding machine illustrated herewith is built by the Brown & Sharpe Mfg. Co., Providence, R. I. In the broad lines of its design it resembles the larger plain machines of the same make, being intended for rapid and accurate manufacturing of such parts as spindles, shafts, rolls and other work (either straight or taper) capable of being finished on dead centers. It will take work up to 8 inches in diameter and 36 inches long, being thus intermediate between the makers' No. 11 and No. 13 plain grinding machines; the former of these is of different design, built especially for small work. The No. 12, which is here under consideration, will take in the major portion of the grinding work of the ordinary machine shop, and handle it with a rapidity and accuracy corresponding to the highest present attainments in the art of grinding.

General Construction of the Machine

The base supports the entire mechanism on a single casting; it rests on the floor or foundation on a three point bearing, one at either end of the front view of the machine in Fig. 1, and the other at the center of the base in Fig. 2. This three-point bearing gives assurance that the machine will always be supported under the same conditions as when it was planed and scraped, so that the original accuracy of workmanship is preserved. While this compensates for any unevenness in the floor, a solid, steady support is desirable, and a cement foundation will be found a valuable factor in increasing the output in manufacturing work. The base is hollow, and is fitted with

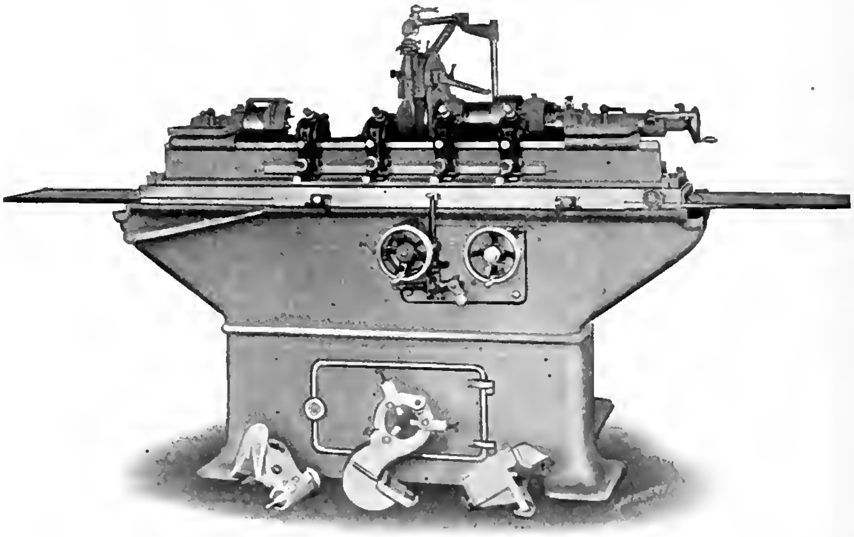


Fig. 1. Brown & Sharpe No. 12 Plain Grinding Machine

shelves to receive small tools and accessories. A tank and pump for wet grinding are also located inside the base. The pump is of the centrifugal type, with bearings above the water line. It is self priming, and no packing is required. (See Fig. 3.) A complete set of water guards and pans protects the floor and returns the waste to the settling tank and pump. On the carriage is mounted the swivel table, carrying the head- and foot-stocks, to provide for grinding tapers. A quick adjustment and graduated scale is provided for obtaining the taper desired. The head- and foot-stocks are adjustable on ways on the inclined face on the swivel table. These ways are protected from the water by adjustable guards. The universal back-rests furnished with the machine for supporting long slender work or splined shafts, are supported on independent ways of their own on the vertical front face of the swivel table, as is plainly shown in Fig. 1. The head- and foot-stocks are adequately protected from water and grit. The foot-stock has permanently attached a device for holding a carbon point in truing the wheel, which can thus be done without removing the work.

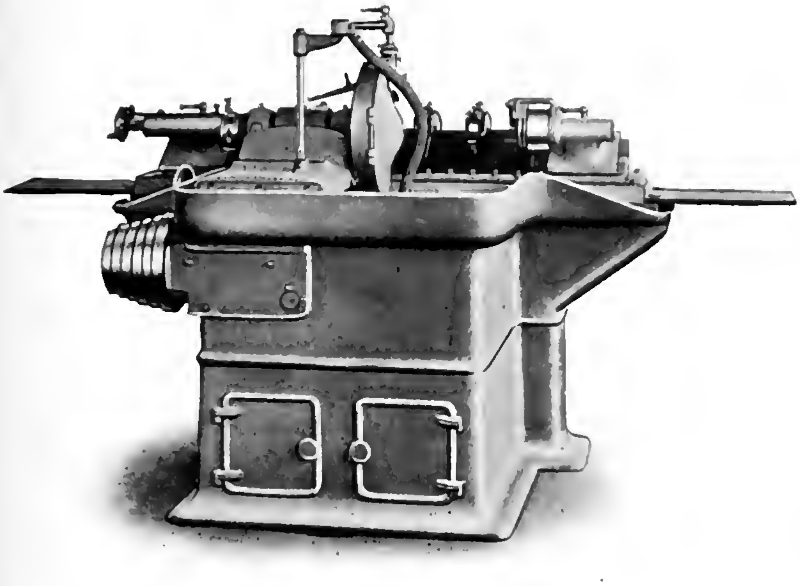


Fig. 2. Rear View of Grinding Machine

Improvements in the Cross-feed Mechanism

Fig. 3 shows a section through the wheel spindle, and illustrates an improvement in construction which makes possible the rapid traverse of the wheel spindle slide. The cross adjustment is effected by a vertical pinion on shaft *A*, meshing with rack *B*, which is firmly screwed to the slide. To *A* is pinned the clutch *C*, which engages a corresponding clutch member screwed and doweled to worm-wheel *D*, which in turn is operated by worm *E* controlled from the cross-feed hand-wheel at the front of the machine. By turning the short lever shown below and between the two hand-wheels on the front of the bed in Fig. 1, cam *F* is rocked into the position shown in Fig. 3, thus raising shaft *A* and disengaging clutch *C*, leaving the slide free from worm-wheel *D* and from connection with the cross-feed adjusting hand-wheel at the front of the machine. Hand-wheel *G* at the side of the slide is mounted on a short pinion shaft engaging a stationary rack on the stand. This may now be operated to give a rapid movement to the slide. Rocking cam *F* downward again by the lever at the front of the machine again throws clutch *C* into engagement and gives a fine cross adjustment from the regular hand-wheel.

The rapid movement thus provided is useful for moving the wheel slide quickly from one extreme of its travel to the other, so as to thoroughly distribute the oil along the ways of the wheel slide. This is very important, particularly in starting the machine after it has been idle over night, or for some time during working hours. If these bearings are not thoroughly lubricated it is impossible to get the fine adjustments required, which often have to be made as close as 0.000125 inch. This quick movement is also useful in altering the adjustment of the wheel for considerable changes in the diameter of the work.

Another point of interest shown in Fig 3 is the method of gibbing the wheel slide to the stand. Gib *H* is fitted into position by scraping, and is drawn down tightly into place by means of the bolts shown. This construction does not permit the operator to tamper with the adjustment. If it becomes necessary after years of service to compensate for the wear at this point, this is done by removing the gib and scraping its upper surface until the desired closeness of fitting is obtained.

The spindle construction is shown quite plainly in Fig. 3. The spindle is of one diameter throughout the main part of its length, and is exceptionally heavy. Suitable oil wells with felt distributing pads are provided, and the boxes are self-aligning and adjustable for wear. The thrust of the spindle is taken by two washers, bearing in spherical seats in the hub of stationary sleeve *J*. This construction makes possible a much closer fit, so far as end movement is concerned, than can be obtained in any other way. A two-step cone pulley is provided to keep up the speed as the wheel wears down. A safety belt stop shown at *K* attached to the adjustable cap of the wheel guard, makes it impossible to shift the belt on to the smaller step until the wheel has worn down to a point that makes it safe to do so.

The automatic cross-feed is of the standard design developed by the makers. The simple pressing of a thumb latch sets the feed for any desired size, automatically stopping it when the required depth of cut has been reached. The feed can be set to give the full amount at either or both ends of the stroke. The same movement also, if desired, may be used for giving a fine hand feed. The hand-wheel is graduated to read to thousandths of an inch on the diameter of the work.

Improvements in the Table Traverse Mechanism

Figs. 4 and 5 show quite plainly the mechanism of the automatic traverse for the table. The reversing device is of the "load and fire type," which has been used for many years by the builders. Arm *K* in Fig. 4 is keyed to a rock-shaft extending through to the front of the machine, where it is actuated by the adjustable reversing dogs at the front of the carriage. As the carriage approaches the end of its movement, arm *K* is rocked to the right or left as the case may be. If rocked to the left in Fig. 4, by means of the connecting rod and tappet *L*, spring M_1 on rod *N* is compressed, bringing block O_1 against the catch on latch P_1. Continued movement of *L* to the left finally raises latch P_1, allowing O_1 and *N* to fly to the left under the impulse of compressed spring M_1. Latch P_2 then drops in behind block O_2. The movement of *N* to the left, by means of fork *Q*, throws feed-shaft *R* to the left, and with it the reversing clutch *S*, which is keyed to it. The table traverse is thus reversed. At the end of the stroke

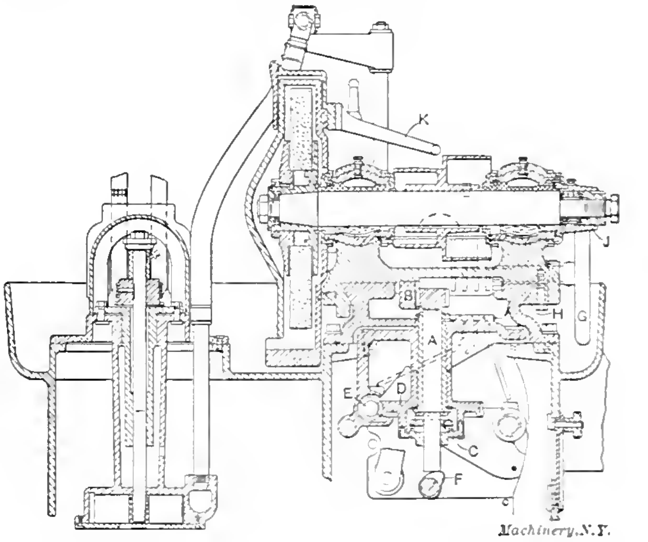


Fig. 3. Cross-section through Grinding Head Spindle, showing Centrifugal Pump and Improvements in Cross Feed

in the other direction, L is moved to the right, spring M_2 is compressed, latch P_2 and N, Q, R, and S are thrown to the right, thus again reversing the table. This mechanism avoids the possibility of stopping the clutch on dead center.

An improvement in the design makes it possible for the operator to stop the traverse at the end of the stroke if he desires. This is clearly shown in Fig. 5, where the same reference letters apply as in Fig. 4. A knob T in the center of the traverse movement hand-wheel X, by means of the connections shown passing through the hollow shaft, operates the plunger U. By pressing the knob T, U may be held under spring pressure against the surface of revolving clutch S. When the latter, at the end of the stroke, flies over under the influence of springs M_1 and M_2, latch U drops into the groove turned in the periphery of S, holding it in the central position. The workman may thus at any point of the stroke of the machine set knob T to stop the traverse at the end of the stroke. This requires less watchfulness and care, and leaves the operator free to concentrate his mind on the matter of making accurate measurements. The spring detent at V holds the knob T in either its open or closed position. The withdrawal of the knob again starts the traverse without requiring any further movement on the part of the operator.

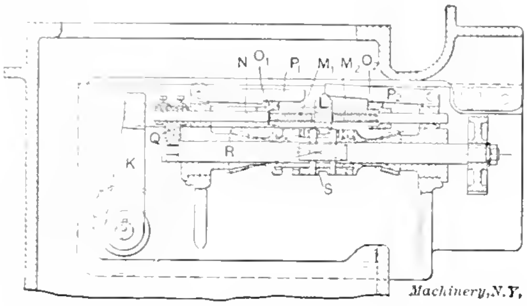


Fig. 4. The "Load and Fire" Reverse Mechanism for the Table Feed

Knob T serves another purpose simultaneously with that of stopping the machine at the end of the stroke. It is pinned to the shaft which receives the movement from the feed gearing, and is provided with clutch teeth engaging corresponding teeth on the hub of hand-wheel X. The latter thus hangs free during the operation, and is only thrown into engagement with the table traverse gearing when the operator stops the power movement. This is advantageous in the production of accurate work. The nature of the grinding operation requires the operator to stand close to the machine for the delicate adjustment of rests, etc., during the movement of the table. This is inconvenient and dangerous with a revolving hand-wheel having a handle protruding from it. Besides this, the hand-wheel is necessarily geared up to give an easy and accurate movement to the table when facing a shoulder on a piece of work. This means a comparatively high speed, so that its momentum becomes a serious factor in reversing the direction of the table feed mechanism. Since with this improved arrangement the hand-wheel never reverses, it can be made much larger in diameter than has hitherto been possible. Throwing it into engagement, as explained, requires no further movement on the part of the operator than that of stopping the machine.

Another improvement in the table feed mechanism is effected by the gearing shown at Z, in Fig. 5. This gives two rates of table feed, controlled by a hand lever (shown just above the table hand-wheel in Fig. 1), mounted on shaft B. When this lever is set for the slow movement and the belts on the counter-shaft cones are properly set for roughing out a piece of work, the shifting of the feed gearing to the fast movement makes the proper change in the table feed for the fine finishing cuts desired for bringing the work down to size. It is thus possible to have the proper feeds for roughing and finishing without requiring the shifting of belts during the progress of the work.

Improvements in the Driving Mechanism

The counter-shaft of this machine has been re-designed so as to make the wheel and work speeds and the table feeds entirely independent of each other, so that either of the three may be changed without affecting the others. This feature, particularly in relation to the work speeds and table feeds, is an important factor in commercial grinding. By this arrangement it is possible to obtain a correct table feed for any work speed, so that when it is desired to remove stock rapidly, a slow speed and fast feed are available. Any of the changes can be made without stopping the wheel, work or table.

A further convenience in the drive is afforded by the horizontal lever shown at the left of the bed in Fig. 1. This is for starting and stopping that portion of the overhead works that feeds the table back and forth and reverses the work. This lever replaces the shipper arm generally employed for this movement, and changes the tiresome horizontal movement over the workman's head to a vertical movement in a convenient position where his hands would naturally be in operating the machine. As this lever is moved every time a piece of work is calipered or removed from the grinder, the relief to the operator becomes an important factor in increasing the output of the machine. The connection with the counter-shaft is by means of a piece of wrought iron piping not shown in the engraving. This improvement has been found of so much importance that all of the grinding machines in the shops of the builders have been equipped with it even when it was not provided for in the original design.

General Dimensions and Specifications

The machine takes work 8 inches in diameter and 36 inches long. It takes a wheel 16 inches in diameter, 1 inch or 1½ inch face. The automatic cross-feed ranges from 0.00025 to 0.004 inch at each reversal of the table. The scale for the swivel table reads up to 8 inches per foot and 3½ degrees taper. The ways of the table are provided with roller oil distributors, and are protected by metal covers. The table movement is controlled by quick shifting dogs with micrometer adjustment. Six changes of wheel speed are provided, ranging from 1,200 to 2,400 revolutions per minute. There are twelve changes of work speed, from 42 to 312 revolutions per minute, and twelve changes of table feed, from 8 to 100 inches per minute in two series, available for any work speed. The counter-shaft is driven by tight and loose pulleys 14 inches in diameter for 4-inch belt, and should run about 400 revolutions per minute. The floor space occupied is 144 inches by 51 inches. The net weight of the machine is 5,050 pounds. The equipment includes one plain back-rest, four universal back-rests, a center rest, center grinding attachment, water guards and a set of dogs. Two grinding wheels are also provided, together with wrenches and complete overhead works.

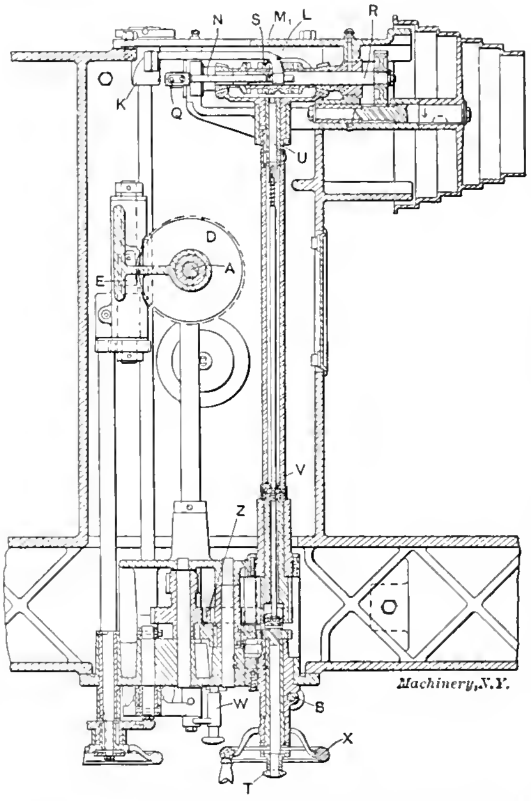
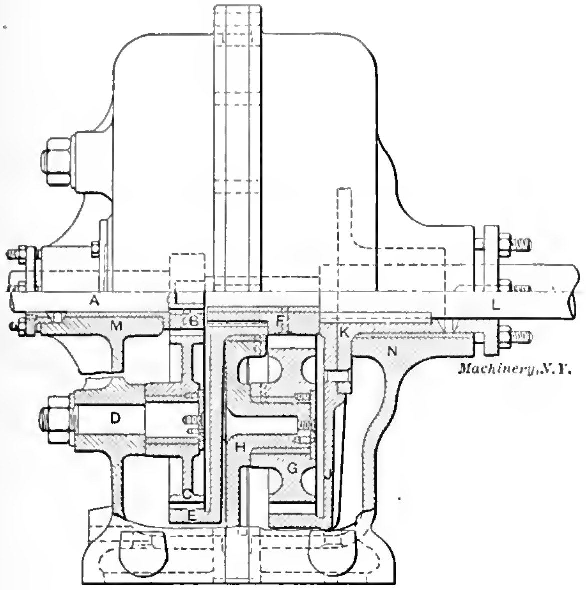


Fig. 5. Horizontal Section of the Feed and Traverse Mechanisms

FOOTE BROS. SPUR GEAR SPEED REDUCER

The Foote Bros. Gear and Machine Co., 44-50 No. Carpenter Street., Chicago, Ill., have devised a very neat form of speed reducing gearing, intended particularly for direct connection to electric motors. As may be seen from the engraving, the casing of the mechanism in itself closely resembles a motor, so that the combination of the two on the same base plate gives a pleasing mechanical appearance to the apparatus. In laying out the design it has been the endeavor to get the reduction for the horse-power required as nearly as possible into the same center height as the motor, thus avoiding raising strips on either the reduction or the motor.



An Enclosed Spur Gear Reduction Mechanism of Rigid and Pleasing Design

This reducer employs spur gears only, the two larger members being of the internal spur gear type. The driving shaft at *A* has keyed to it a steel pinion *B*, meshing with a series of four intermediate gears *C*, of which one only is shown. This intermediate runs on a stud *D*, fast in the casing head *M*. It meshes at its outer diameter with the first internal gear *E*, which is journaled in a bearing in diaphragm *H*. The hub of *E* is keyed to pinion *F* and the latter is bored and bushed as shown, to furnish a bearing for driven shaft *L*, so that *L*, *F* and *E* support and stiffen each other. Pinion *F* engages with a second series of intermediate gears, of which one is shown at *G*. These are journaled on bearing studs integral with the diaphragm *H*. Pinions *G* mesh with the second internal gear *J*, riveted to flange *K*, which is in turn keyed to the driven shaft *L*.

It will be seen from the engraving that the design provides for a mechanism of high class, especially as relates to rigidity and durability. All the bearings throughout the casing are bushed with phosphor bronze, and are of ample length and diameter. The studs for the idlers are rigidly supported, so that there is no chance for springing or loosening to cause cramping of the teeth, with consequent breakage. It will be noticed also that the driven or slow speed shaft is supported at the center of the diaphragm, as well as at the outer bearing. The internal gears, which are the only ones rotating in the oil, have long hubs, preventing them also from tipping sideways and cramping the teeth. These internal gears distribute the oil effectively over the whole driving mechanism. The shafts are provided with glands, as shown, packed to prevent leakage of the oil. Since the high speed shaft does not pass through the slow speed internal gear, it is not necessary to turn this shaft down. Stopping off the high speed shaft in this way allows the use of a more compact design to transmit the power the device is intended for.

In comparison with other spur gear reducing mechanisms, the makers call particular attention to the following points: Strong central support of the shafts, and particularly of the idler studs in the diaphragm; smooth frictionless action of the parts in the oil bath, instead of the thrashing and consequent loss of power resulting from the rotating of idler plates or disks at high speeds; no rotating parts so constructed as to be liable to get out of balance, so that the machine runs smoothly and is not racked to pieces. These speed reducers are made in three styles, one of them with a compound idler for extreme reductions. The ratio of reduction may be made anything desired from 8 to 1, to 60 to 1. For ratios greater than 60 to 1, the makers prefer to furnish a worm gear spiral reduction as being better adapted to the conditions. These reducers are made in seven sizes, ranging from 1 to 50 horse-power capacity. They will be furnished, if desired, with a universal coupling between the motor and the casing, to obviate all danger due to misalignment of the armature and driving shafts.

REED 13-INCH SINGLE SPINDLE DRILL PRESS

The new single spindle drill press illustrated herewith is built by the Francis Reed Co., Worcester, Mass. It is noteworthy from the number of adjustments provided. It embodies a sliding head and sliding table, with provision for either tilting or swinging the working surface of the latter. The drive also is unusual in being set parallel with the machine, so that the latter faces the line-shaft, thus agreeing also with the makers' regular A style of drill press.

Straight belts only are used, all quarter turns and twists being done away with. The parallel drive is accomplished through miter gears, one of which is rawhide, connecting the counter-shaft with the vertical driving shaft. The latter runs on a step to prevent the gears from crowding together. The counter-shaft, which is a part of the machine, runs in a bushing on an extension of the frame. The loose pulley runs on a hub on the outside of the frame, and has no connection with the shaft, so that conditions are ideal so far as durability and lubrication are concerned. The changes of speed are obtained by three-step cones at the top of the machine. The main drive is down low enough to reduce the vibration to a minimum, so that with smooth belts no shaking is noticed at the highest speeds.

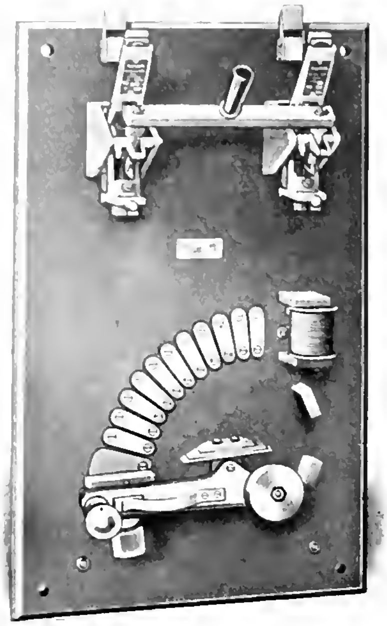
The Reed 13-inch Drill Press

The table is large and heavy, having a 12 by 12 inch surface with an angle plate 12 by 6 inches. This latter may be used to take a chuck for centering long work, making it unnecessary to throw the whole table around at right angles. The style of table shown tilts 45 degrees on each side of the center, the angle plate taking care of the other 90 degrees. Three styles of table will be furnished; the plain round table, a tilting and swinging table, or a plain swinging table. Cup and V centers are furnished with each machine to fit the lower arm. They are aligned with the spindle so as to center the drill properly.

The machine is furnished with either a No. 1 or a No. 2 Morse taper spindle. The spindle has a feed of 5 inches, and the vertical head is adjustable for 12 inches. The lower table has a vertical adjustment of 32¼ inches. The total height of the machine is 70 inches and the weight is about 280 pounds. The machine has a capacity for drills up to ½ inch, and is capable of extremely high speed.

WESTINGHOUSE STARTING PANELS FOR DIRECT-CURRENT MOTORS

The illustration shows one of a line of starting panels recently placed on the market by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa. This panel has been found better than the usual separate starting boxes for many installations, since it insures a more satisfactory location for the rheostat, switches and fuses or circuit breaker than when these parts are mounted separately. Each panel consists of a slate slab, on which the parts are mounted. In the smaller sizes the resistance is mounted on the back. The terminals are so plainly marked that there is little excuse for anyone making mistakes in the wiring, even though unfamiliar with apparatus of this kind.


Westinghouse Starting Panel, equipped with Circuit Breaker

The engraving shows what is known as the type "ZB" starting panel, on a carbon break circuit breaker. Other styles are provided with fuses in place of the circuit breakers. All of them have a low voltage release coil, independent of the field circuit so that any panel may be used for shunt, series, or compound motors. All the contacts are protected from burning by a quick arcing tip on the front of the panel, or by a blow-out coil on the rear, which also prevents burning the contact on opening the circuit.

As stated, these panels are furnished with either fuses or circuit breakers. Both have their advantages. The fuse will carry currents in excess of its capacity for brief intervals, so that it may perhaps be considered preferable for motors that are liable to very brief over-loads, and have expert supervision. The circuit breaker opens immediately, as soon as the circuit reaches the strength for which it is set. It can be reset in less time and less trouble than is required to replace burned-out fuses. Either the circuit breaker or the fuse opens the circuit of the low voltage release magnet, so that the motor is protected from over-loads at all times.

This line of starting panels is furnished in a wide range of sizes, for motors from ¼ horse-power at 110 volts, up to 120 horse-power at 220 volts. A wide range of panels for 500-volt circuits is included in the list. They are made in several different styles, either for mounting on wall brackets, or provided with tubular supports resting on the floor.

LEEDS & NORTHRUP HARDENING AND ANNEALING PYROMETER

In the department of New Machinery and Tools of the March, 1909, issue of MACHINERY, we published a short note describing a pyrometer placed on the market by the Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. The distinctive feature of this pyrometer was its use of a pure platinum conductor exposed to the heat to be measured, in place of the usual thermo-electric couple. The resistance of this conductor was measured by an instrument of the same type as an ordinary ammeter. This arrangement combines the convenience of a pyrometer of the ordinary type with the easy reading and durability of the standard electrical measuring instruments. The current used is obtained from any direct current system, and the readings are practically independent of voltage fluctuations.

In the apparatus previously described, the operation of measuring consists in adjusting a resistance for about the desired temperature (within 200 degrees) and then reading the finer calibrations on the ammeter dial. The improvement consists in furnishing a form of direct reading resistance or "indicator," as it is called, which may be set exactly to the temperature desired. Then the pointer of the deflector or ammeter will stand at 0 when the furnace has been brought to this temperature. There are 100 divisions on either side of this 0 point. When the temperature is 50 degrees too high, the needle stands approximately on the + 50 mark; when it is 75 degrees too low, the needle stands approximately at —75, etc. By turning the index on the indicator, the temperature corresponding to 0 may be varied at will. Thus, if it was desired to treat a piece of steel at 1,380 degrees F., the index would be set at 1,380, and the temperature of the furnace raised until the needle stood at the center of the scale. If the next piece was to be heated at 1,420 degrees F., the index would be set at 1,420, and the needle again brought to the center of the scale.

The apparatus is shown diagrammatically in Fig. 2. *A* and *H* represent the terminal poles of the apparatus where it is connected to the shop lighting or power circuit, storage battery or other convenient source of current. From *A* the circuit leads to the shifting contact *C* of the indicator. From *C* the circuit flows through the resistance on either side, flowing out through *E* to *D* or through *F* to *D'*. *D* and *D'* are two coils of a balanced ampere meter, forming the deflector. When the current is the same in each coil, the dial indicates zero. When the current is stronger in one coil than the other, this condition is shown on the dial by a deflection to the right or left, as the case may be. The upper circuit of the divided current passes from *D'* through the bulb *B*, containing the platinum resistance member, which is subjected to the heat, and back to the minus binding post at *H*. The other half of the divided circuit leads from coil *D* of the ampere meter through the permanent resistance *G*, back to the binding post *H*.

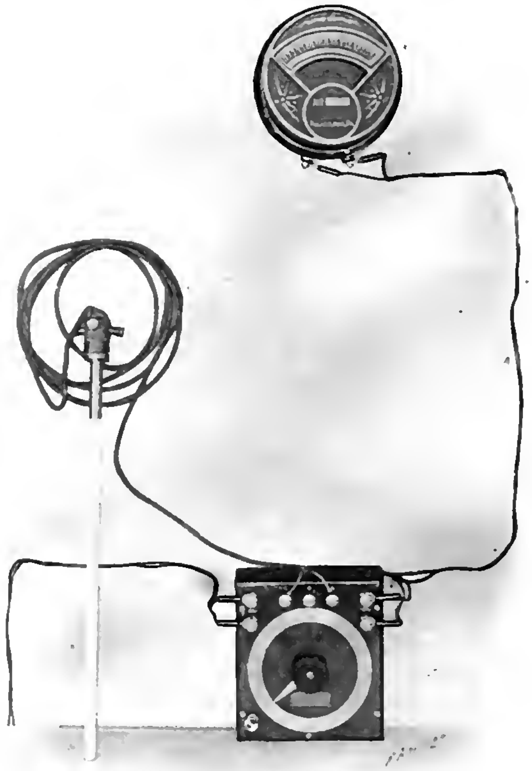


Fig. 1. A Pyrometer used on an Ordinary Lighting Circuit, which gives Magnified Readings for Minute Temperature Changes

The action of the apparatus will now be easily understood. The sliding contact *C* is set to indicate a desired temperature. When so set, as shown in Fig. 2, the resistance of the upper circuit is decreased while that of the lower is increased. (It should be mentioned that the permanent resistance *G* has the same resistance as the bulb *B* at normal temperatures, and it is made of a material whose conductivity

is unchanging for changes of temperature, so that no attention has to be given to the cold end of the apparatus.) Owing to the smaller resistance in the upper circuit, the needle of the balanced ampere meter will fly to one side indicating this condition. If now the element be subjected to heat, its resistance will be gradually increased until both branches of the circuit are again carrying the same amount of current, and the indicator dial, under the influence of coils *D* and *D′* again indicate a balanced condition. If contact arm *C* is again moved upward, so as to further increase the resistance of the lower circuit, the element *B* has to be heated to a still higher temperature to bring the ampere meter to balance again. It will thus be seen that each position of the contact arm *C* corresponds, when the ampere meter is in balance, to a definite temperature of *B*, no matter what the voltage of the current flowing in the apparatus. By indexing these definite temperatures with graduations on the resistance box, a very effective means of temperature control is provided.

The ordinary thermal couple instrument has crowded on its single 6-inch scale its total temperature range from 0 to 2,000 degrees F. In a given process with a given kind of iron or steel, at least 90 per cent of this scale is never used. On such an instrument, ⅛ inch on the scale corresponds to from 20 degrees to 50 degrees. On this deflection indicator, ⅛ inch corresponds to 5 degrees approximately. The workman does not have to remember at what temperature he is working. The deflector does not tell him what the temperature of the furnace is; it tells him that the furnace is so many degrees from the correct temperature. He can at any time, by looking at the index on the box, tell at what temperature the furnace is supposed to be held. Or, should it be desired, this index may be in the superintendent's office or kept from the furnaceman's sight. In any case, the first thing that strikes the furnaceman's eye is that the temperature is higher or lower than it should be, or that it is just right, depending on whether the needle is to the right or the left of the center or just in the center. When 30 degrees means a deflection half way off the scale of the pyrometer, even the most careless workman will get busy to correct the error, but when 30 degrees means only 1/16 inch to 1/8 inch motion, the average man naturally thinks "that little bit won't hurt."

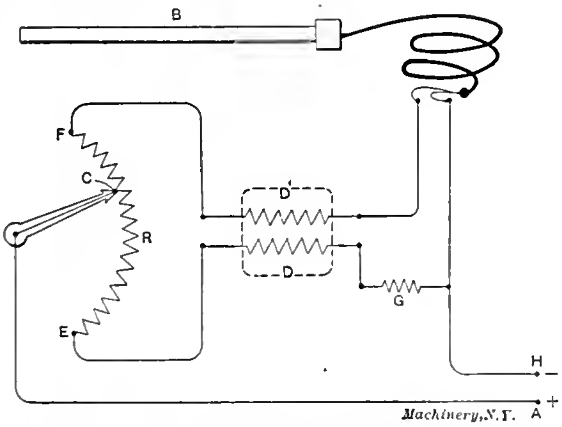


Fig. 2. Diagram illustrating Principle of Action of Leeds & Northrup Pyrometer

It does not require a deep knowledge of psychology to know that small things do not receive the consideration that big things do. With the average workman reading a pyrometer, it is the amount of space covered by the needle which counts; the scale receives scant consideration. An eighth of an inch is to him an eighth of an inch, regardless of whether that eighth of an inch stands for 5 degrees or 50 degrees. Hence a pyrometer on whose scale an eighth of an inch equals 5 degrees acts on the workman as an unconscious stimulant to accuracy.

It is also true that with a pyrometer readable to 2 degrees it is very much easier to control temperature within set limits than it is with an instrument readable to only 25 degrees, for the reason that as soon as the source of heat, be it gas, coal, oil or electricity, begins to vary, the change is immediately noticeable and may be immediately remedied. This does not give the furnace conditions a chance to get "a set" which necessitates radical action to correct, such action starting the temperature change too far in the other direction.

From what has been said it will be seen that this instrument is primarily designed for telling the operator whether or not his furnace is being maintained at the proper temperature; what this particular temperature is is really to the workman a matter of secondary consideration. In fact, it is occasionally desirable that he should be kept in ignorance of it. The usual construction of pyrometers emphasizes first of all the true temperature, often in unfamiliar units, and the workman must transpose this in one way or another to figure out how far his temperature is in error. The measurement of temperatures is in reality a problem in electrical measurement. The makers' long experience and high reputation in this work gives them confidence in introducing this new form of pyrometer for general use.

LANG TOOL-HOLDER FOR TRIANGULAR BLADES

The tool-holder illustrated herewith is made by the G. R. Lang Co., Meadville, Pa. The makers believe that they have succeeded in producing an inserted blade tool-holder which will effectively take the place of the solid forged tool in general work. The blade, as may be seen, is made from triangular steel, which is rolled in bar length accurate to size. The shape of the stock and the provision for clamping allows the use of a cutter of much larger section than is possible in the old style tool-holder.

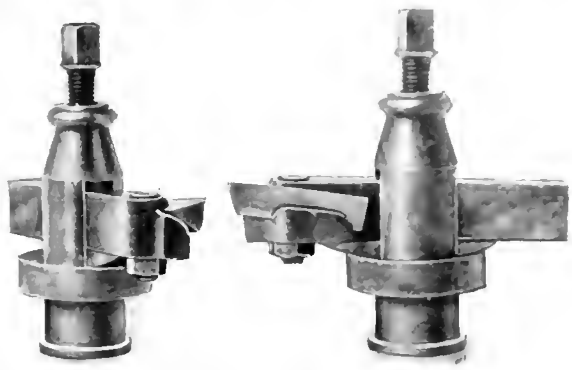


Fig. 1. A Simple and Rigid Tool-holder, using a Blade of Triangular Section

The seat for the blade and the way in which the point is ground gives it an angle of nine degrees back rake at the top, and fifteen degrees side rake. The clearance angles on the front and side are ground to about seven degrees, with very little waste of steel. To secure the same conditions with a cutting edge of square section would require stock about twice the area, and would necessitate the grinding away of a considerable amount of high-speed steel.

Fig. 2. The Holder with Blade Removed, showing Method of Holding

As an example of the heavy blades used, it may be stated that in the ⅝ × 1¼-inch tool-holder, a ¾ triangular steel bar is used, as compared with the usual ⅜-inch square. The cutter is supported entirely on the end opposite the direction of the thrust of the cut, and is held by a method which insures rigidity. There is no swell or head on the side to interfere with working close up to a shoulder, and there is no obstacle on the top to the passage of the chips. This makes it unnecessary to furnish offset tools. Severe tests have shown that the blades will not slip under the heaviest cuts. It is made in both right and left-hand styles and may be used as a side tool or as a drill starting tool, as well as for ordinary turning.

GRATON & KNIGHT CO.'S SPARTAN BELTING

The Graton & Knight Mfg. Co., of Worcester, Mass., has recently placed on the market a new brand of belting which they call the "Spartan." The special advantage claimed for it is pliability. This carries with it the advantage of dur-

ability, and closer gripping of the belt at less tension. The belting is also claimed to be steam proof, and to be unharmed with contact of lubricating oil. It is proof, also, against the action of hot water, coal gas, and acid fumes, so that it would seem to be able to stand almost anything it is likely to come in contact with. The makers give the strong guarantee that "it will, when used under the same conditions, outlast any other belting material."

WESTERN GEARED DRIVE PLAIN RADIAL DRILL

The radial drill herewith illustrated and described, is built by the Western Machine Tool Works, Holland, Mich. It is notable from the ingenious design of the geared driving mechanism, the thorough provision for automatic lubrication of all important members, and the wide range of feeds and speeds provided. Another noticeable feature is the maker's well-known method of driving the spindle from a gear at the lower end, as shown in Fig. 8.

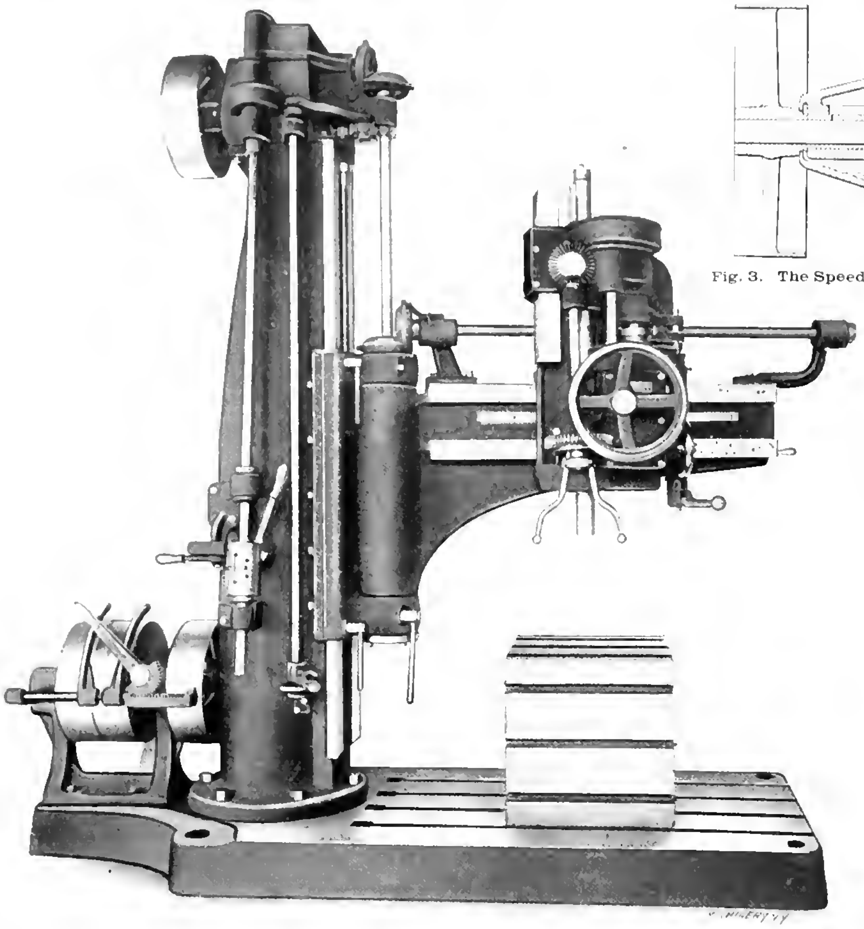


Fig. 1. The Western Plain Radial Drill, with Geared Speed Changes and Positive Feeds

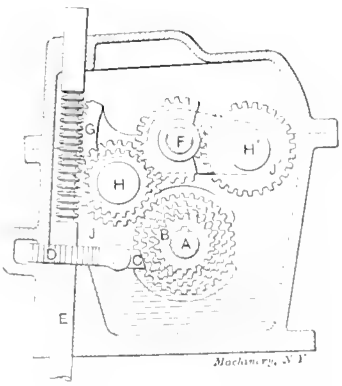


Fig 2. End View of Change Gearing, showing Control by Rod E

The Driving Connections

As may be seen in the front elevation, Fig. 1, the usual vertical shaft passing up through the column is dispensed with, a belted connection being made instead between the counter-shaft at the base of the column and the change gear box at the top. The counter-shaft has self-oiling journals and a self-oiling loose pulley. The individual oil reservoirs contain enough oil to last for a year of constant use. The loose pulley is of single piece construction with a reservoir cored around the bearing, packed with cotton and oil. In the reservoirs of the journals and the loose pulley, wicks are provided, leading from the bearing surface to the oil supply. A feature of the counter-shaft, which will be seen in Fig. 1, is the belt shifter. This, by means of the rack and sector construction shown, gives such a leverage that the shifting of the belt requires but a very light touch of the hand. If a motor drive is desired on the machine, a constant speed motor may be bolted on in place of the counter-shaft with very little trouble, being belted to the gear box at the top of the column in the same way.

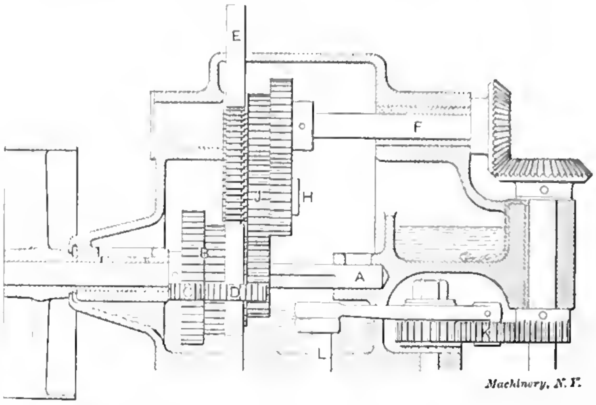


Fig. 3. The Speed Box, furnishing Eight Changes on the Selective Principle

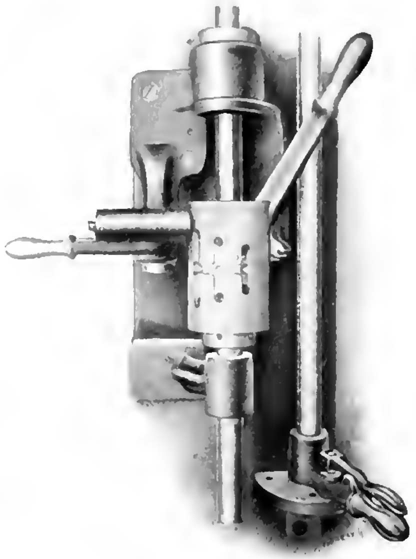


Fig. 4. Speed Changing Control at Lower End of Rod E

Figs. 2 and 3 show the construction of the speed change box. The constant speed shaft *A* is keyed to the pulley which, in turn, is belted to the counter-shaft or driving motor. A cone of 4 gears *B* is splined to shaft *A* and may be shifted thereon longitudinally, by means of fork *C*, sliding on the stud fixed in the gear casing. The rear side of the fork has rack teeth cut in its face, engaging a gear *D*, keyed to the vertical shaft *E* so that the rotating of the latter shifts the cone of gears *B*. The shaft to which the variable speed is transmitted is shown at *F*. This has mounted on it a rocker arm *G*, having two pivots *H* and *H'* supporting two intermediate gears *J* and *J'*. The latter is directly geared to pinion shaft *F*, while *J* is connected by compound gearing as shown. In the upper part of rod *E* are cut circular rack teeth, which engage corresponding gear teeth cut in the sector face of rocker arm *G*. Rod *E* may be both raised and lowered, and rotated to the right and left. Raising and lowering it rocks arm *G* and permits either *J* or *J'* to mesh with the corresponding gear on shaft *A*, as may be required. Rotating to the right or left shifts the cone *B* on shaft *A*, to bring either one of the four gears into position to engage either *J* or *J'*.

As may be seen in Fig. 4, a drum is mounted on the lower end of *E*, which is guided and locked in position by a lock bolt and lever shown. Raising or lowering this drum by means of the handle provided, brings *J* or *J'* into mesh with the mating gear *B*. Rotating the drum and shaft *E* brings either

one of the four gears on *A* into position to mesh with *J* or *J'*. By this means eight changes of speed are provided by a very simple mechanism, with no possibility of interferences or false moves. An inspection of Figs. 2 and 3 shows that at this point also the matter of lubrication has been carefully considered.

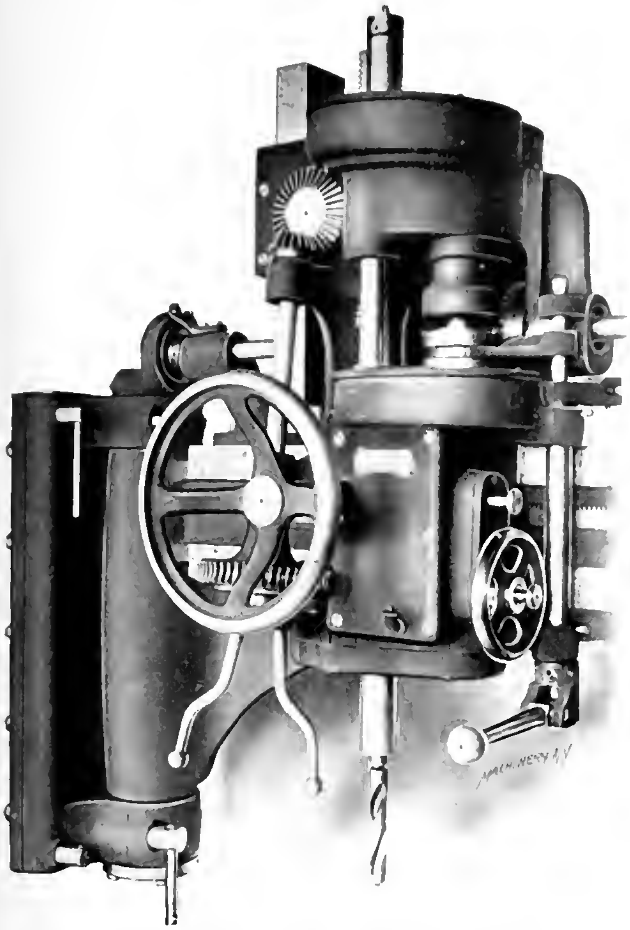


Fig. 5. The Spindle Head, showing Enclosed Construction

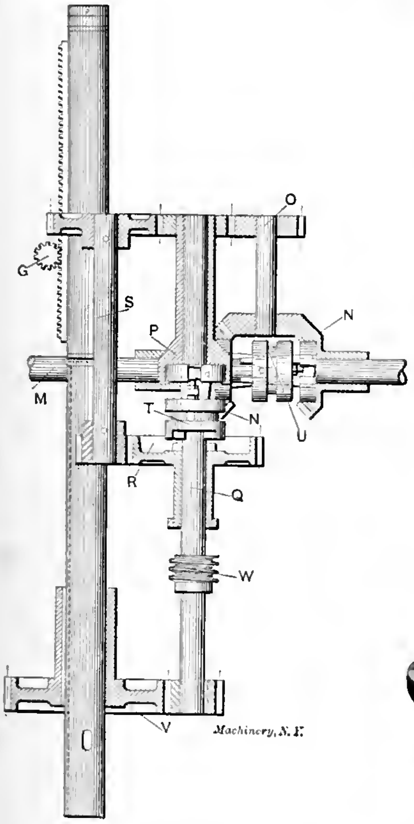


Fig. 7. Diagram of Driving Gearing in Head

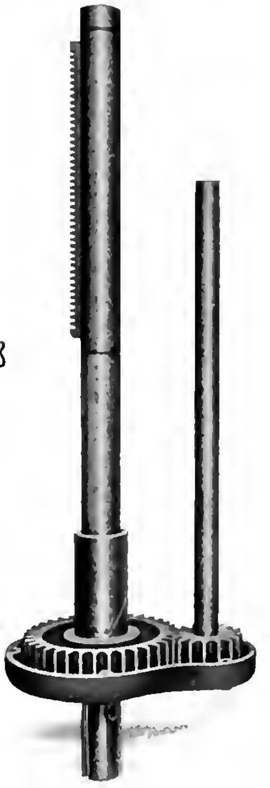


Fig. 8. The Spindle with Large Diameter Driving Gear, close to the Drill

The vertical screw for raising and lowering the arm is driven through the tumbler gearing shown at *K* in Fig. 2. This is operated by a handle attached to the vertical rock shaft *L*, plainly shown in Fig. 4. The arm rests and turns on ball bearings in the slide, giving the operator an easy and quick adjustment.

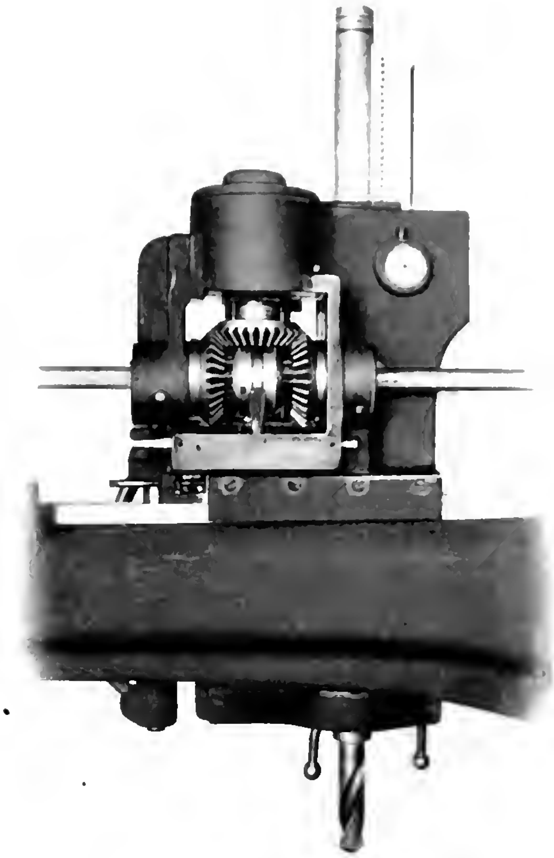


Fig. 6. Rear View of the Head, showing Tapping Reverse for Spindle Drive

The Driving Mechanism in the Head

From the speed box the power is transmitted through two sets of bevel gears to the horizontal shaft on the arm. Figs. 5 and 6 show front and rear views of the head respectively, while Figs. 7 and 10 show the details of the driving mechanism. *M* is the horizontal driving shaft. It has revolving loosely upon it bevel gears *N* and *N*. Either of these may be connected to *M* at will by means of the friction clutch shown in Fig. 9, so that short shaft *O* may be driven either forward or backward. The latter is geared with a loose quill *P* on spindle driving shaft *Q*. A second loose quill gear *R*, also mounted on *Q*, receives the movement from *P* through the back gear shaft *S*. *Q* may be clutched to either *R* or *P*, as may be required, by shifting clutch collar *T*. When this is dropped, *Q* is clutched positively to *R*. When it is raised, it is engaged with *P* by means of the friction clutch shown. This back geared drive, in connection with the speed box, gives sixteen changes of spindle speed, suitable for driving anything from a 3/8-inch drill to a 6-inch pipe tap.

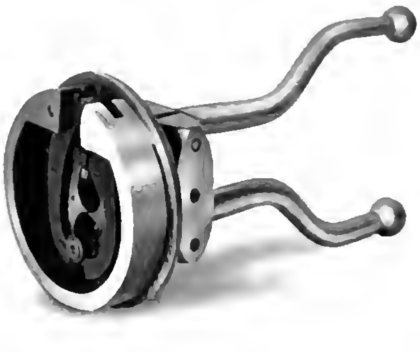


Fig. 9. The Friction Clutch for Connecting the Power Feed

The matter of lubrication of these members, seen most plainly in Fig. 10, should be noted. The driving gears are all enclosed in oil-tight casings, and are provided with reservoirs of oil for both the bearings and the gear teeth.

It should be noted that the same handle is used for the reversing clutch and the back gear clutch. This is shown at

the lower right-hand side of the head in Fig. 5. Raising and lowering this handle operates clutch *T* and controls the back gears. Swinging it to one side or the other operates clutch *U* for reversing the spindle movement. The starting, stopping, back gears and tapping device being thus controlled by one handle, it is possible to throw from one position to the other instantly, without danger of conflict or interferences.

The head is rigidly constructed, with webs of suitable thickness. The stiffness of the spindle drive is enhanced by the position of the driving gear *V* which is splined to the lower end of the spindle where it is driven by a pinion on shaft *Q*. The spindle and the driving gear are shown separately in Fig. 8. The spindle is thus driven in its large diameter and close to the gear, minimizing the torsional deflection, which is localized in a short, stiff length of spindle. In the ordinary construction, the power has to be transmitted through a long, slender spindle, cut down to pass through the feeding quill. It is stated that a torsional rigidity is obtained of from $2\frac{1}{2}$ to 3 times that given by the usual construction. This drive is, we believe, an exclusive feature of the Western machine.

The Feed Gearing

The feed mechanism is shown plainly in Fig. 10. The spiral gear *W* on shaft *Q* (Fig. 7) engages a mating gear *X* in the feed box. The shaft on which *X* is mounted carries also two gears, either of which may be connected with it by sliding the pull pin *Y* in or out, thus giving two rates of speed to the cone of gears *Z*. Gears *Z* in turn mesh with corresponding gears *A*, any one of which may be keyed to shaft *B* by means of the pull pin *C*. Eight feed changes are thus obtained, ranging from 0.008 to 0.060 inch per revolution of the spindle. These gears are enclosed in an oil-tight casing and run in oil.

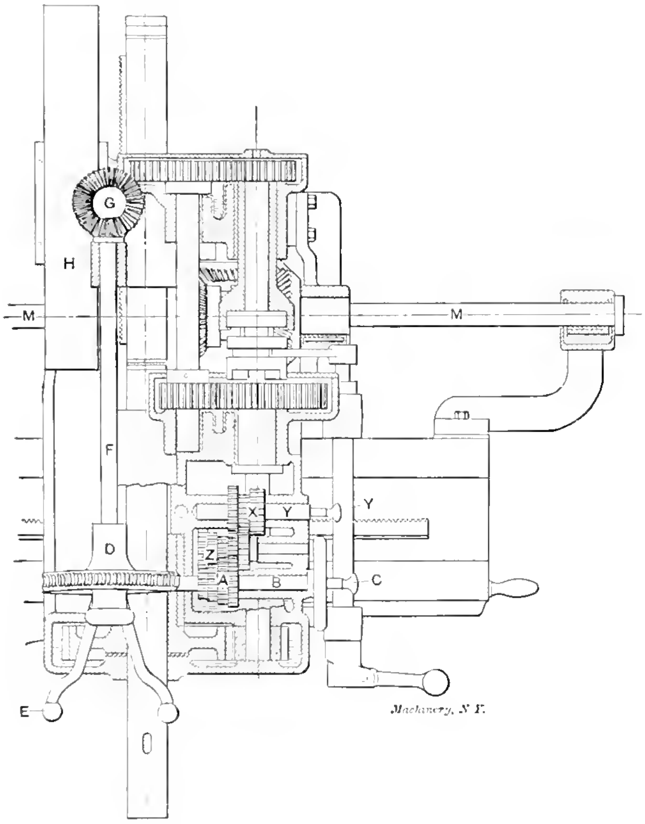


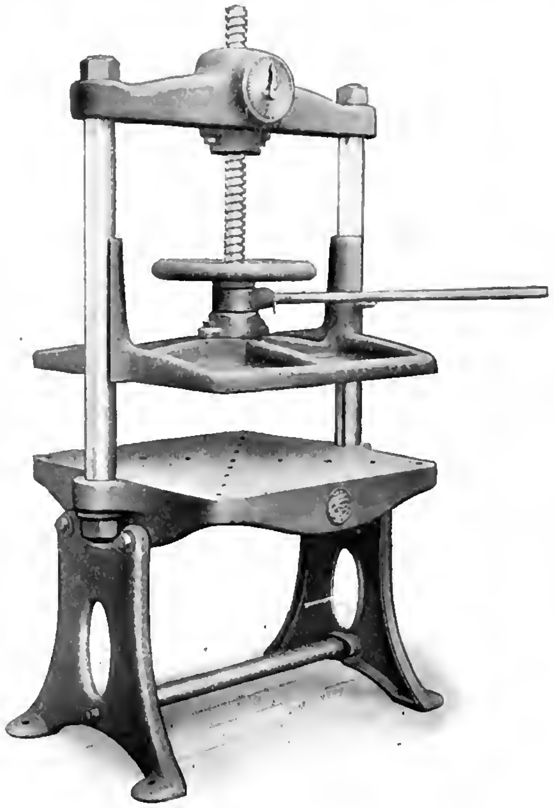
Fig. 10. The Positive Quick Change Feed

A worm on shaft *B* engages worm wheel *D*. This is clutched to the feed shaft by the mechanism shown in Fig. 9, operated by handles *E* (see Fig. 10). These serve to operate the clutch or to feed the spindle rapidly by hand when the clutch is disengaged. By pressing together handles *E*, a toggle joint mechanism expands the friction ring of the clutch, thus giving a powerful grip with easy operation. A suitable wedge is placed between the two fingers to vary the gripping pressure as desired. This clutch is keyed to the vertical feed rod *F*, which transmits the movement through a set of bevel gears to the pinion spindle *G*. This latter meshes on one side with the feed rack on the spindle quill, and on the other with the counter weight *H*.

The Western radial drill is built in four sizes having 3, 4, 5 and 6-foot arms respectively. As may be inferred from the illustrations and description here given, it is a strongly driven machine adapted to heavy work, and especially suitable for pipe tapping. Hill, Clarke & Co., of Boston, Chicago, and branch offices, are the selling agents.

FERRACUTE HAND SCREW PRESS

The tool illustrated herewith is a hand screw-press built by the Ferracute Machine Co., Bridgeton, N. J. It is designed for miscellaneous work of considerable area and height, having a bed 36 inches square and a maximum distance from the bed to the ram of 24 inches. It is designed for pressures of from 0 to 15 tons.



A Hand Press, provided with Dial for Indicating the Pressure Produced

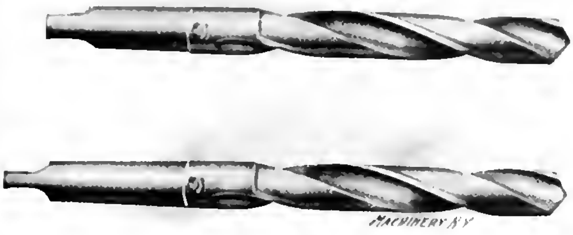
One of the features of novelty is the dial shown in the head of the press. The nut, set in the head, through which the screw runs, bears against a heavy steel spring, and the indicator hand on the dial is driven by a pin connected to this spring, giving the effect of a spring balance, which indicates on the dial the amount of pressure applied at any moment. Another point of interest is the combined handwheel and ratchet. Several tons pressure may be obtained by the hand-wheel alone. By connecting the ratchet lever, which may be done instantaneously, the maximum pressure is easily available. The ratchet is reversible, enabling the operator to start the ram upward with a minimum of effort.

The total height of the press with the screw raised is 98 inches. It occupies a floor space of 47 by 36 inches and weighs 2,300 pounds.

THE "STANTOOL" TAPER FOR DRILL SHANKS AND COLLETS

It seems to be practically agreed to that the old standard Morse taper shank and tang is too weak for the high duty required of it under modern conditions with modern cutting steels. The dimensions of the tang were settled on in days when the chips now taken with the twist drills would have seemed out of the range of the possible. To provide a stronger drive for new twist drills, and for giving added life to old ones from which the tangs have been broken, a number of devices and methods have recently been proposed. In the opinion of the Standard Tool Co., of Cleveland, O., all of these

devices have objectionable features. Some of them are complicated, some of them expensive, and some of them require a special preparation of the drill, which is only possible with the assistance of a skilled mechanic, and machines not found in every shop. This firm has therefore decided to meet the situation in a radical way. They are putting on the market drills having what they call the "Stantool" shank. While preserving the Morse taper, these shanks are shortened, thus permitting the use of a tang of much greater strength.



The New and the Old Standard Taper Shanks for Twist Drills

The upper drill in the engraving has the new shank, while the lower drill has the old standard. The difference in the strength of the tang will be seen at a glance. The dimensions are such that old drills on hand, whether broken or not, can be converted into the new type at very little cost and trouble. The makers furnish a gage which can be placed over the regular taper shank and used for scribing the size and location of the tang of the "Stantool" shank.

DIMENSIONS OF "STANTOOL" SHANKS AND TAPER HOLES

Number of Taper	Diameter, Small End of Shank	Diameter, Large End of Shank	Total Length of Shank	Depth of Hole in Socket	Length of Tongue to End of Socket Hole	Thickness of Tongue	Width of Keyway	End of Socket to Keyway	Length of Keyway	Diameter of Socket	Taper per Foot	Taper per Inch
	A	B	C	D	E	F	G	H	J	K		
1	0.378	0.484	$2\frac{1}{8}$	$1\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	0.263	$1\frac{5}{8}$	$\frac{3}{4}$	$\frac{25}{32}$	0.600	.05000
2	0.587	0.706	$2\frac{3}{8}$	$1\frac{15}{16}$	$\frac{5}{16}$	$\frac{3}{8}$	0.388	$1\frac{3}{4}$	1	$1\frac{1}{16}$	0.602	.05016
3	0.800	0.941	$2\frac{13}{16}$	$2\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	0.520	2	$1\frac{1}{4}$	$1\frac{5}{16}$	0.602	.05016
4	1.050	1.244	$3\frac{3}{4}$	3	$\frac{9}{16}$	$\frac{5}{8}$	0.645	$2\frac{11}{16}$	$1\frac{1}{2}$	$1\frac{11}{16}$	0.623	.05191
5	1.515	1.757	$4\frac{5}{8}$	$3\frac{3}{4}$	$\frac{5}{8}$	1	1.020	$3\frac{1}{4}$	2	$2\frac{7}{16}$	0.630	.05250
6	2.169	2.501	$6\frac{3}{8}$	5	$\frac{3}{4}$	$1\frac{1}{4}$	1.270	$4\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{7}{8}$	0.626	.05216
7	2.815	3.283	9	$7\frac{3}{4}$	1	$1\frac{1}{2}$	1.520	7	3	...	0.625	.05208

The accompanying table gives the exact dimensions for all sizes of the new standard. Special sockets and sleeves are, of course, required, to adapt these tools to drill presses now in use. The makers furnish these sockets and sleeves with an outside taper to fit the spindles, and an inner taper suitable for the new shank. They are also made with the new taper both outside and inside. These latter interchange or nest into each other.

The use of a new standard, made stiff enough to begin with, would seem to be a logical way out of the broken tang difficulty.

JAEGER AUTOMATIC FRICTION CLUTCH

One of the many disadvantages experienced with the ordinary design of automatic pin clutches, such as are extensively used on power presses, is the heavy blow against the clutch pin, a fact which quite often causes injury to some parts of the clutch mechanism, and is accompanied by expensive delays while the broken parts are replaced. In order to overcome the difficulty of breakages, many press builders have designed their clutch parts very heavy, giving the clutch mechanism a clumsy appearance and, sometimes, a slower action.

Another disadvantage of the ordinary pin clutch is the necessity for a special brake for the crank-shaft. If this brake is not provided, the crank-shaft will not stop at its highest point after the fly-wheel has been released. The brake power acts constantly on the shaft, while the press is performing its work, and, therefore, a considerable amount of power is absorbed by the brake when the press is running continuously. Besides, the brake is rather unreliable, and requires frequent adjustment in order to do its work properly. Another disadvantage of many clutches is the loss of time. A number of clutches require that the fly-wheel at times make half a revolution before striking the clutch pin for engaging the crank-shaft.

In order to overcome the disadvantages referred to, Mr. M. Jaeger of 109 North Terrace Ave., Mt. Vernon, N. Y., has undertaken extensive experiments on a new design of automatic friction clutch, the results of these experiments being a device of the type shown in the accompanying illustrations. In Fig. 1 a clutch is shown as applied to power presses of smaller sizes. The main parts of this clutch are the eccentric *B* turned directly on the crank-shaft *A*, an expansion ring *C*, and a wedge *D*. The fly-wheel *E* is provided with a recess bored out in the hub in the side towards the press frame, and the whole clutch mechanism is placed in this recess. The eccentric in the design shown in Fig. 1 is turned directly on the crank-shaft, but it can, of course, be made as a loose ring and attached to the crank-shaft in any suitable manner. The fly-wheel revolves freely on the shaft, the hole in the fly-wheel being preferably lined with a bronze bushing.

The expansion ring *C* is originally turned larger than the recess in the fly-wheel. It is then cut open, pressed together, and then turned to fit the diameter of the recess, so that when laid inside of the recess and permitted to expand, it will closely fit the recess and at the same time press against the walls. Due to this pressure, the expansion ring will follow the fly-wheel when the latter rotates, whenever the stop *F*, acting against the pin *G* and operated by the foot-treadle, is removed; but when the stop *F* is in the position indicated in Fig. 1, the expansion ring *C* is prevented from rotating with the fly-wheel, and contracts so that the friction between the ring and the fly-wheel is reduced to a minimum.

It will be seen in Fig. 1 that the expansion ring has on the inside two projections. The wedge *D* rests against one, and the other has the same radius as the eccentric *B* on the shaft, there being only a very small clearance between the ring and the eccentric when the former is expanded, and no clearance at all when it contracts. A small spring *H* holds the wedge against the inside of the expansion ring.

The operation of the clutch is as follows: The fly-wheel runs continuously, but crank-shaft *A* does not rotate when the clutch is not in operation. When a stroke of the press is required, the operator, by means of a foot-treadle connected with the stop *F* by the link *K*, releases the expansion ring so that it follows the fly-wheel, thereby forcing the

wedge *D* between the inside of the ring and the eccentric, and imparting motion to the crank-shaft *A*. The expansion of the ring is still further increased by the wedging action of *D*, so that practically a positive drive is obtained. When the treadle is released, the stop *F* slides up in the position shown in Fig. 1 and the pin *G* strikes against the stop and prevents the ring from following the fly-wheel any further. The experiments undertaken with the clutch show that the blow against the pin is but slight, as the momentum of the shaft, pitman and other moving parts quickly releases the wedge and permits the ring to contract. The projection at *L* at this time also acts as a brake, stopping the crank-shaft at its highest point. If the foot-treadle is released immediately after being depressed, only one revolution will result.

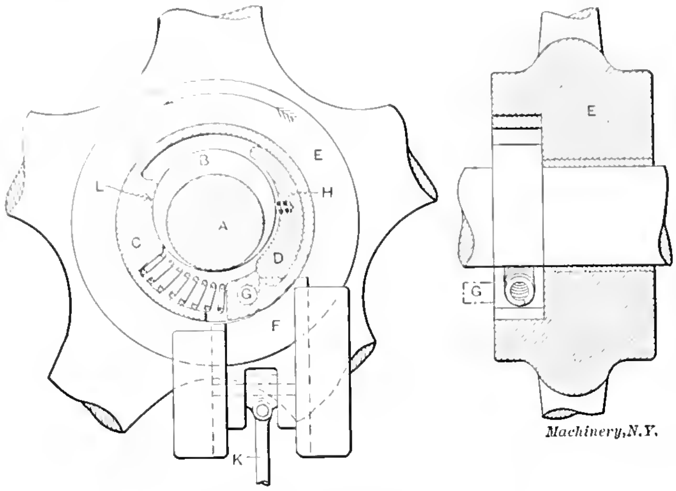


Fig. 1. Jaeger Automatic Clutch applied to a Power Press

The engagement is practically instantaneous as the clearance between the eccentric and the wedge is made as small as possible. An incidental advantage of this clutch is that the fly-wheel can be brought very close to the frame of the machine which, of course, is very important. A great many clutch designs make it necessary to place the fly-wheel a considerable distance from the frame and the bearings, thus producing bending stresses, and requiring larger shaft dimensions. A special brake acting on the crank-shaft is avoided. The design is very simple and reduces the cost of the clutch mechanism to a considerable extent. There is nothing in the design of the clutch that is liable to get out of order or break, and the experiments undertaken show that the efficiency of the design is very satisfactory.

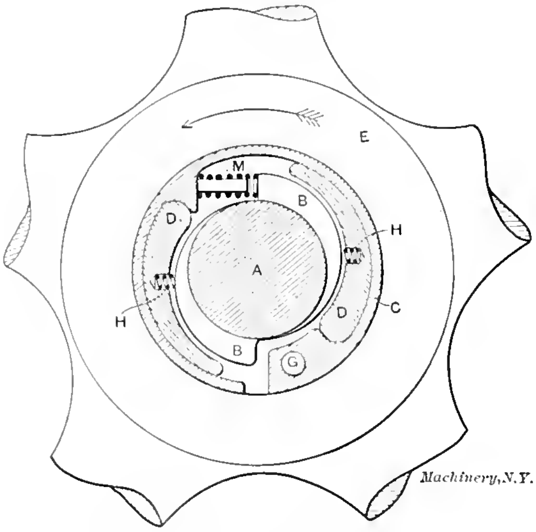


Fig. 2. Variation of Design of Jaeger Automatic Clutch, as used on Heavy Presses

In Fig. 2 is shown a modification of the design intended for heavy presses. Here two wedges are provided instead of one, and the eccentric or cam on the crank-shaft is provided with a double rise. In order to provide for a stop for the crank at the right position a spring *M* is provided, inside of which is placed a small rubber cylinder. This cylinder prevents the spring from bending sideways and at the same time acts as a final stop if the momentum is greater than that which will be taken up by the spring itself. The clutch is not limited to applications to presses only, but can, slightly modified, be used for a great many purposes where quickly releasing clutches are required.

BUFFALO FORGE CO.'S HAND I-BEAM AND CHANNEL PUNCH

While the tool here illustrated is a hand punch, it is designed, as a glance at its proportions will show, for far heavier work than is ordinarily considered feasible for hand operation. It will quickly and easily pierce a ½-inch hole in a ½-inch plate. Its maximum capacity by hand operation is for 1-inch holes in ½-inch plate. This would require a dead weight of about 40 tons on the plunger, considering the shearing strength of the material being punched as being 50,000 pounds to the square inch, which is about that found in the steel ordinarily used in bridges and similar structural work.

In the first place the construction of the frame is notable. It is composed of two sides of armor plate, rigidly bolted and riveted together in a box form of construction. The planed sides of the frame form guiding surfaces on two sides of the plunger, while the main guides are bolted between the sides and have adjustable gibs, which assure the permanent alignment of the punch and die. The die holder is a steel casting of a style designed to adapt it to working on the webs of channels, I beams, etc. It is mounted on the frame, and bolted on an extension machined to fit the frame space.

Hand-operated Punch of Large Capacity with Armor-plate Frame

The great force which this hand operated punch is capable of applying is due, of course, to the construction of the operating mechanism. This consists of a combination lever, ratchet wheel, and crank mechanism, which will be easily understood from a study of the engraving. It gives a leverage of 2,200 to 1 from the end of a 6-foot lever to the shearing edge of the punch; this does not include the power lost in the friction of the working parts, which is small for a machine of this kind. The lever bearing studs are bolted to the frame, making a very rigid support. The socket in which the lever is inserted is provided with three holes for the connecting links to the secondary lever, so that a movement of 1, 2 or 3 ratchet teeth for each stroke is obtainable.

The ratchet wheel is cut from solid steel, and is hardened. It can be turned by a convenient handle to quickly adjust

the punch to the work, and to run it back again as well after the completion of the operation. The plunger crank-shaft, on which the ratchet wheel is pressed, is supported by flanged bearings bolted to the main frame. The throw of the crank-shaft is ¾ inch, and the motion is transmitted to the plunger head by a steel one-piece connecting rod the full width of the frame space, bored from the solid and bronze bushed.

This is believed by its maker, the Buffalo Forge Co., Buffalo, N. Y., to be the only punch press with armor plate frame made in the country. Its portability, in connection with its great capacity, should make it a useful tool in many structural operations. As may be seen, heavy angle plates are riveted to the frame on both sides, making a substantial base plate when it is desired to mount it permanently. Otherwise it is provided with a truck for portable use. It weighs about 1,000 pounds.

ST. LOUIS MACHINE TOOL CO.'S GRINDING MACHINE

The plain grinding machine, or grinding head, is so simple a piece of mechanism that it is no wonder that little thought is ordinarily given to its construction. There is no complicated mechanism, and the parts required are few and simple. Nevertheless, it is possible to put thought into the design of a machine as simple as this, as will be realized from a study of the accompanying illustrations, which show one size of a line recently placed on the market by the St. Louis Machine Tool Co., of St. Louis, Mo.

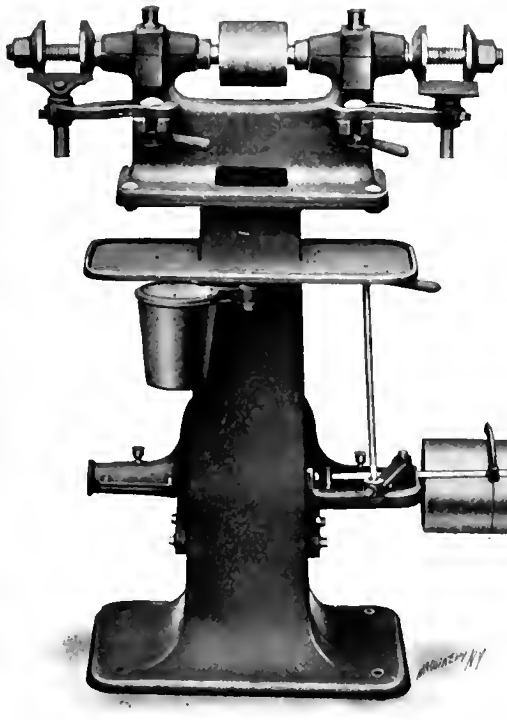


Fig. 1. Front View of the St. Louis Grinder

The points of advantage claimed for this grinder relate both to the workmanship and the design. Considering first the construction of the heads, the arbors are of 50 point carbon steel, with square threads coarser than standard, giving a strong and quick acting screw. The arbors for each size are of larger diameter than usual. The boxes are lined with a high grade of anti-friction metal, and are provided with oil reservoirs and felt oilers with a length four times the diameter of the arbor. The bodies are unusually long, extending out for their full size beneath the bearings, giving the latter a very rigid support. The arms supporting the rests are curved. This permits the use of a shorter fork than when the straight rest arms are used. This is very advantageous when large work is to be ground.

The column is of new design, being large and well proportioned to agree with the service it is called on to perform. The pan is 4 inches below the base of the machine, allowing more room than usual. All of the batter or slant of the column is at the back, thus setting the head as near the front of the base as possible, giving the tool somewhat the appearance of being braced toward the operator.

The column is furnished either with or without a self contained counter-shaft. The machines shown are provided with this counter-shaft, which is the most interesting feature of the whole machine. The lower half of the boxes (see Fig. 3) are cast integrally with arms extending backwards the full depth of the column, being pivoted at the rear end. Each arm is also clamped to the column at the side by a screw passing through an elongated slot. The top halves of the boxes are cast in one piece and connected by a strong yoke which passes over the driving pulley. This yoke is provided with a lug passing beneath a corresponding projecting lug on the column, into which an adjusting screw is tapped. The driving belt passes over the large pulley at the base of the counter-shaft up back of the machine, over the spindle pulley and down through a hole, into the middle of the column to the pulley again. The tension of this belt tends to draw the driving pulley and its shaft upwards, bringing the yoke against the adjusting screw. By screwing down on this, the counter-shaft is swung downward upon its supporting arms and the belt tightened. The screws passing through the slots in the arms provide means for holding the adjustment once it is obtained. This tightens the driving belt and the belt from the main line-shaft at the same time. The belt shifter is conveniently located, as shown, it being unnecessary to reach overhead for it as usual.

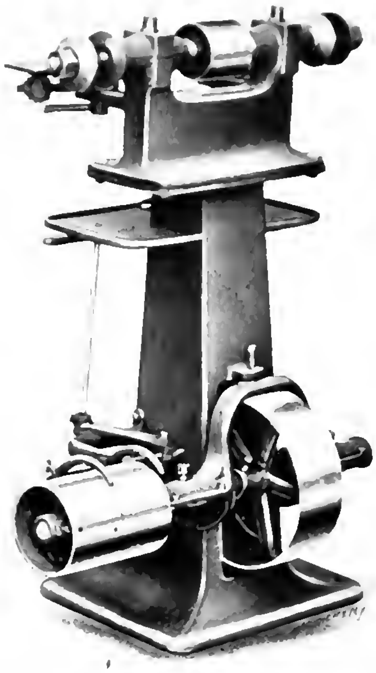


Fig. 2. Side View of the Grinder, showing Counter-shaft

This arrangement gives several advantages over the separate counter-shaft from the ceiling. One of the most obvious is the avoiding of the necessity for mounting the counter-shaft on the ceiling. Another is the advantage of bringing the driving belt down in an out-of-the-way position, which is often a great convenience in handling large work. The most important advantage, however, is the smooth running of the wheels which is the result of the direction of the belt pull, this being such as to draw the spindle down against the frame of the machine, instead of up against the caps.

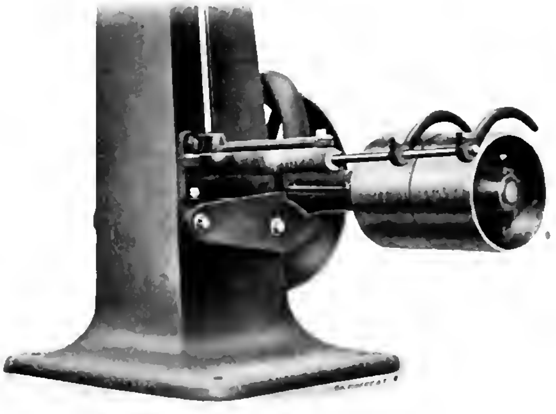


Fig 3. Detail View of Belt Tightener and Shifter

A short belt on a machine of this kind without a belt tightening device is impracticable. The only objection to the use of short belts is the matter of keeping them tight. In long belts the elasticity serves to allow considerable stretch without affecting the belt pull seriously. In short belts,

however, it is necessary to take up the stretch as fast as it occurs by some simpler means than by cutting and resplicing the belt. The use of the adjustable swinging supports for the counter-shaft does away with the great difficulty hitherto met with in furnishing a satisfactory self-contained counter-shaft.

These machines are made in five sizes, for work from the smallest to the heaviest which the workman is ordinarily called on to perform on a grinding wheel stand of this type.

TWENTY-FOUR-INCH FAY AUTOMATIC LATHE

The Fay Machine Tool Co. of Philadelphia, Pa., makes an automatic lathe especially adapted to the performance of turning operations on castings in large quantities. To the 14- and 18-inch swing sizes previously built, the makers have recently added the machine with a 24-inch swing shown herewith.

Without going minutely into the mechanism, the machine may be described as follows: The work spindle is driven by Hindley worm gearing from the high speed shaft extending across the top of the head-stock. This shaft is belted at the rear side to the counter-shaft, and at the front side to the feed-driving pulley at the left-hand end of the bed. This latter is geared to a longitudinal shaft carrying a series of cams controlling the cutting tools. By means of a clutch mechanism operated by adjustable dogs, the cam shaft may be given a slow feeding movement, or a rapid idle movement, over any desired portion of its periphery.

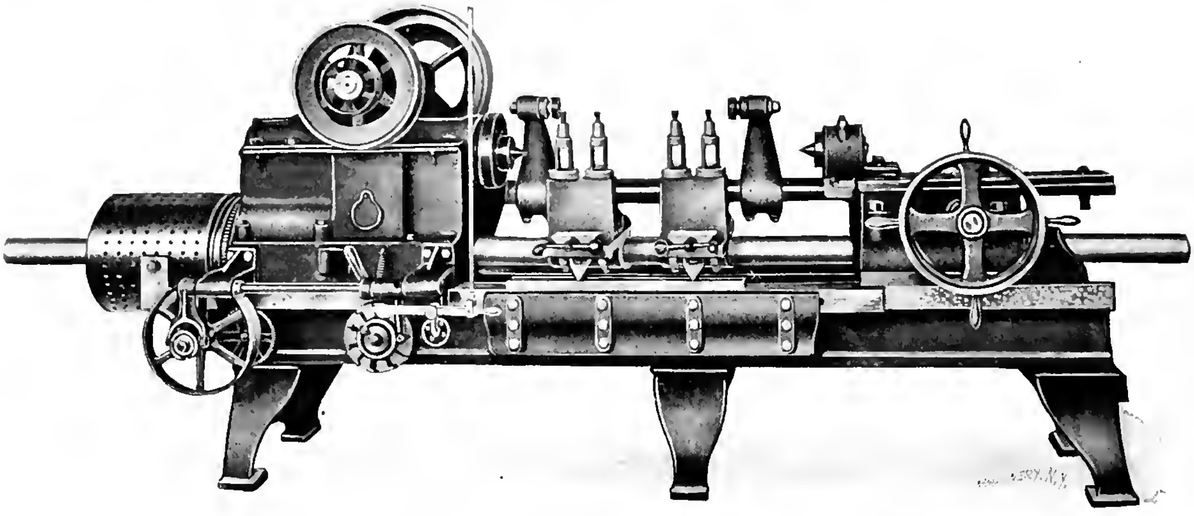


Fig. 1. An Automatic Lathe for Turning Pulleys, Gear Blanks, etc., on Centers

Two heavy bars extend the length of the machine, and on these the various carriages and tool holders are mounted. Each of these bars is controlled by the cam shaft, both as to longitudinal movement and the rocking movement about their axes. The rocking movement for the main bar at the front is controlled by a templet on the slide at the front of the bed, on which the outer ends of the carriages rest. This templet may be given any desired shape, which will be copied by the tool as the bar is fed longitudinally. On the other hand, if desired, the bar may be held against longitudinal movement while the slide carrying the templet is fed to the right or left, by means of its connection with a cam roll operated by the drum cam shown at the left of the machine. Cams of any required shape may be bolted on this drum to operate the former slide or the tool bar at the rear. The latter is rocked by a cam beneath the head-stock, while the main tool bar is operated by an internal cam surface within the cam drum.

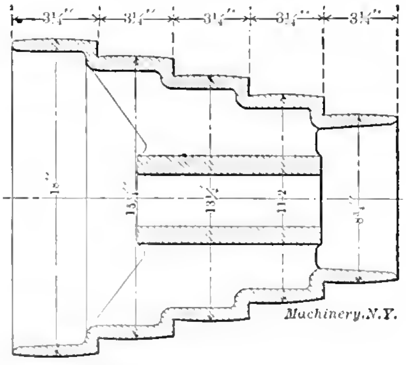


Fig 2. A Cone Pulley, which was roughed out and finish-turned Complete in Forty-two Minutes

The large machine here shown swings twenty-four inches over the ways, eighteen inches over the carriage and will take thirty-six inches between centers. The automatic feed of the main bar and its carriages is fourteen inches. The provision for turning between centers is unique in automatic machines, and permits the production of a quality of work comparable with that produced on the engine lathe. One operator can attend several machines, or can run one of these in combination with work on a regular lathe.

The 5-step cone pulley shown in Fig. 2 was turned in two operations, roughing and finishing in forty-two minutes. This included turning and crowning the five steps, and facing both ends of the pulley. The crowning was done by suitable templets acting on the carriages attached to the main bar, as described. Facing down the ends was effected by tool holders on the rear bar.

IMPROVED MURCHEY AUTOMATIC OPENING DIE HEAD

The machine shown in Fig. 1 is a double-head pipe and nipple threading machine, made by the Murchey Machine & Tool Co., 4th and Porter Sts., Detroit, Mich. This machine follows the general lines of the older design built by the makers, with the exception of the die heads, which are of radically new and improved construction. The mechanism of this new die head will be understood from a study of the line engravings, Figs. 2 and 3. Its purpose is to furnish a die head of rigid construction, wide range of adjustment, and strong, simple construction, and one that will operate readily and automatically and will preserve its accuracy through a long period of use. As may be seen, the head is composed of comparatively few members, and there are also few wearing parts and no light and delicate pieces in the mechanism.

The body *A*, which is of strong close-grained cast iron, is pressed on and keyed to the spindle *B* of the machine. In the face of the body are milled four large T-slots, carrying the steel die blocks *C*. These, in turn, are drilled and slotted to receive the dies *D* and the bearing pins *E*. These bearing pins are closely fitted in the holes in *C*, into which the slots for the die blocks are cut, so that there is a solid backing for the latter against the thrust of the cut.

On the hub of the body *A* slides a collar *F*. This is provided with lugs which are milled, drilled and reamed to form pivots for the die levers *G*. These latter are restrained from outward movement by a tapered bearing on the inner rim of the adjusting shell *H*. This adjusting shell is threaded to the collar at the rear end as shown, and is fitted at the front end to an internal flange on the rear face of the body *A*. When it is screwed in or out, the bearing of its taper surface on the four die levers *G* adjusts them inward simultaneously, or allows them to move out simultaneously as the case may be. These die levers bear at their front end on a seat cut to receive them on bearing pins *E*. When the sliding collar is moved to the right from the position shown in Fig. 2, the

ends of the die levers slip off of the seats on the bearing pins to a lower position, when the spring *J* forces the pins *E*, die blocks *C* and dies *D* outward, thus opening the dies and releasing the work. When the adjusting shell is moved to the left, levers *G* ride up on the cam surface onto the upper bearing on pins *E*, closing the dies. The turning of the adjusting shell *H* evidently affords means for setting the dies accurately to any desired diameter within the range of the adjustment.

The sliding collar *F* is moved to the left to close the dies by hand through a lever connection with the handles shown between the two work-slides in Fig. 1. The die is opened automatically when the desired length of thread has been cut. This is done through the reaming mechanism shown in Fig. 3. It will first be necessary to describe the operation of this mechanism in reaming a pipe. The reamer holder *K* is of malleable iron with a squared socket for receiving the squared pipe reamer shanks. The reamer is held in place by a single set-screw. The holder is supported on rods *M*, which pass through holes in the body *A*. It is free to move outward, but its backward movement is resisted by plunger *N* and spring *O*. The latter may be compressed to give more or less tension by means of threaded adjustment collar *P* (seen also on the spindle between the head-stock bearings in Fig. 1) which bears against collar *Q* and plunger *R*, furnishing the rear abutment for the spring. After the work has passed far enough into the dies to secure a good hold on the thread, the continued feeding forward of the pipe brings it in contact with the reamer *L*, pressing it back against plunger *N* and spring *O*, thus giving sufficient pressure for taking the chip. Owing to the construction the extra tension which may be applied by adjusting collar *P* affects the thread only when the work is well through the dies, where a heavy chip will not cause a thin thread.

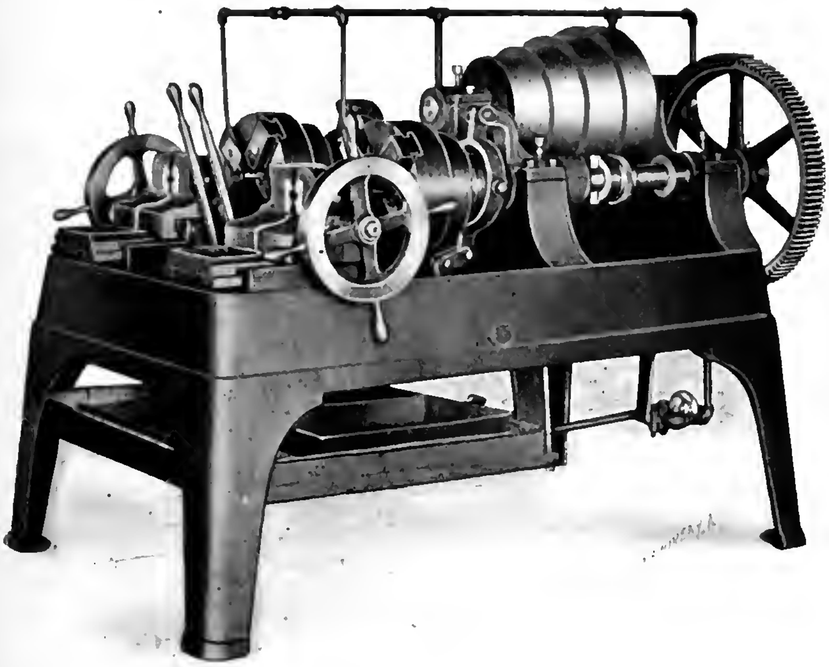


Fig. 1. Murchey No. 2 Pipe and Nipple Threading Machine equipped with Improved Opening Die Heads

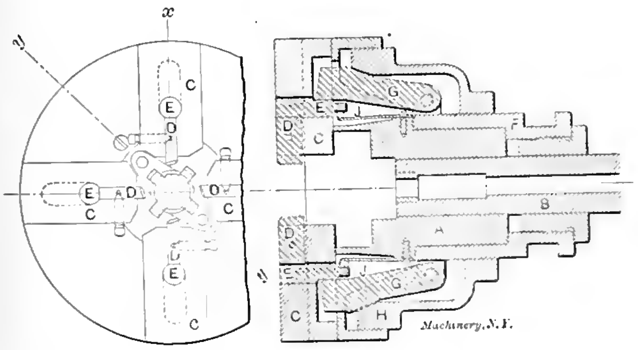


Fig. 2. Face View of Die Head and Section on Line x—x, through Die Blocks, with Reamer Removed

The automatic opening of the dies is effected by the longitudinal movement of reamer holder *K*, caused by the pressure of the work on the reamer. This forces back *K* and rods *M* against sleeve *S*, which is threaded into sliding collar *F*. As *F* is thus forced backward, levers *G* are withdrawn from their seats on bearing pins *E*, allowing the dies to open. By screwing sleeve *S* in or out, the length of the thread on the work can be shortened or increased. Spring *O* being set up tight enough so that the reamer faces the end of the pipe, it will be seen that the stop movement is governed by the end of the pipe itself, so that the threads come to a uniform length. Shoulders are provided on reamer rods *M*, which strike against the shoulder on the sliding collar *F*, in case *S* is adjusted out too far. When the die head is open, the reamer holder with the rods may be drawn out, allowing long or "running threads" to be cut.

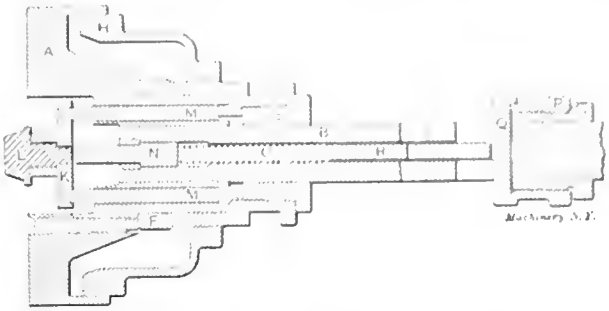


Fig. 3. Section on Line y—y of Fig 2, showing Reaming Mechanism

The adjustments for this die holder are few, simple and quickly made. They are the adjustment of shell *H* for the size of the thread, of sleeve *S* for the length of the thread, and of sleeve *P* for the depth of internal reaming. The large amount of adjustment of sleeve *H* makes it easily possible to re-hob dies in this head. The workmanship is of a high grade, the tool being made with jigs and fixtures throughout on the interchangeable plan. The die blocks are of case-hardened machine steel, the bearing pins *E* are of tempered steel, and the bearing levers *G* are of tool steel. Attention has been given to the quality of the steel material in the dies, which is the best obtainable.

The double nipple and pipe turning machine shown in Fig. 1, equipped with the die heads just described, has a capacity for work from ½ inch up to 2 inches inclusive.

WALTHAM MULTIPLE SPINDLE DRILLING MACHINE

The accompanying half-tone shows an addition to the line of precision machine tools built by the Waltham Machine Works, Waltham, Mass., which we have illustrated from time to time. This particular tool is a multiple spindle drilling machine, built on the lines of the larger tools used for drilling holes in cylinder flanges, machine frames, etc. The idea here, however, is reduced to the smallest scale on which we have ever seen it used.

The frame of the machine is in two parts; one is a base, carrying the work table, and the other is a stand mounted on the base, carrying the driving mechanism for the spindles. The drive shafts are evenly spaced about a central gear, which is connected with the double driving pulley shown at the top. These gears are enclosed and accurately cut, so that a very high drilling speed is obtained with practically no noise. The lower, or drill spindles are held in interchangeable cast iron blocks, accurately bored to the desired location of the holes. As these blocks can be reversed, it will be seen that the holes may be drilled from either side of the work; or, in the case of clock plates, the upper and lower members may each be drilled from the inner face. By using short drills, holes may be accurately located without the use of a jig, and the ma-

chine can be used for reaming and countersinking holes already drilled or punched. Provision is made for using a jig, however, if desired.

An important feature in the construction of this machine is the extremely close spacing with which the holes may be drilled. This may be less than 0.200 inch center distance. This is accomplished by the use of special ball and pin joints. The joints and all the spindles are of hardened steel, the latter having bronze bearings which can be easily replaced when worn. The connections between the driving and the drill spindles are two or three times as long as is usual in machines of this type, thus making the angle very slight, and materially reducing the wear on the joints.

A Multiple Spindle Drilling Machine, built on a Minute Scale

The table carrying the work is operated either by a hand wheel, or a lever connected to a rack and pinion. An adjustable stop is provided to regulate the depth of drilling. There is also a screw adjustment for setting the vertical position of each spindle separately.

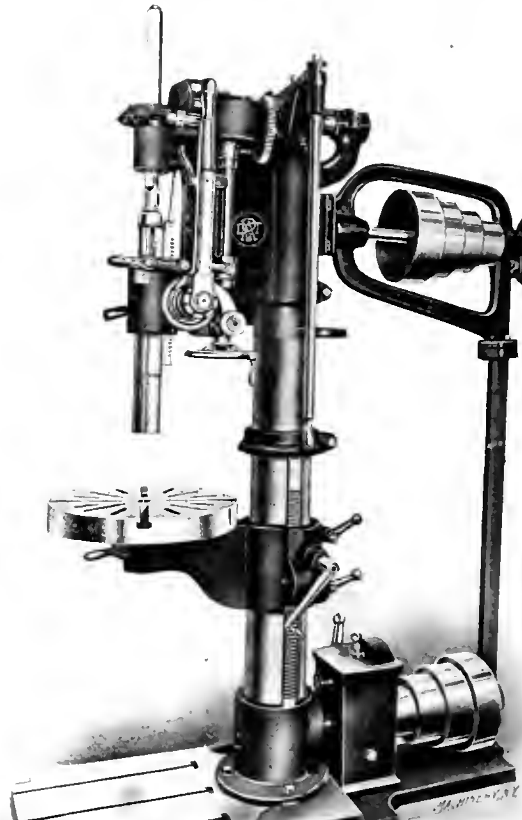
This machine is made in two sizes. The larger, which is particularly intended for clock and similar work, weighs 240 pounds, and is made with any number of spindles up to 14. It will drill to any position inside of a 6-inch circle. The smaller, or watch size, weighs 50 pounds, and can be built with any number of spindles up to 8. It will drill anywhere inside of a 3½-inch circle.

ROBERTSON DRILL & TOOL CO.'S 21-INCH DRILLING AND TAPPING MACHINE

The accompanying illustration shows a 21-inch drilling and tapping machine made by the Robertson Drill & Tool Co., Dept. 5, Buffalo, N. Y. This resembles somewhat in its general lines the 21-inch upright drill illustrated among the new tools in the May issue of MACHINERY. The driving mechanism, however, is entirely different, and the machine is provided, in addition, with a self-contained tapping attachment.

Contrary to the usual construction, the driving cone on the countershaft is placed at the top of the machine, with the driven cone at the base. Four-step cones of large diameter for a 2¾-inch belt are used. The back-gearing is enclosed in the casing shown on the lower cone shaft. The back-gearing may be thrown in and out while the machine is in motion. From this point the power is led to the top of the machine again by miter gearing and a vertical shaft passing through the center of the column. At the upper end it is connected through reversing miter gears with the usual horizontal driving shaft. The long lever which hangs from the top of the column controls the clutch playing between these miter gears, and thus serves to reverse the motion of the spindle, or stop it, as may be required. The clutch provided on the driving pulley of the countershaft is not used in the operation of the machine, being employed only when the workman starts his job or finishes it.

The feed is geared and has 24 changes. It may be operated by a wheel or lever, as well as by power. An automatic stop is provided. The spindle is 1¾ inch in diameter, and is driven by its squared shank, which fits a corresponding hole in the driving gear, as explained for the machine described in the May issue. The gears are all cut from solid metal. All the bevel and miter gears have planed and generated teeth.



Robertson Drill Press with Self-contained Tapping Mechanism

The racks are of steel cut from the solid. All clamps and adjustments are furnished with permanently attached handles.

The height of the machine over all is 77 inches. It occupies a floor space of 18½ by 58 inches. The table is 18 inches in diameter and the machine drills to the center of a 21¾-inch circle. The net weight is 1,450 pounds.

RECENT ADDITIONS TO THE BROWN & SHARPE LINE OF MACHINISTS' TOOLS

The ten accompanying illustrations show the latest additions to the line of machinists' tools made by the Brown & Sharpe Mfg. Co., Providence, R. I. While some of the additions relate principally to improvements in design of older tools, others are radically new in principle. All of them are of interest.

Universal Surface Gage with Fine Adjustment

This firm has been making a universal surface gage for some time. The principal feature of its construction is the fact that the spindle can be swiveled about a horizontal axis

and is so mounted on the base that it can project down past it in a slot provided for the purpose, if desired. The base is provided with a V-groove for use on cylindrical surfaces. For small work the spindle can be removed, and the scriber inserted in a hole provided for it in the clamp.

The new gage preserves all these features, and gives the added advantage of a fine adjustment by means of a knurled screw at the top of the spindle clamp. Turning this brings the spindle and the scriber accurately to the height desired. It has a distinct advantage over other devices intended for the same work, in that the movement is always vertical, no matter what the position of the spindle or scriber. Two gage pins at the rear of the base can be pushed down so as to line the tool up against the edge of a plate, or the side of a T-slot. The scriber may also be used below the base as a depth gage. This tool is made with 9-, 12-, and 18-inch spindles, and with light or heavy base.

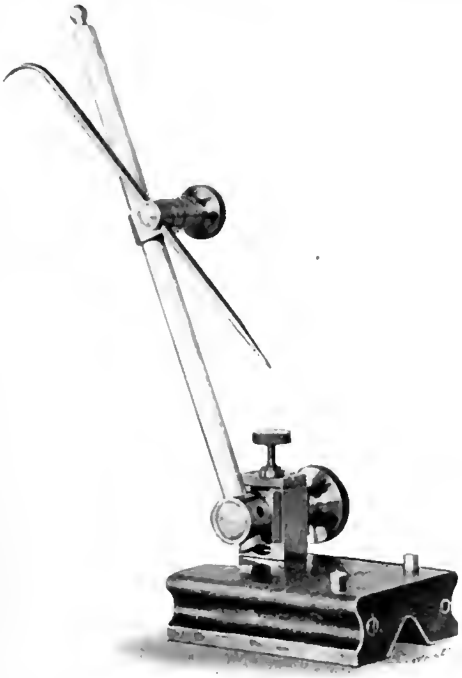


Fig. 1. Surface Gage with Micrometer Adjustment

Standard Caliper Gages

The Brown & Sharpe standard caliper gages have been furnished for many years with internal and external surfaces on the same piece, for all sizes up to 3 inches; larger than that the gages have been made separately for external or internal measurements. To meet the demand for tools for use where measurements of one kind only, either internal or external, are to be taken, separate gages with handles are now furnished for all measurements between ¼ and 3 inches. Furnishing them separately instead of in one piece has a distinct advantage whether both are to be used or not, as it enables one to be employed as a standard gage for testing the other.

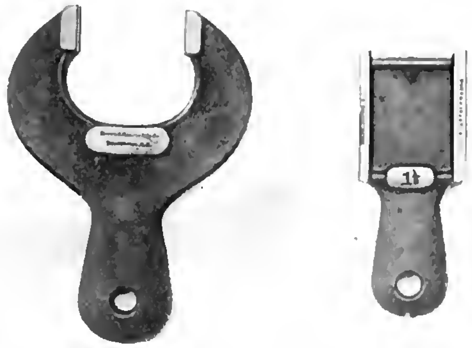


Fig. 2. Standard External and Internal Caliper Gages

A Large Automatic Center Punch

The well-known automatic center punch made by this firm is now furnished for heavy work in a size 11¾ inches long and 1⅜ inch in diameter. This heavy tool has found considerable use in many ways not thought of at the time of the introduction of the smaller size a few years ago. It is employed, for instance, in rolling mills for testing the hardness of metal. The hardness is judged by the size of the impression made, in something in the same way as in the Brinell test. It may be used, as well, for testing the depth of case-hardening, or for laying out heavy work for drilling.

Among the miscellaneous uses which have been found for the automatic center punch may be mentioned its employment by amateurs in making art objects of hammered copper or brass. For this work it has been found much easier to use than the usual punch and hammer, requiring considerably less exertion. It has been recently employed also in the makers' automatic screw machine, where it was desired to punch a square center in the end of a piece of work held in the chuck. It was not found feasible to bring the turret up forcibly enough to make the desired impression. To overcome the difficulty, the striking mechanism of one of these hammers was employed in the turret tool. The latter was brought up with the punch bearing on the work, thus compressing the striking spring of the tool. The spring plunger, being released by this movement, was forced against the head of punch, making the desired impression the same as in the hand-operated tool. The spindle of the screw machine was stopped and held fast for this work.

Tubular Inside Micrometer Gages

These gages are a new design, intended for use in manufacturing operations for measuring inside diameters from 8 to 40 inches. A particular advantage in their construction is the fact that they are of tubing, making them very light and convenient to handle, especially in the longer size. They are used in taking inside measurements as in measuring rings and cylinders and in setting calipers, comparing gages, and in doing other work of a similar nature.

Fig. 3. An Automatic Center Punch of Unusual Size

Fig. 4. Tubular Inside Micrometer Gage

The gage consists of a tube or body, provided with a 1-inch micrometer head at one end, and a fixed measuring point at the other. The measuring points are hardened and ground spherically, thus adapting the gage for measuring parallel or curved surfaces. Provision is made for adjustment to compensate for wear, and a clamp screw is provided for preserving the setting after it has been obtained. A fiber handle prevents the hand from coming into direct contact with the tool, and thus varying its temperature.

Each gage has a movement of 1 inch, and the entire line embraces 32 different sizes, covering the range from 8 to 40 inches.

Universal Indicator

Fig. 5 shows an indicator of new design, of which the distinguishing feature is the fact that it reads movements in any direction—up, down, sidewise or inward. The point which bears against the work is of steel, hardened and ground spherically, thus allowing pressure to be brought upon it from any direction. A scale on the top of the case registers the movement by means of a pointer. This scale is graduated to thousandths of an inch and reads to 0.007 inch either side

of zero. The shank is of hardened steel, and is designed to be held in the tool-post of a lathe. By means of a swivel joint at the end of the shank, the head may be adjusted either above or below the center within a range of 30 degrees on either side.

This tool will be found useful in setting centrally a point or hole in a piece of work to be operated on in a face-plate or chuck. It may be used, also, for testing lathe centers, shafting and other work held between centers, inside and outside diameters of pulleys, cylinders and similar work; and may be employed in testing finished machinery.

Heavy Micrometer Calipers

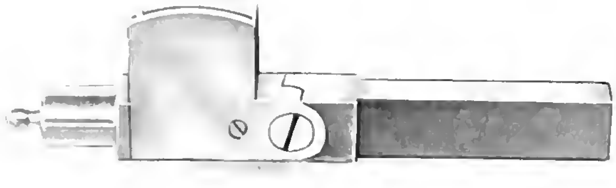


Fig. 5. An Indicator which reads in All Directions

It has always been considered that the careful handling of fine measuring tools is one of the distinguishing marks of a good workman; so the apprentice is always warned not to use a vernier caliper for a monkey-wrench, or a micrometer for a C-clamp. It is not considered good practice, as well, to use the micrometer as a snap gage with the spindle clamped fast. Whatever the case may be for the vernier caliper, the makers of the micrometer shown in Fig. 6 have concluded that there is a legitimate demand for an instrument which can be handled more freely and carelessly than the standard design of micrometer caliper. In consequence, these tools have been made with all parts of much greater weight, stiffness and bearing surface than have been hitherto employed.

Fig. 6. New Design of Heavy Micrometer Caliper

The frame is of heavy I section, of a design which gives exceptional strength and rigidity. The spindle and screw are of larger diameter than usual, giving great stiffness and long life under adverse conditions, owing to the larger bearing surface for the threads. The screw is encased and protected from grit and from injury. Provision is made for adjustment to compensate for wear. The thimble is of unusually large diameter, so that the thousandths graduations are more distinct and easily read.

The clamp ring shown in the engraving securely locks the spindle in any desired position, and it is intended that the tool should be used freely when thus set. This makes it adaptable for use in the grinding room, where there is necessity for taking frequent measurements under these conditions. The construction of the tool is also such as to make it durable under the unfavorable conditions of water, grit, etc., found in this work. Each caliper is provided with a specially designed ratchet stop. It is made in three sizes to measure up to 1 inch, from 1 to 2 inches, and from 2 to 3 inches, respectively.

Hardened Squares with Beveled Edges

In Fig. 7 is shown a hardened steel square with both edges of the blade beveled. This gives practically a line contact with the work under observation, making possible the detection of slight errors, and fitting the tool for use in the tool-room and on all classes of work where the requirements are most exacting.

Besides the provision of the beveled edges, these squares are made with all the care taken with the makers' well-known cast steel try-squares. Every precaution is taken to insure accuracy, the blades being at right angles to the beam. A recess in the beam at the base of the inner edge of the blade is an improvement in the construction which will be appreciated. This is a very desirable feature, as it enables the user to easily remove dust and dirt from the corner of the square and thus obtain accurate results on work having sharp corners. This tool is made in four sizes, of which the smallest has a blade 1½ inch long and a beam 1 9/16 inch long, while the largest has a 6-inch blade and a 4⅜-inch beam.

Fig. 7. Hardened Square with Beveled Edges

Height Gage Attachment for Inside Micrometer

The device shown in Fig. 8 is an attachment which may be used to convert the inside micrometer gage into a convenient height gage. The measuring rod is inserted upwards through the base and clamped securely by turning the knurled nut shown in the engraving. The micrometer is then adjusted and clamped to the upper end of the rod. When thus set, it will be found useful in obtaining the heights of projections on plane surfaces, the location of bushings in jigs, and other measurements on work of a similar character. Its range of measurement is from 2 to 9½ inches or 50 mm. to 230 mm. The V-groove in the base adapts the gage for use on cylindrical work.

Fig. 8. Height Gage Attachment for Inside Micrometer

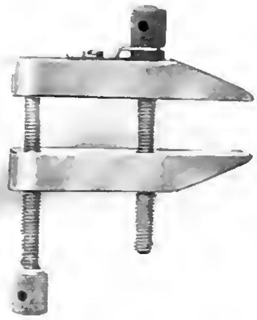


Fig. 9. An Improved Toolmakers' Clamp

Improved Tool-makers' Clamps

The little clamp shown in Fig. 9 is of conventional design, with the exception of one improvement which greatly increases the handiness of the tool. This improvement is the provision of a spring or clip, entering a groove in the head of the inner adjusting screw. Its purpose is to prevent the sliding jaw from dropping when inserting or removing work. It will be found very convenient where a large quantity of pieces of the same size are to be clamped for drilling, as it holds the jaws at the required distance for removing or

inserting each piece, it being necessary to manipulate only the outer screw. These clamps are of steel, case-hardened. They are proportioned throughout to furnish great strength in a light and compact form. The jaws are rounded at the ends to allow clamping under a shoulder or into a recess. The screws are of as fine pitch as is consistent with strength, thus giving great clamping power. The engraving shows the smallest of the line, which ranges from a tool with a maximum opening of the jaws of from $\frac{3}{4}$ inch up to $2\frac{1}{2}$ inches.

Two New Rules

The upper rule shown in Fig. 10 is graduated on one side to 64ths. As may be seen, the reading of these graduations has been greatly simplified by numbering every eighth line, thus: 8, 16, 24, 32, etc. This makes the rule much more convenient and reduces the risk of error from a faulty reading.

Fig. 10. Two New Rules

The lower rule in Fig. 10 is provided with beveled edges similar to those furnished on the ordinary draftsman's instrument. This is intended, however, not only for draftsmen but for tool-makers as well. It will be found useful in laying out fine work, where close measurements are required. Beveling the edges brings the graduations closer to the work, insuring accurate measurements. This style of rule is beveled and graduated on both edges of one side only.

Both of these rules are furnished in a variety of lengths from 1 up to 24 inches.

THE "CISCO" HAND-POWER CRANE

The Cincinnati Iron & Steel Co., Cincinnati, O., is building the remarkably simple and rigid hand-power crane shown herewith. It is intended for general use in machine shops and industrial works of all kinds. It is very easy of action, and the workman requires but one hand in operating it.

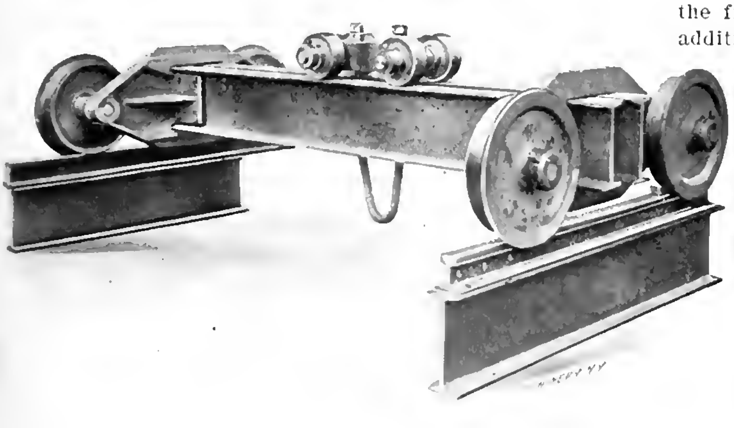


Fig. 1. The "Cisco" Hand-operated Crane

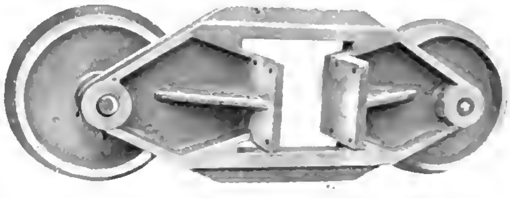


Fig. 2. Detail View of the Truck, showing the Simplicity of the Design

Fig. 1 shows the crane ready for use. The structure is composed of the two end trucks (see also Fig. 2), the cross beams and the trolley. The end trucks are solid castings, with pivots for the wheels, which are mounted in roller bearings. The cross beams overhang on both sides, so that in the case of an overload beyond the capacity of the crane, causing any part of the trucks to break, these beams would drop down onto the crane runway, preventing serious accident. Provision, not visible in the illustrations, is made for keeping the trolley from diverging from the straight line of travel. On the hanging loop of the trolley are placed wheels revolving in a horizontal plane, and supported by collars and set-screws. These bear against the inner faces of the webs of the I beams on each side, thus furnishing a rolling guide.

It will be seen that this crane is so arranged that the purchaser can furnish the I beams himself, if desired, only the end trucks and trolley being shipped from the factory.

TUCKER POSITIVE LOCK COMPRESSION GREASE CUP

The engraving shows a grease cup recently designed by W. M. & C. F. Tucker, of Hartford, Conn. It is of the compression type. The new feature in its design relates to the positive lock against turning under vibration, which makes it particularly adapted to automobiles and other classes of machines that are subject to severe and continued jarring.

The cup itself is not higher above the base than the ordinary grease cup. The locking mechanism is placed on top of the cap in a handy position to operate. To unlock, the small cap is pressed down and turned to the right, when the cap may be screwed down as desired. If left unlocked, it will lock itself after the first quarter turn from vibration or other cause. To remove the cup for refilling, turn the small cap toward the left until it stops, reversing the movement for assembling again. The locking mechanism is covered, so that it is thoroughly protected from dirt and grit of any kind.

A Grease Cup which automatically locks Itself against Vibration

STOEVER 1909 MODEL PIPE MACHINE

The accompanying engravings show the most recent design of the pipe threading and cutting off machine made by the Stoever Foundry & Mfg. Co., Myerstown, Pa. The particular machine here illustrated has a capacity for threading and cutting off pipe from $2\frac{1}{2}$ to 8 inches in diameter, inclusive. The improvements relate to provisions for giving a higher output and making the machine more convenient in operation as well. The style shown is belt driven, though it can be readily changed to use a constant speed motor, as may be seen.

The massive construction of the bed and head-stock has been retained. The spindle, as in the previous models, is provided with heavy three-jawed independent chucks at both the front and back ends, the rear chuck being furnished, in addition, with special grips for use on flanged work. These chucks are made in one piece, with the slots for the slides milled out of the solid. The internal gear drive of the front chuck has also been retained, with few changes in the design.

As may be seen in Fig. 1, all the speed changes of this machine are obtained from quick change gearing. The gear box is oil-tight, giving thorough lubrication to the gears, which are all cut from the solid. A single driving pulley is used. The five changes obtained in the gear box are doubled by the back gearing handle shown at the right of the box, giving ten separate speeds suitable for cutting either iron

or steel piping throughout the whole range of sizes for which the machine is listed. The bore of the spindle is sufficiently large to take extra heavy 8-inch fittings, which is its maximum capacity.

Fig. 2 shows a front view of the slide, with the new design of opening die head in place. This head slides on ways on the front of the stand, thus accommodating itself to eccentricity in the pipe and relieving the machine of the strain produced under these conditions on a rigid head. This naturally results also in far better threads. The adjusting mechanism for opening and closing the chasers and setting them to the desired size is simple and easy of operation. The dies are opened and closed by the lever above the head. This closes with a toggle movement, the three joints being in a straight line as shown, so that there is no possibility of digging into the pipe before the chasers are released. The hand knob for making the adjustments is directly in front of the operator, as is also the dimension scale on the face of the cam ring.

A unique provision of this die head, shown in Fig. 2, is the mounting of the steel front die ring on hinges, so that it may be swung open to facilitate the changing of chasers. This also gives free access to the head for cleaning it of any chips and grit which may have worked their way into the mechanism. If desired the chasers may be removed when the front of the slide is closed, as they can be withdrawn or inserted from the inside of the head, as well as by the means shown in Fig. 2.

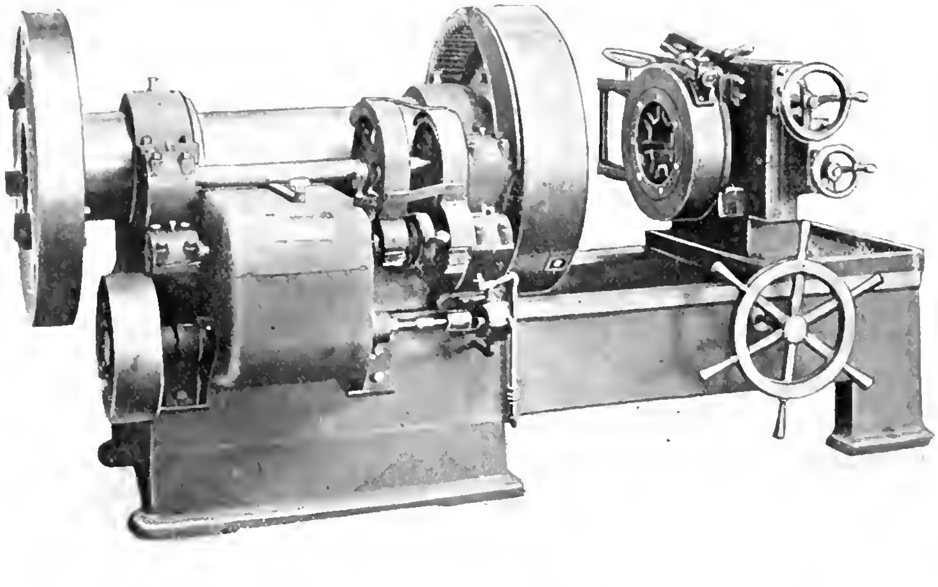


Fig. 1. The Stoever 1909 Model, Geared Drive, Pipe Threading and Cutting-off Machine

The bottom of the slides in which the chasers travel are reinforced with hardened steel plates, thus keeping them true at all times and insuring accurately cut threads. The cam ring is of interchangeable, sectional construction. The cams are of steel, inserted into the ring, so that replacement is possible at a low cost when a cam becomes worn or broken. The chasers are also interchangeable, to the extent that it is possible to replace one without getting a whole set. They are numbered to correspond with the slots in the die ring, and any chaser purchased from the makers at any time may be used with other chasers of the same size, when mounted in its proper slot. This provision is one of the noteworthy improvements in the machine.

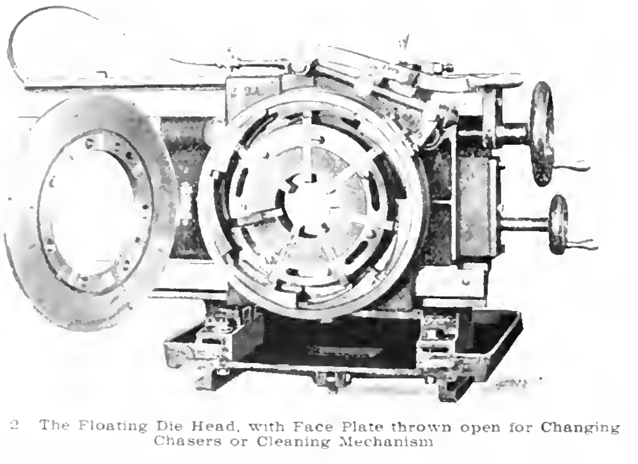


Fig. 2. The Floating Die Head, with Face Plate thrown open for Changing Chasers or Cleaning Mechanism

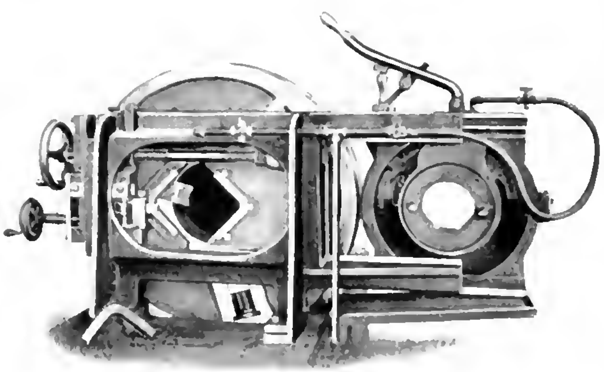


Fig. 3. The Die Head Moved to One Side, to permit Cutting Off Close up to the Chuck, note the Removable Jaws for the Steady Rest

Another feature to which special attention is called is shown in Fig. 3. Here it will be seen the die head is pushed out of the way and clear of the front chuck, allowing the slide to be brought up so close as to make the machine available for 3-inch nipple work. Another improvement, seen in this illustration, relates to the construction of the steady-rest slides. The wearing surfaces of these slides are interchangeable, and may be easily replaced by the operator when necessary, so that it is no longer necessary to await replacements from the factory in case of wear or accident. One of the removable wearing surfaces is shown lying on top of the slide in the engraving.

The oil pump for this machine is of the rotary type, and is fastened to the main driving shaft as shown in Fig. 1, thus insuring a steady and constant flow, irrespective of the diameter being machined. Fig. 3 shows the arrangement of the piping which, by means of the flexible tubing shown, directs the oil to the point of the cutting off tool and to the die head, by connections which adapt themselves to the varying adjustments of the machine.

This machine is one of a complete line, both of standard and automatic types, ranging in capacity from ¼ up to 12 inches.

THE KINKEAD SYSTEM OF ALIGNING SHAFTING

Long experience in the cotton mills of New England had convinced the inventor of the instruments herewith illustrated that the loss of power from friction is a serious item in large establishments, even when unusual pains are taken to keep the shafting in line and well lubricated. He therefore set to work to design instruments which would test the alignment of shafting more rapidly and more accurately than any at that time in use, thus making it possible to keep the transmission of a large plant in good condition at a minimum of expense. The devices herewith illustrated and described were the results of his study on the subject.

The apparatus comprises three instruments—the level shown in Fig. 1, the portable target shown in Fig. 2, and the fixed target shown together with the level and portable target in Fig. 3. The level is a special architect's instrument with an 11-inch telescope, provided with cross hairs and accurate adjustments. The glass magnifies twenty diameters, and is capable of handling an 800-foot line of shafting. The portable target is hung from the shafting by an ingenious jaw clamp,

which is one of the important features of the mechanism This clamp which is operated by the spring and toggle mechanism shown, is so designed that the distance from the shafting to the center of the target is invariable, no matter what the diameter may be. This is very important on a long line, where it may be hung from a 1½-inch shaft at the driven end, and moved to a 12-inch shaft at the driving end without altering the height of the target. The jaws are of cast iron, nickel-plated. The spring which closes the jaws on the shaft is of steel. The target has a fine adjusting screw for vertical movement on the bow by which it is hung, as well as the rapid telescopic adjustment locked by the thumb-screw. The fixed target is mounted on a dead wall or other convenient support at the further end of the line from the level. It is provided with horizontal and vertical adjustments, and carries a lantern so that it may be used at night if desired.

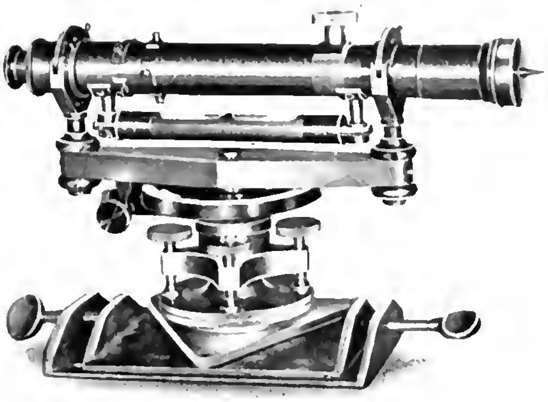


Fig. 1. Special Architect's Level, used for Lining up Shafting

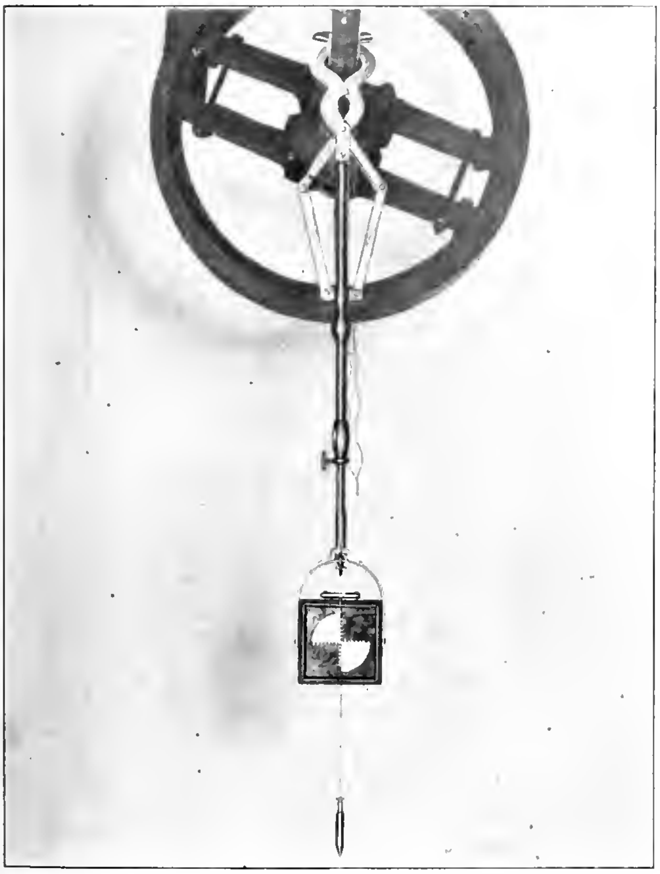


Fig. 2. Portable Target, with Self-adjusting Jaws for Gripping the Shaft

This apparatus is used as follows: First, the portable target is placed on the shaft at the end of the line where the operations are to be begun. The plumb bob is hung from a hook at the base of the clamp as shown in Fig. 2, and the center of the shafting is marked on the floor. At the same time the center line of the target face is lined up with the plumb line, and the spirit level is adjusted, if necessary, to read to zero, the spirit level being relied upon in the future operations to bring the target plumb. The target is then moved a short distance away from this position, and the architect's level is centered over the spot marked on the floor. The telescope is then set to match the vertical center line of the target and the latter is again brought up close to the telescope and adjusted vertically until its center matches the indicating point on the cap shown in place in Fig. 1. The portable target is now removed, and the fixed target is set up on the dead wall or other suitable support at the further end of the line and adjusted in both directions to center with the cross hairs on the level. This target acts as a foresight, and, by comparing the level with it from time to time, it is possible to tell if anything has happened to disturb the adjustment.

In lining up the shafting, a sketch is first made, numbering each hanger, and giving a space to record the levels (whether high or low) and the lateral displacement (whether north or south, or east or west, if the line shaft runs north or south). The portable target is then placed on the shaft at the first hanger and sighted through the level. The edges of the sighting spaces in the target, it will be noticed, are notched to read to eighths of an inch both vertically and horizontally. By reading these on the cross hairs of the level the operator is informed as to the amount of displacement up and down or sideways. The chart record for the No. 3 hanger might read No. 3, ¾ inch high, ¼ inch west.

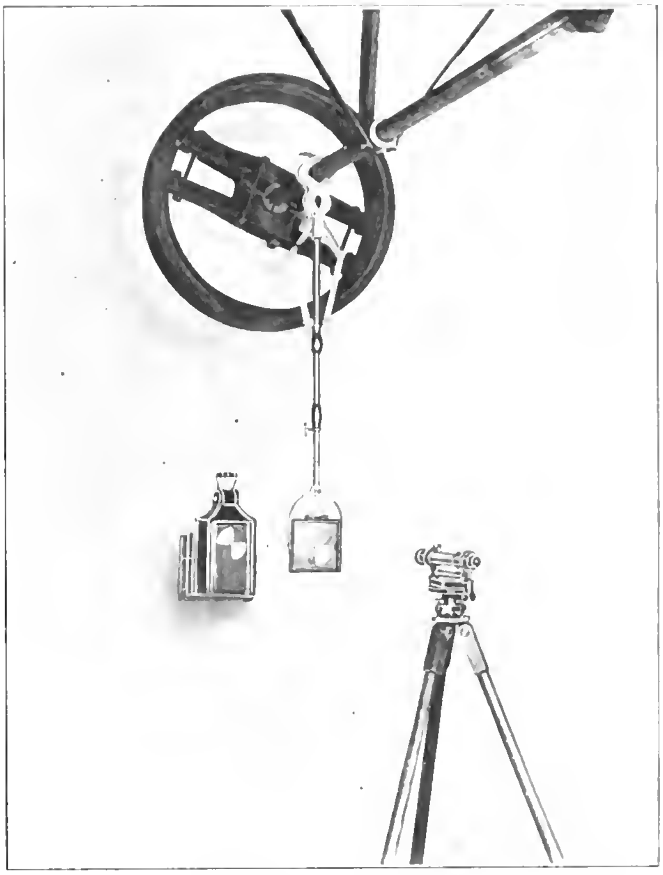


Fig. 3. The Level, Portable Target and Fixed Target, the latter provided with a Lantern for Night Use

After readings for all the hangers in the line have been put down on the chart, the latter is examined to see if any of the hangers are badly out. Sometimes where two or three are way out of line trouble can be avoided by changing these first. It is usually best, however, to adjust the portable target at the furthest hanger and bring that shaft to line and level, and then so on, from hanger to hanger, one man making the adjustments as required by the chart, while the other checks them up as fast as made by sighting through the level at the portable target. If it should be found that there is a decided difference in level from one end to the other of a long line of shafting, it will not be necessary to bring it to the level. It can be graded uniformly from one end to the other by properly adjusting the leveling instrument.

Appropriate variations of this method of operation allow it to be used on shafting running beneath the floor, fastened in wall boxes, or running beneath the bench, as well as when

supported from the ceiling in the usual way For shafting running beneath benches the target is used horizontally. Offset supports are provided for special cases in which obstructions prevent the portable target from hanging vertically. The instruments will also be found useful in setting up counter shafts, in lining shafts parallel with each other or with the main shaft, or in setting shafting at right angles.

It has been the experience of the makers of this apparatus, the Kinkead Mfg. Co., 7 Water St., Boston, Mass., that no line of shafting of the five hundred, more or less, which they have tested has been found in really good condition, even when lined up by millwrights skilled in the ordinary methods of doing this work. The loss of power in shafting is seldom less than thirty per cent or thereabouts. With reasonably good hangers this loss is reduced to fifteen or twenty per cent of the total load. This saving in power can be figured out to a saving in the coal pile for the ordinary plant which will make the use of the equipment decidedly profitable.

The operation of lining up with this apparatus is very rapid. It is possible, for instance, in ordinary work to test and line up 250 feet of shafting in three-quarters of an hour, by using two men. The apparatus does not require experts to handle it, as a little instruction will enable the intelligent millwright to use it as successfully as the engineer. The use of a lantern with the fixed target permits the work to be done as easily, rapidly, and accurately at night as during the day. This apparatus is being used in a large number of mills and factories, using anywhere from 300 to 10,000 feet of shafting.

LODGE & SHIPLEY CRANK-SHAFT LATHE

The accompanying engravings illustrate a set of lathe attachments of unusual interest. They were designed by the Lodge & Shipley Machine Tool Co., Cincinnati, O., for adapting their regular 22-inch patent head lathe to the work of turning the throws of four-cylinder automobile crank-shafts, for manufacturing in large quantities. This attachment is quickly adjusted for the changes in centers required. It affords a strong drive, and supports the crank in such a way that its tendency to spring under heavy cuts is largely overcome, thus permitting a high rate of output for the machine.

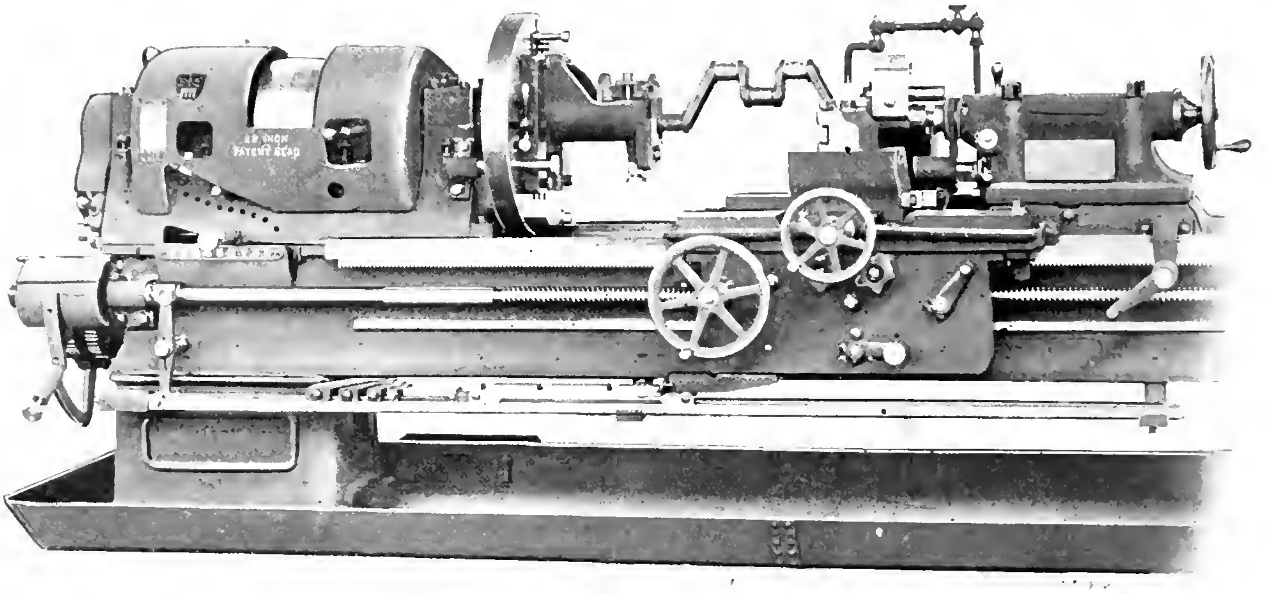


Fig. 1. Lathe, provided with Special Chucks, Tool-posts and Stop Mechanism for Turning Crank-shafts

The special chuck for holding the shaft will first be described. To the face-plate are bolted adjustable ways for guiding the sliding chuck, which is provided with locating holes for a locking bolt for bringing it to the required positions on each side of the center line. This locking bolt with the lever for operating it is plainly seen in Figs. 1 and 2. The chuck is shown in its two positions in these two engravings, Fig. 1 showing it set for machining the outer throws, while Fig. 2 shows it at work on the inner throws.

Fig. 2 shows the shaft as it is first placed in the machine. The crank, whose journals have been previously turned is gripped in a bearing in the chuck, having a hinged cap. It is centered and driven by the sliding jaw, whose forked opening embraces the cheek of the crank. This is most plainly shown in Fig. 3. The tail-stock chuck is a simple block of steel, bored for three bearings. The two end bearings are bronze bushed and tapered, and either of them may be used for either the taper plug bearing in the tail spindle, or for the taper lock bolt, as will be described. The crank itself is held fixed in the central hole of the chuck, by means of a clamp screw plug.

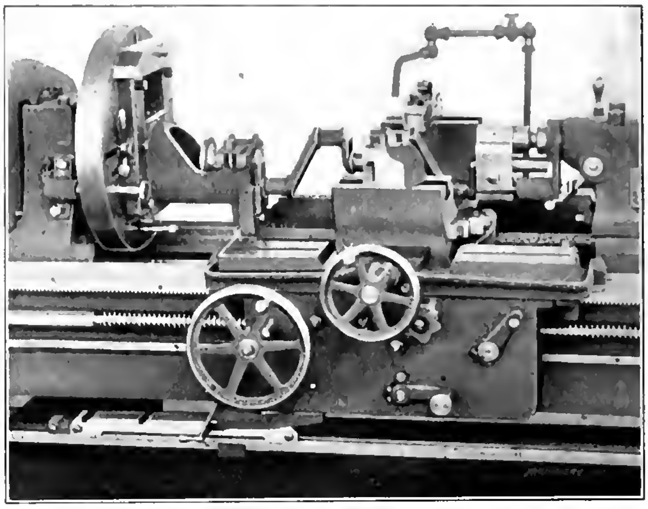


Fig. 2. Locating the Crank-shaft in Position

In setting the work in the proper position in the lathe, the face-plate is first located and held from revolving by means of the pin shown in Figs. 1 and 2, engaging a hole in the lug bolted to the side of the head-stock. The crank-shaft is then clamped in the face-plate chuck as previously described. The tail-stock chuck is placed over the journal at the rear end, and the tail-stock is brought up to the position shown in Fig. 2, with the taper bearing pin in the tail spindle entering the bushed hole provided for it. Bolted to the front face of the tail-stock is a bracket centered accurately by means of a boss encircling the tail-stock spindle. This carries a locating pin which enters the other bearing hole in the chuck, and aligns the chuck at this end with the face-plate drive. When thus aligned, it is clamped by the screw plug arrangement. The locating pin is then withdrawn by the lever shown, leaving the chuck free to revolve on the plug arbor, after withdrawing the locating pin in the face-plate. The arbor and centering pin are made of tool steel, hardened and ground. An adjustable thrust bearing prevents the arbor from seizing in the taper thrust bearing, no matter what the end pressure.

After machining the two inner crank-pins on the center line shown in Fig. 2, the lathe is stopped, the face-plate is again located by the lock bolt in the head-stock and the tail-stock is withdrawn. The locking bolt which holds the spindle to its position on the face-plate ways, is then released and the chuck is raised to the position shown in Fig. 1, where it is located again by the bolt, so that the crank is on the new line of centers. The tail-stock is again brought up, the plug arbor entering the bearing prepared for it in the other end of the tail-stock chuck. After freeing the face-plate, the machine is then ready for turning the other two crank throws.

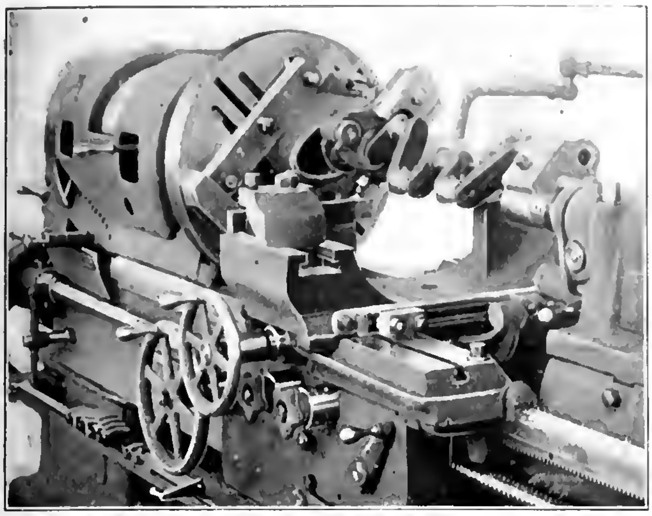


Fig. 3. The Lathe at Work

In addition to the work-holding device, just described, further attachments are provided for holding the proper tools, and for setting them to accurate stops for the various operations. The carriage is most plainly seen in Fig. 3. The front and rear tool blocks are cast in one piece, on a long slide mounted on the bridge of the carriage. This slide has both hand and power movement. The rear tool block carries two cutting tools which are set at the proper distances for fileting out the corner of the blank. The remainder of the stock is turned off with the front tool, leaving the pin ready for finishing on the grinder. The firm support given the tools can be seen in Fig. 3. A vertical rib extends for practically the whole length of the overhang for each tool, supporting it solidly almost out to the cutting point.

Positive stops are provided for both longitudinal and cross movements. The cross-slide stops are shown in Fig. 3, mounted to the side of the cross-slide and abutting against a heavy bracket bolted to the carriage. The construction of the longitudinal stops, most plainly shown in Fig. 1, is of unusual interest. A long bar, with a dove-tail sliding surface on its top, is mounted in bearings extending the whole length of the bed at the front of the machine. This bar, which has a limited longitudinal movement against the pressure of a spring, is connected with a lever at the head-stock end of the lathe as shown, which disengages the clutch connecting the splined lead-screw with the gear box. On the dove-tail of this bar are clamped a series of stops as shown. The long stop with four notches cut in its upper surface is the one used in this operation. These notches are spaced apart the same distance as that between the throws on the crank, thus serving to locate the carriage for the operation on each throw.

As shown in Fig. 1, the apron is provided with a projecting bracket carrying a lever. As the apron is traversed along the bed, this lever drops in the first notch it comes to. The carriage may then be fed along until the bar comes up against its solid stop at the left, when it will be found located in the position desired. By raising the lever the carriage will feed along until the lever drops into the next notch, when the carriage will be stopped for the next throw and so on.

This apparatus serves, however, not only as a positive lock, but for stopping the automatic feed as well. After locking the carriage as described for the operation of feeding down the fillet tools, the latter are moved back out of the way, the carriage is turned back, and the turning tool is brought up to begin its cut. The automatic feed is thrown in and the carriage feeds ahead until the lever drops into the notch as before, when it forces the stop bar to the left and thus throws out the feed clutch at the proper point.

The long stop with the four notches is special for this job. This form of stop motion has been found, however, very useful on regular work and provision has been made for setting it to any desired series of shoulder distances. For such work the special stop is removed and the series of five stops shown at the left are employed. These telescope over each other in such a way that they may be set for any shoulder distance, no matter how short. The carriage will feed until it comes to the first of them, when it will be stopped automatically by the means just described. The tool may then be adjusted to the diameter of the next shoulder, and the stop lever raised again, whereupon, without further adjustment, the carriage will feed until it meets the next of the stops. After again adjusting the tool for the new shoulder, the lever is raised and the feed continues to the next one—and so on. This mechanism gives a usefulness and adaptability to the stop movement of the lathe, closely approximating the more complicated provisions found on turret machinery.

CARROLL-JAMIESON QUICK-CHANGE GEAR ENGINE LATHE

The Carroll-Jamieson Machine Tool Co., Batavia, Ohio, has designed the quick-change gear lathe shown herewith. The gear box gives 32 ratios for turning and threading without changing the gear. This range comprises all standard threads from 3 to 32, including pipe threads. The gear box, which is of very simple construction, will be understood from an examination of Fig. 1. The shifting idler is moved longitudinally by a knob sliding in the slot of the swinging carrier shown above the gear box. The idler is swung toward


Fig. 1. Carroll-Jamieson 14-inch Engine Lathe

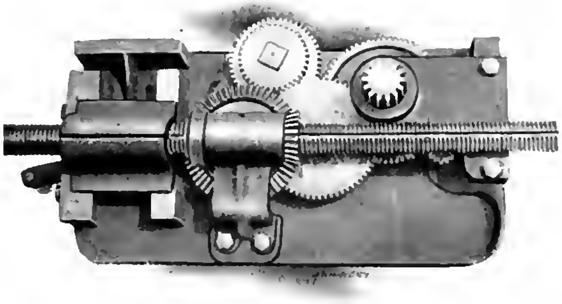


Fig. 2. Detail View of Apron Mechanism

or away from cone of gears to agree with the diameter of the one it is to mesh with, by loosening the clamp handle shown in front of the gear box, and setting the frame to the required position. The changes can be made instantaneously, with one hand on the knob and one on the handle.

The improved construction of the apron is shown in Fig. 2. This is provided with friction drives, and an uncommonly long slide for the nut, provision being made for taking up wear at this point. The rack pinion has an outboard support, as shown. While nominally a 14-inch lathe, this lathe swings 14⅞ inches over the bed.

NEW TOOL-HOLDERS MADE BY THE WESTERN TOOL & MFG. CO.

The Western Tool & Mfg. Co., Springfield, Ohio, has recently added to its line a number of tool-holders of various kinds, of which examples are shown herewith. The first of these (see Fig. 1) is a turret tool-post. It is designed to give the engine lathe some of the advantages of the screw machine and turret lathe for producing duplicate work, and should be found very useful for this service, particularly in shops which do not care to go to the expense of purchasing an expensive turret machine.

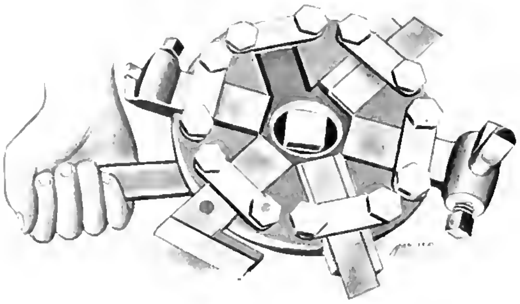


Fig. 1. A Turret Tool-holder for the Engine Lathe

As may be seen, this device is mounted on an angle plate which is clamped to the tool block of the lathe in which it is to be used. The various tools are clamped by the straps and binding bolts shown, into slots in the face of a disk. This disk is mounted on a pivot, provided with a screw adjustment for centering the tools with the center line of the lathe. The clamping handle shown binds the whole structure firmly together when the cut is being taken. To change from one tool to another, it is only necessary to release the binding lever, index the disk to bring the next cutting attachment into action, and tighten it again. The separate clamping of the various tools permits each to be adjusted for the diameter of the cut to be taken.

This turret tool-post is fitted with a set of regular tool-holders furnished by the makers, including turning, threading, side, parting, and boring tools. In ordering, it is necessary to furnish exact measurements of the tool-post slot of the lathe. The attachment is made of steel throughout, carefully hardened. It is furnished in three sizes, of which the smallest takes tool-holders with shanks ⅝ x 1¼-inch, the middle size ¾ x 1½-inch, and the large size ⅞ x 1⅝-inch.

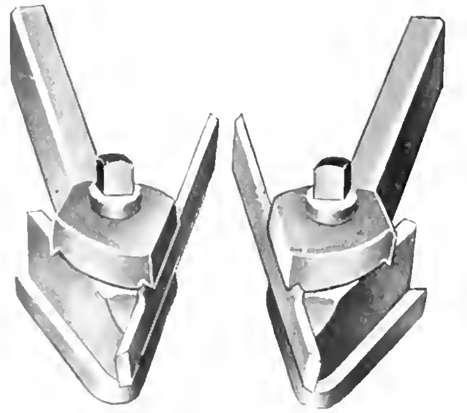


Fig 2. A Side Tool-holder which may be used with either Right or Left-hand Blades

The side tool shown in Fig. 2 is interesting in its provision for cutting either right- or left-hand in the same holder. A dovetail groove for receiving the blade is cut on each side of the body, and the clamp may be revolved to correspond with the side in use. The tool is thus either a right- or left-hand side tool as required. A new turning tool of similar design has also been constructed, giving a choice of a right- or left-hand turning tool in the same holder.

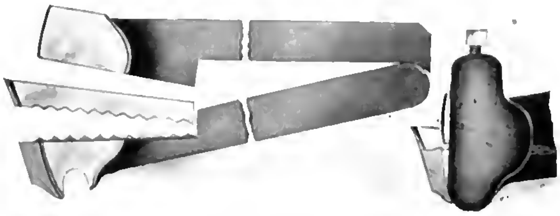


Fig. 3. A Turning Tool for Heavy Work

In Fig. 3 is shown a design of turning tool-holder intended for the heaviest work. The blade, it will be seen, is clamped in a holder which somewhat resembles a pair of tongs in its construction, having a hinge at the rear end. The clamp shown binds the two sides together with the blade between them, at a point near the cutting edge. The bottom of the blade is serrated to match corresponding serrations on the lower jaw of the holder. It is thus impossible for it to slip under the pressure of the heaviest cut.

BAUSH THREE-SPINDLE DRILL PRESS WITH MULTI-SPINDLE ATTACHMENT

The three-spindle drill shown in Fig. 1 is built by the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. While designed particularly for use with the multiple spindle attachment shown in Fig. 2, it is well adapted to the general manufacturing work commonly performed on the multiple spindle drills of the sensitive type. It is shown with three spindles, but will be furnished with four or less, as may be required by the purchaser, although the makers have found that the three-spindle machine is the best adapted for the usual run of light drilling.

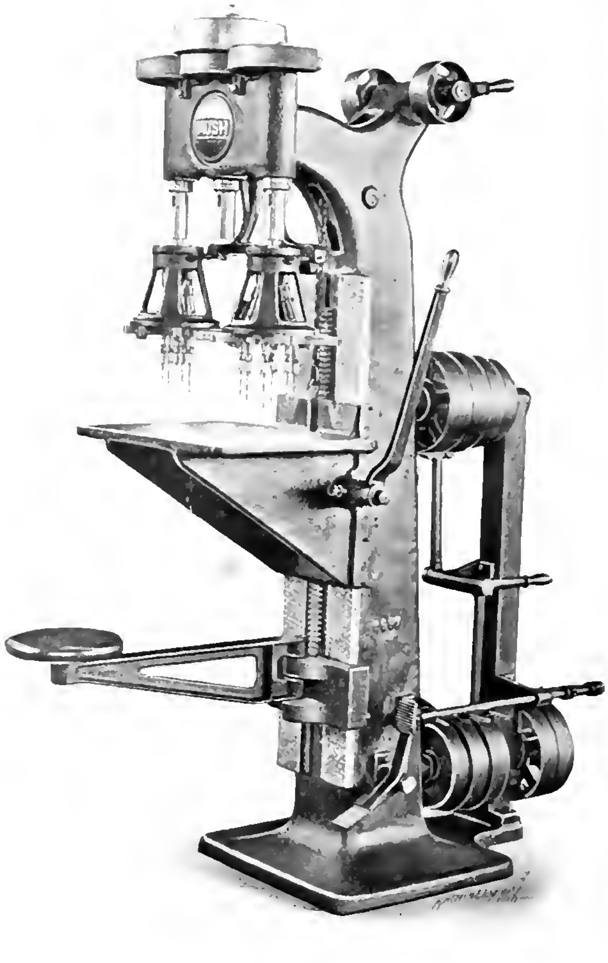


Fig. 1. Baush Three-spindle Drill

The frame is made in one piece, with ways on the face along which the stiffly designed work table is fed and adjusted. This table is counterbalanced and provided with an adjustable hand lever for feeding and an adjustable stop at the depth to be drilled. The total travel of the table is twenty-two inches. A revolving-top seat for the operator is adjustably mounted below the table.

The three-drill spindles are spaced seven inches apart and are provided with No. 3 Morse taper holes. They are connected by gearing and driven by the single vertical driving pulley shown, which is belted over the quarter turn pulleys at the rear to the upper shaft at the back of the machine. The latter is connected with the counter-shaft at the base, cone pulleys giving the machine three speeds, ranging from 272 to 377 revolutions per minute when the counter is speeded up to 320 revolutions per minute. The diameter of the tight pulley for the latter is 10 inches, for a two-inch belt. The quarter turn pulleys are mounted on an eccentric shaft for tightening the belt. The belt capacity is sufficient to drive one-inch drills.

Fig. 2 shows an attachment for the machine which is a multiple spindle drilling machine in itself. It is, in fact, a reproduction on a minute scale of the drilling head of the regular Baush multiple-spindle machine. It was designed to meet a demand for something capable of performing the same work as these large machines, but for much lighter service. As shown in Fig. 1, the attachment is very simply mounted in the drill press, it being only necessary to insert the taper shank in the spindle and hold the device from revolving by catching the steadying rod in slots provided to receive it in a bracket attached to the frame of the machine. The attachment can, of course, be used in any other make of drill press, it being a simple matter to provide means to keep the head from rotating.

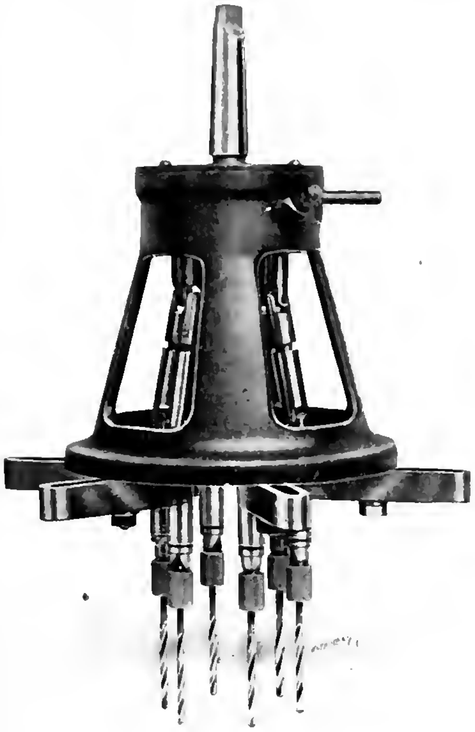
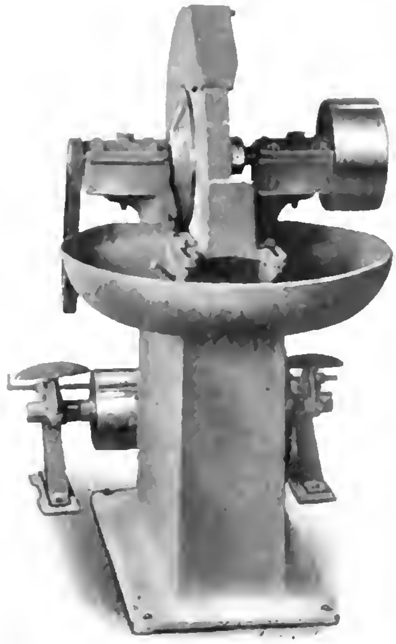


Fig. 2. Small Multiple-spindle Attachment; may be used on Regular Drill Press

This multiple drill head will be furnished with eight spindles or less, to drill anywhere within a circle of from five to eight inches diameter. The lay-out will be varied when the customer's work demands a special arrangement. The head shown in the engraving drills anywhere within a five-inch circle. It is provided with six spindles, and weighs twenty pounds. The largest drill that can be used is ¼ inch, and the maximum distance between adjacent drills is ¾ inch. The spindles are ⅝ inch in diameter. With the spindle speeds given by the machine the drill speeds are 1,000, 1,200, and 1,400 revolutions per minute respectively. A ball thrust is employed to take the pressure of the cut. A No. 3 Morse taper is provided for the driving spindle. The 5-inch head with six spindles weighs twenty pounds.

STERLING TWENTY-FOUR-INCH SINGLE WHEEL TOOL GRINDER

The Sterling Emery Wheel Mfg. Co., Tiffin, Ohio, has just brought out the wet tool grinder illustrated, which has no pump to get out of order. Water is supplied to the wheel by a special device which acts when the wheel is running. As soon as the machine stops the water drains off the wheel, leaving it dry and in balance. The machine may be used as a dry grinder by disconnecting the belt at the left-hand side operating the device, which floods the wheel with water when in operation.

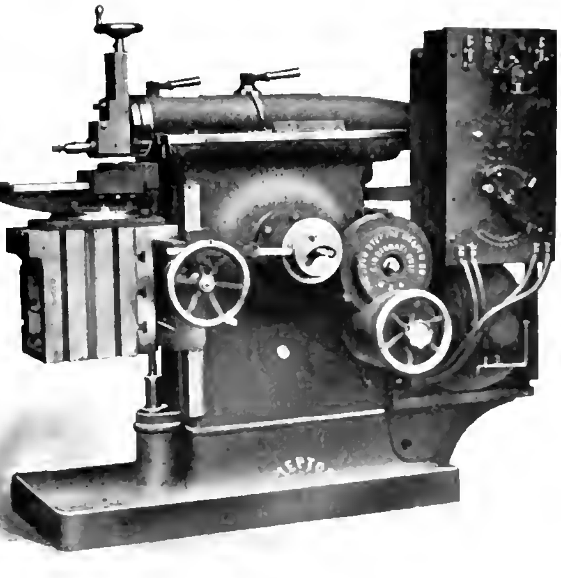


Sterling 24-inch Single-wheel Tool Grinder

Each grinder is equipped with a 24-inch by 2-inch approved grade and grit grinding wheel; the machine can be made to accommodate a wheel three inches thick if desired. The bearings are of the self-oiling type, and the following are the principal dimensions of the machine: Floor space, 30 x 45 inches; height of machine to center of arbor, 37 inches; driving pulley, 4½ x 10 inches; diameter of flanges, 12 inches; weight with counter-shaft and wheel, 900 pounds.

STEPTOE SHAPER WITH COMPACT MOTOR DRIVE

The halftone illustration shows a 16-inch shaper with an unusually compact motor drive built by the John Steptoe Shaper Co., Cincinnati, Ohio, for the United States battleship *Delaware*.



Steptoe 16-inch Shaper with Compact Motor Drive

The principal feature of the drive is the motor stand, which is set on the base of the machine, thus avoiding vibrations when the motor is running, and at the same time placing it as close to the column of the machine as is possible to get it. The arrangement of the motor is such that it takes up no more room than is actually required for the return stroke of the ram. This compact arrangement was necessary on account of the limited space available for its installation in the space assigned to it on the *Delaware*. The

controller is placed on top of the motor so that the operator is not compelled to leave his position to change the speed of the machine The motor is made by the General Electric Co., and has a speed variation from two to one.

Another new feature of the machine is an adjustable feed rod which permits the table to be either raised or lowered by the operator without attention, the feed rod automatically adjusting itself. The device is simple, consisting of a friction box through which the feed rod of flat cold rolled stock passes. The hooks on the end of the friction box pull out the rod or shorten it as the table is raised or lowered. By means of this device the common cause of breakage of the feed mechanism is avoided, i. e., the table feeding to the end of the cross-rail and the nut on the back of the apron striking the cross-rail. The friction element then comes into action, avoiding the destruction or breakage of any part.

* * *

NEW MACHINERY AND TOOLS NOTES

Power Hammer: Fritz A. Schulz, 66 N. Jefferson St., Chicago, Ill. This is a light hammer of the horizontal beam type. It weighs about 500 pounds, and will strike about 300 blows per minute. The front or anvil end of the machine is mounted on a wooden block, while the rear is supported on legs.

"Cresco" Pipe Wrench: Crescent Forging Co., Oakmont, Pa. This wrench is made in 10, 14, 18, 24, and 36 inch sizes, taking pipe from ½ to 3⅛ inch diameter. This wrench is of very simple construction, with the gripping parts made of hardened tool steel. The thread and nut are also hardened. It is light, strong and moderate in price.

Rivet Spinning Machine: Fritz A. Schulz, 66 N. Jefferson St., Chicago, Ill. This machine is arranged for rolling simultaneously the two heads of a through rivet. The work is held between the riveting spindles, which are mounted on a headstock of the lathe type. Suitable provision is made for clamping the work, and for adjusting the distance between the spindle heads.

Lathe Tool Holder: Ready Tool Co., New Haven, Conn. These tool holders are made in a variety of designs adapted for turning, threading, facing, etc. They are made to take stock sizes of either carbon or high-speed steel, so that no forging of any kind is required, except for the threading tool, which has ratchet teeth cut in its rear face. They are made in a variety of designs and sizes.

Quick Acting Vise: Oliver Machinery Co., Grand Rapids, Mich. This vise is intended particularly for wood workers and pattern makers' use. The steel screw is provided with buttress threads, working in a solid bronze nut. The quick action is obtained by lifting the screw to free it from contact with the nut, when the front jaw may be pushed in or out as desired. When raised, it at once drops back into the nut.

Crude Oil Forge: Tate, Jones & Co., Pittsburg, Pa. This is a portable forge intended to solve the difficult problem of the use of coal forges around construction work. The base of the forge furnishes the reservoir for the crude oil which is used as fuel, so that no separate receptacle is required, as when coal or coke is used. It is for this reason a much safer piece of apparatus to use, particularly in exposed and dangerous places.

Wrench With Separate Handles: New Metal Tool Steel Co., 338 Cumberland Ave., Portland, Me. This wrench is of unusual construction in that a separate handle is provided for the adjusting screw, in place of the usual knurled nut. This gives much greater power than can ordinarily be obtained, so that it can be used as a pipe wrench, or to hold round-headed bolts. By a peculiar provision in the jaws, it may be employed for cutting iron wire up to ⅛ inch diameter as well.

Hydraulic Valve: Bowes-Adams Co., Monessen, Pa. This valve is designed to be used under the heaviest hydraulic pressure. By an ingenious form of construction the valve is packed against the escape of the water on bronze valve seats, instead of by cup leather packing as is usual. The continual annoyance and repairing incident to the use of leather packing is thus avoided. It is made in the three-way or four-way type and operates for given service much easier than orthodox designs.

Automatic Grinder for Inserted Tooth Saws: Newton Machine Tool Works, Inc., Philadelphia, Pa. The automatic grinding device for sharpening face mills, described in the department of New Machinery and Tools in the February, 1909, issue of Machinery, has recently been adapted by the builders in the form of a special machine for sharpening saws, the attachment being mounted on a frame, provided with driving mechanism for rotating the saw blade. The same motor is used for driving the emery wheel and the work.

Pneumatic Counter-Shaft: Hannifin Mfg. Co., 88-92 West Jackson Boulevard, Chicago, Ill. This counter-shaft, which provides for two speeds or forward and reverse, is operated by air, controlled by a valve at the side of the machine. The clutch surface inside of the pulley is forced into contact by a pneumatic piston, provided with cup-shaped packing. The connection with the air valve may be made by rubber tubes, or by any other form of piping, and the valve may be placed in any convenient position, considerably removed from the counter-shaft, if required.

Abrasive Metal Cutter: Slack Mfg. Co., Springfield, Vt. Sales office, 15 Madison St., Hartford, Conn. On page 486 of the February, 1909, issue of Machinery, we described a grinding machine having thin disk wheels of alundum or other suitable abrasive, used for cutting off steels bars, piping and similar materials. This wheel is capable of severe service for this work, cutting through high-speed steel with the greatest ease. This business has been purchased by the Slack Mfg. Co. from the Colton Combination Tool Co., who were making it at the time of our previous note.

Quick Acting Monkey Wrench: Leo. M. Barrett, K. of P. Building, Indianapolis, Ind. This wrench, instead of employing a single screw as usual, makes use of a double-ended screw, one threaded right and the other threaded left hand, thus giving twice the movement to a turn of the thumb nut, ordinarily obtained. A lock nut is provided if desired to hold the adjustment permanently, though there is no more tendency for the adjustment to change than with the usual design. The wrench has a malleable hollow one-piece handle with wood grips. It is made in seven sizes, ranging from 6 to 21 inches.

Single-Phase Self-Starting Motor: Bell Electric Motor Co., Garwood, N. J. This motor is designed for single-phase service. It is arranged to start itself automatically as a direct-current motor operating on a single-phase current, the armature being wound for this purpose and provided with a commutator. High starting torque is thus obtained. When the motor has come nearly up to speed, a short-circuit mechanism automatically comes into use. This short circuits the commutator so that the motor, during its regular work, operates on the induction principle. The mechanism is exceedingly simple and, being automatic, it operates of its own accord when the current is turned on again after a stoppage from accident or intention.

Tooth Chamfering Attachment: Long Arm System Co., Cleveland, Ohio. In the March, 1908, issue of Machinery, in the department of New Machinery and Tools, we illustrated and described an attachment for rounding the ends of the teeth of transmission gears. The makers of this attachment have recently re-arranged it to bring the cutter work spindle into a horizontal position instead of vertical as in the older design. This permits the use of a tail-stock if desired, and thus adapts the machine for work on gears located in the centers of shafts. It also permits swiveling the attachment to any desired angle, thus varying the shape of the chamfered tooth. The device is of very simple construction and works automatically until the gear is completed.

* * *

It is stated in the *Engineering Record* of March 20 that a vanadium steel locomotive spring in recent tests was stressed to 115,000 pounds per square inch, 23,600 times before fracture. This would indicate the great superiority of vanadium steel over other steels for purposes of this kind. It is not stated, however, when and where the tests were undertaken

OPERATIONS PERFORMED ON THE "LO-SWING" LATHE

The accompanying illustrations show a number of operations which can, to advantage, be performed on the "Lo-swing" lathe, manufactured by the Fitchburg Machine Works of Fitchburg, Mass., and described in MACHINERY, September, 1907. The feature of the lathe is that it is adapted for rapid turning of small parts, not exceeding 3½ inches in diameter. Such parts as axles, automobile steering knuckles, transmissions and cam shafts can be more economically produced on this machine than in ordinary lathes. The usual cross slide is eliminated and the adjustment of the tools is obtained by a micrometer adjusting screw bearing against the end of the tool which is itself placed in a heavy tool-holder. This construction reduces vibration at the cutting point and permits higher speeds and greater depth of cut.

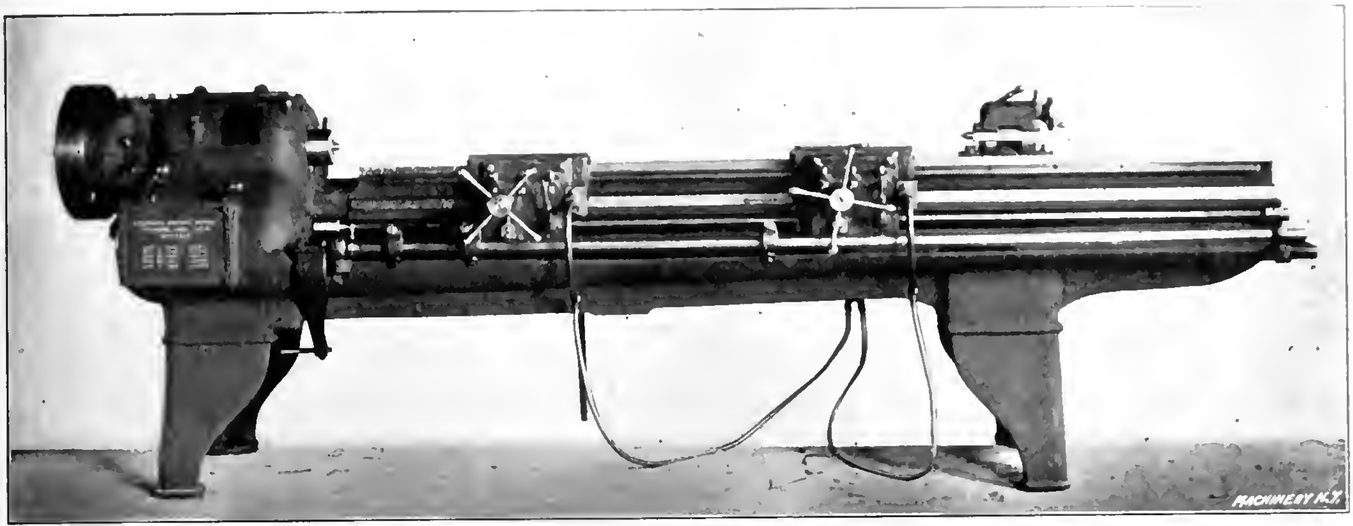


Fig. 1. "Lo-Swing" Lathe with Bed extended to Increase the Capacity of the Machine

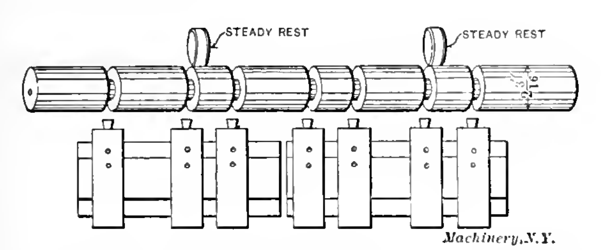


Fig. 2. First Operation in Turning Cam-shafts on the "Lo-Swing" Lathe

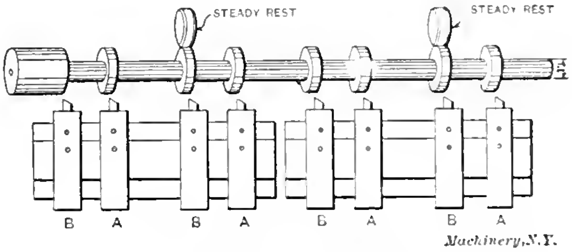


Fig. 3. Second Operation Metal between Cams Removed

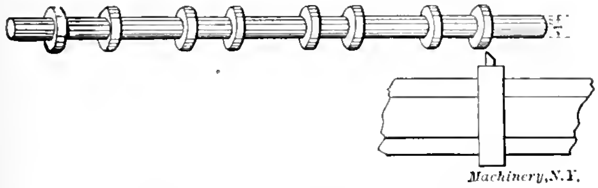


Fig. 4. Third Operation: End Turned Down

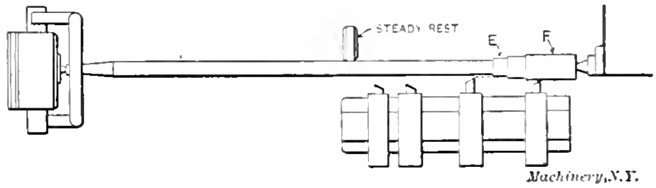


Fig. 5. Second Operation Turning E and F

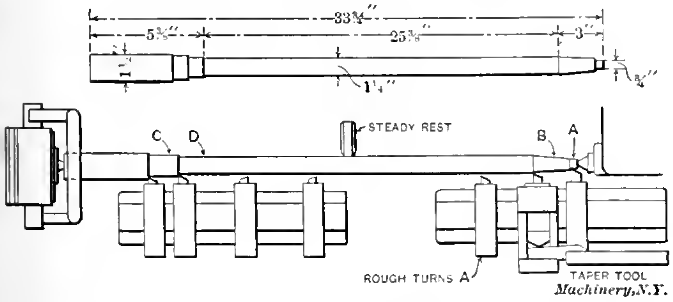


Fig. 6. Shaft to be Turned and First Operation: Turning A, B, C and D

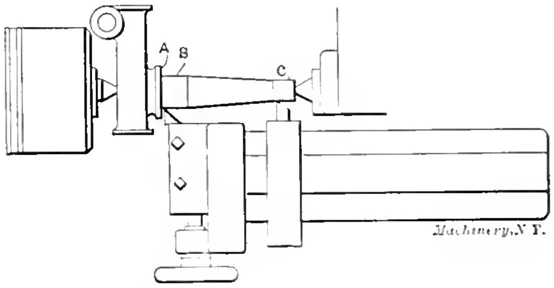


Fig. 7. Turning Steering Knuckle, First Operation Turning A, B and C

The machine as shown in Fig. 1 with its bed extending beyond the rear leg, is provided with two carriages which are so designed that they can pass by the tail-stock. Six tool-holders are provided regularly, and by means of these, a piece having several shoulders can be finished at one travel of the carriage, instead of, as usual, machining one diameter at a time. A stop mechanism is provided to take care of the varying lengths and depths, so that after the lathe is set up for one particular job, no time is lost by the operator in measuring lengths or calipering the work.

An interesting example of a piece which would ordinarily require considerable time for measuring is a cam shaft cut from a solid bar. Fig. 4 shows an 8-throw cam shaft, which is finished by the following method in the "Lo-swing" lathe. The first operation, as shown in Fig. 2, consists of cutting seven grooves with accurately spaced tools, so as to permit the cutting tools for removing the metal between the cams to start. The second operation, as shown in Fig. 3, consists of cutting out the metal between the cams with two travels of the carriages. The tools *A* take the cuts over the longer distance between the cams, and the tools *B* the cuts over the shorter distance. The third operation, as shown in Fig. 4, consists of removing the metal from the end held by the dog in the second operation. By this method, the three separate operations require altogether only one hour.

Another application of the lathe is shown in Figs. 5 and 6, where the operations necessary for turning the driving shaft of an automobile are shown. The finished shaft is shown in the upper part of Fig. 6. The illustrations indicate clearly the method followed, and Fig. 6 also shows how a tapered portion is turned in conjunction with a straight part. This

shaft can be turned in seven minutes on the "Lo-swing" lathe, whereas in an engine lathe it would require about forty minutes to finish the shaft. In the first operation the diameters *C* and *D*, Fig. 6, are turned by the tools in one carriage and the taper *B* and the diameter *A* by the tools in the other carriage. In the second operation, Fig. 5, the diameters *E* and *F* are turned.

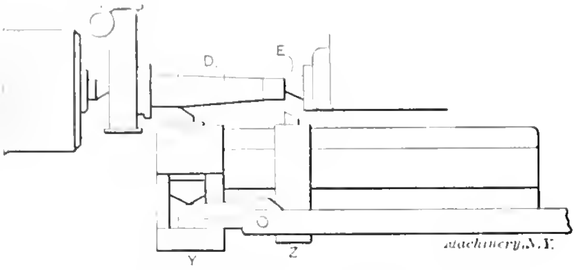


Fig. 8. Turning D with Y and Facing End with Z

Another example of work done to advantage in this machine is that of turning steering knuckles in two operations as shown in Figs. 7 and 8. In the first operation, Fig. 7, *A*, *B* and *C* are turned, and in the second operation, Fig. 8, the tapered part *D* is turned and the end *E* faced.

* * *

POWER REQUIRED FOR TAPPING

A series of experiments has been made by the American Tool Works Co., 300-350 Culvert St., Cincinnati, Ohio, for obtaining the pulling capacity of the friction drive of the radial drills built by the company. These tests, however, are also interesting on account of the fact that they record the power required for driving pipe taps. In the accompanying table are given the results of experiments covering nominal pipe tap sizes from 2 to 8 inches, inclusive. The holes tapped were reamed with standard pipe tap reamers before tapping.

POWER REQUIRED FOR TAPPING

Nominal Size of Pipe Tap, Inches	Revolutions per Minute	Net Horse-power	Thickness of Metal, Inches
2	40	4.24	$1\frac{1}{8}$
$2\frac{1}{2}$	40	5.15	$1\frac{1}{8}$
*$2\frac{1}{2}$	38.5	9.14	$1\frac{1}{8}$
3	40	5.75	$1\frac{1}{8}$
*3	38.5	9.70	$1\frac{1}{8}$
$3\frac{1}{2}$	25.6	7.20	$1\frac{3}{4}$
4	18	6.60	2
5	18	7.70	2
6	17.8	8.80	2
8	14	7.96	$2\frac{1}{2}$

* Tapping steel casting; other tests in cast iron

The horse-power recorded was read off just before the tap was reversed. In the table, however, is given the net horse-power, deductions being made for the power required to run the drill without a load. The material tapped was cast iron, except in two instances, where steel casting was tapped. It will be seen that nearly double the power is required for tapping steel casting.

The results obtained will, of course, vary with the conditions. More power than that indicated in the table will be required if the cast iron is of a harder quality or if the taps are not properly relieved. The taps used in these experiments were of the inserted blade type, the blades being made of high-speed steel.

* * *

NEW APPRENTICE EDUCATIONAL SCHEME

A new idea in cooperative apprentice education has been developed by Mr. B. B. Quillen, of the Cincinnati Planer Co., Cincinnati, Ohio, and a committee of Cincinnati manufacturers consisting of Messrs. Fred. A. Geier of the Cincinnati Milling Machine Co., William Lodge of the Lodge & Shipley Machine Tool Co., James Hobart of the Triumph Electric Co., J. M. Manley of the National Metal Trades Association, Ernest Du Brul of Miller, Du Brul & Peters, and B. B. Quillen of the Cincinnati Planer Co., presented the plan to Superintendent Dyer of the public schools, who received it with much enthusiasm, and presented it to the Board of Education with the recommendation to adopt same. It is expected that the school committee will establish it not later than July 1.

The plan is to send the apprentices to school one-half day each week, the employer paying the apprentice for the time he is in school. The cooperative school course will be continued throughout the term of apprenticeship contract, which in Cincinnati is four years. There are about 500 apprentices working in Cincinnati machine shops, and the manufacturers have agreed to start the course with 150 each week, which would make a class of 15 boys each half day for five days in the week.

The manufacturers feel that the loss of time of the apprentices attending school will be more than made up by their increased efficiency, and that the plan will be the means of securing many more apprentices than has been possible in the past. The course in instruction will be confined to shop mathematics, shop drawing and to other studies that will be of direct benefit to the apprentice in his daily work.

The development of the new plan will be watched with much interest. It is apparent from this move and other developments of similar nature that the need of more education for apprentices in connection with their shop training is generally recognized and the cooperative school courses devised are steps in the direction of rounding out the apprentice training more fully than is possible with the ordinary shop training common in the past. Whether it is practicable to devote only one-half day a week to this plan of educational work remains to be demonstrated.

* * *

NATIONAL MANUFACTURERS' ASSOCIATION CONVENTION

The National Manufacturers' Association held its annual convention in New York, May 17-19, the headquarters being the Waldorf-Astoria Hotel. The program included the following papers: "Mutuality and Fair Exchange in Trade Relations," by Count von Bernsdorff, the German ambassador; "The Iniquity of Anti-Injunction Legislation," by Hon. Charles E. Littlefield; "Legislation Affecting Labor Relations," by James A. Emery, general counsel of the National Council for Industrial Defense; "Law and Reason—Labor's Best Friend," by F. R. Boocock; "The Open Door and Your Opportunity," by S. D. Scudder, of the International Banking Co.; "Industrial Education and Manual Training Schools," by J. C. Monahan, superintendent of the Stuyvesant schools; "Desirable Improvements in Interstate Trade," by Thomas E. Durbin of the Erie City Iron Co.

The meeting was characterized by a bitter attack on Samuel Gompers and other leaders of organized labor in connection with the report of the committee on industrial education. It was claimed that the cause of industrial education was imperiled by the attitude of organized labor and Mr. Anthony Ittner declared that the committee could still be of service to keep the movement free from the dominance of organized labor which has its own special purpose in view and tends to sacrifice the public welfare to the supposed advantage of a class. This attack on organized labor was not unanimously supported and one member of the committeee, Mr. Fred W. Sivyers, of Milwaukee, refused to sign the report on the ground that it contained too many personal opinions.

The powers of the Interstate Commerce Commission over freight rates were declared inadequate, because it gives the commission no authority to deal with a freight rate, no matter how unreasonable, until it has actually been put in force. A considerable period of time must necessarily elapse between the date of complaint and the completion of the investigation. The great variety of rates was alluded to, over 150,000,000 rate items having been filed with the Interstate Commerce Commission between July 1, 1906, and January 15, 1909.

John Kirby, Jr., Dayton, Ohio, was elected president of the association following James Van Cleave of St. Louis, who has served three terms. Mr. Kirby advocates a tariff commission which shall have the power to constantly revise the tariff in the interests of all concerned, rather than having it periodically revised by Congress in a manner detrimental to general business and favorable to certain powerful interests.

THE FALLACY OF THE BOILED SHIRT IDEA

"Look on this picture," said a professor in a school of technology, holding out a colored plate advertising a correspondence school and showing in the center of a group a smooth, well-dressed figure of a man in white collar, tie, immaculate derby hat, and trousers creased to knife-edge. On either side of the dressed figure were men in overalls holding oil cans, sledges, and other implements of the workingman. The inference was that the central figure in the boiled shirt was the directing head of the grouped men in caps and jumpers.

"But what is the truth of this picture?" said the professor. "As a matter of fact, this young fellow in the good clothes to-day is drawing a salary of $1,000 to $1,500 a year and he is holding on to that job with clinched fingers. On each side of him are men who are getting $6 a day and pay for overtime.

The point which the professor out of his experience laid emphasis upon is this old invasion of the boiled shirt into a field of training which makes the boiled shirt ideal especially intolerable. Several years ago this professor was in charge of a graduating class of young men which had shown exceptional average talent and capability. There was sharp demand for such men in the work of construction, and positions had been tendered the school graduates. But almost to a man they declined to enter this active field of construction.

"Every one of them virtually decided against the jumpers in favor of the boiled shirt. They wanted to be consulting engineers," said the professor. "I jumped all over them, but it accomplished nothing. I showed them instances in which some of the biggest establishments in Chicago had been dismissing consulting engineers until hardly one of them was left. They wanted white shirts and creased trousers and rather than take good positions as construction men they went out to look for jobs that would allow of the boiled shirt.

"And the result? Most of them to-day are employed as draftsmen in establishments which pay them only the barest living wages. The average draftsman, pursuing his white shirt ideal, is as little considered as is the counter salesman in the average dry goods store. He is making concession of salary in order to wear good clothes.

"There is no position in the field of technology to-day which has as little promise as that will-o'-the-wisp, 'consulting engineer.' A few years ago, when engineering was far more on an experimental basis, the need of the consulting engineer who had knowledge and judgment and initiative necessarily was urgent. But in these years the conditions have been changing. Standard methods have been evolved from past consultations of engineers who have attained best results. There are fewer and fewer opportunities every year for this man who is bent upon becoming a consultant in engineering.

"On the other hand, methods of construction and the active handicraft of the constructor are more than ever in demand. The builder wants somebody to build, not some one to tell him how to build. He needs the educated man in the jumpers and cap, not the fellow in the creased trousers and the colored tie. Creased trousers in the *ensemble* of an organization are the badge of the non-producer; the cap and jumper mark the producer—the man who is making dividends for the company.

"It has been remarked that the graduate of the European technical schools has a hard time in this country—and so he does. They are theoretical men, universally. They have studied to pass their examinations based upon the text book. They can't compete with the graduate of the American schools, which has carried laboratory work right along with theory. Several years ago a young fellow came over here, well equipped in theory in his particular field. He came to me, and, liking the fellow, I tried to help him. The best I could do, however, was a job for him in an establishment where he got $15 a week. He had something in him, however, and his employers saw it. They hooked him up with another young fellow who knew the practical side of things, and the two worked together in team formation. It was an entirely satisfactory arrangement. The foreigner finally was promoted a step. Still with a practical partner in his wake, he was promoted again and again. And to-day he is general manager of the plant. But virtually he got the position through shedding his boiled shirt."—*Chicago Tribune.*

THE CHAMPNEY PROCESS OF DIE SINKING

CHESTER L. LUCAS*

In this era of interchangeable manufacturing, the progress of press work for making duplicate parts has been so rapid, and so many are interested, that the description of a novel method of making dies for drop-press work may be interesting to those engaged in die making for general production as well as to those in the drop-forging industry.

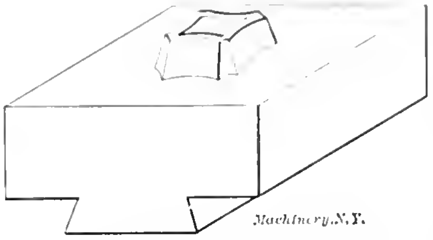


Fig. 1. Casting which forms the Heated Die by being Dropped upon it

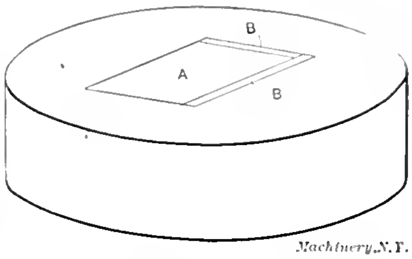


Fig. 2. Ring containing the Die Blank to be formed

Several years ago Mr. George F. Champney (now deceased) was engaged in business in Bridgeport, Conn., under the name of The Patent Steel Die Co., making dies for the forging trade and for the jewelry business, and as far as can be learned he was the originator of the "high drop" method of die sinking. This process was for a long time kept secret, and even to those who had a general idea of it, the details were not very clear. If, for example, a die for striking up a deep hollow-ware bowl was to be made, his plan was to first make a model of plaster of paris. From this model a casting, as shown in Fig. 1, was made of the finest and closest grained iron obtainable, with a large amount of metal left behind the model for strength. The sand was then cleaned from the casting without removing the hard scale, which is an important feature of this process, and it was then keyed to the hammer of the high drop. This high drop was rightly named, for although it was of the usual drop-press design, the ways are eighty feet high, the lower parts of iron and the upper of wood, faced the whole length with steel. The hammer itself is of cast iron and weighs 3,200 pounds. It is about two feet square and three feet long, and is raised by a windlass operated by hand. A pull on the rope attached to the release lever allows the huge weight to drop, and on the ways a latch is fitted to catch the hammer on the rebound, for a double blow is fatal to the die.

To the base of this great drop-press, which was necessarily very heavy, is fitted a cast iron ring (Fig. 2), which is 3 feet in diameter and 10 inches thick. The opening in the center of this ring is square and large enough to take any ordinary size of die blank. After keying the cast iron hub (or type) into the hammer of the drop and raising it to a height judged by the operator to be sufficient, the die blank *A*, which has been heated to a bright red, is placed within the square opening in the ring at the base of the press, and shims *B* placed around it so as to completely fill the space between the blank and the inside edge of the ring. The heavy hammer is then released, driving the hub with its facing of hard scale into the red-hot die blank. As the displaced steel could not go sideways on account of the shims, it had to go upwards and helped to bring the resulting impression up to shape. After being struck, the die was annealed and the scale removed by pickling; then enough was planed from the face to leave the die the proper depth, and by means of scrapers and rifflers the impression was smoothed and finished as in the ordinary methods of die sinking. Next the die was "shanked" to the press in which it was to be used, and after hardening and polishing it was ready for use.

* * *

The plant of the United States Steel Corporation at Gary, Ind., has begun to turn out steel rails—its first product.

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* Address: Saugus Station, Lynn, Mass.

SPRING MEETING OF THE NATIONAL MACHINE TOOL BUILDERS ASSOCIATION

The spring meeting of the National Machine Tool Builders' Association was held at the Plankinton House, Milwaukee, Wis., May 25-26, and was conducted by President Fred L. Eberhardt of Gould & Eberhardt, Newark, N. J., and Secretary P. E. Montanus of the Springfield Machine Tool Co., Springfield, Ohio. Forty-eight of the ninety-one concerns having membership in the association were represented by fifty-three members May 25. Following the regular business of the association, the effect of the proposed tariff on the machine tool industry at home and abroad was discussed, following which was a discussion on the extent to which machine castings should be guaranteed by foundries. This discussion was led by Mr. James N. Heald of the Heald Machine Co., Worcester, Mass., who was followed by William Lodge of the Lodge & Shipley Machine Tool Co., and P. E. Montanus. Mr. Montanus made some observations on manufacturing conditions noticed on his recent European trip, the tenor of which was that American machine tool business in Europe has reached its zenith, and that we may expect more and more strenuous competition abroad as Europeans learn and adopt American manufacturing methods. Murray Shipley of the Lodge & Shipley Machine Tool Co. made an address on "Competition," in which he discussed in some detail the various legal and moral phases of business rivalry.

On Wednesday a paper was presented by Mr. William Forsyth, "Machine Tools for Railroad Shops." In the afternoon the members visited the mammoth plant of the Allis-Chalmers Co. at West Allis, a suburb of Milwaukee. The members of the association as a whole were optimistic, and the consensus of opinion was that the business outlook is good and that the machine tool trade will boom in the Fall.

* * *

At the seventh convention of the International Railway Congress, held in Washington, D. C., in 1905, it was decided to hold the next convention in Switzerland, and it has now been officially announced that the next session will be held in Berne, July 3 to 16, 1910.

* * *

PERSONAL

Lou Hunt, timekeeper of the Fairmount Mining Machinery Co., Fairmount, W. Va., has resigned, and is succeeded by Mr. Gordon Lake.

George E. Marquette, of Kenosha, Wis., has been appointed foreman of the tool-room of the Knox Automobile Co., Springfield, Mass.

George E. Ingalls, assistant manager of the Chapman Valve Mfg. Co.'s shops at Springfield, Mass., has been appointed to a position in the main office at Boston.

U. Anderson, formerly of Fond du Lac, Wis., has been made superintendent of the Prescott Co., Menominee, Mich., following Mr. Loren Prescott, who is vice-president of the company.

Elmer E. Neal, superintendent of the Smith & Wesson Co., Springfield, Mass., revolver manufacturers, has resigned to take a similar position with the Bristol Engineering Co., Bristol, Conn.

James Dillon, of Fond du Lac, Wis., has been made machine foreman of the Prescott Co., Menominee, Mich. Mr. John Roscoe, the old floor foreman is still in place and Mr. Anton Nelson, general foreman, has resigned.

Robert Reed, chief draftsman of the Fairmount Mining Machinery Co., Fairmount, W. Va., has resigned and taken a similar position with Scotdale Foundry & Machine Co., of the same place.

Clement Booth, who for the last four years was in charge of the tool and gage department of the Remington Typewriter Co., Ilion, N. Y., is now with the Standard Roller Bearing Co., Philadelphia, Pa.

W. H. Maxwell, formerly general manager of the Angle Steel Sled Co., Kalamazoo, Mich., has resigned his position to become secretary, treasurer and manager of the Kalamazoo Steel Goods Co.

Carl S. Dow, lately publicity manager of the B. F. Sturtevant Co., and formerly in charge of instruction and textbook departments of the American Correspondence School, has joined the staff of Mr. Walter B. Snow, publicity engineer, 170 Summer St., Boston, Mass.

J. C. Jurgensen, chief engineer of the Hotel St. Regis, New York, has resigned his position to take the chair of engineering plant instruction at Columbia University next fall. A new course has been established for training students in the duties of engineers in charge of power plants.

A committee of five composed of Wilfred Lewis, Hugo Bilgram, Gaetano Lanza, Charles R. Gabriel and E. R. Fellows, was appointed April 13 by the president of the American Society of Mechanical Engineers to investigate involute gearing with a view of recommending standard tooth forms and dimensions.

Milton Thurlow, chief draftsman of the Prescott Co., Menominee, Mich., has resigned, and his position is filled by Mr. Carl Weidling, who was a former employe, before the dull times. Mr. Thurlow has obtained a position with the Berlin Machine Co., Beloit, Wis.

Claude E. Holgate, who for the past ten years has filled the position of assistant to the general manager, and has been in charge of the sales department of Gould & Eberhardt, Newark, N. J., has resigned to take charge of the automobile department of a daily paper in that city.

The author of the series "Design and Construction of Electric Overhead Cranes," now running in MACHINERY, published an article in the April 9 issue of the *Engineer* (London) describing a 150-ton floating crane for the Kawasaki Dockyard Co., Japan, built by Cowans, Sheldon & Co., Ltd., Carlisle, England, which was designed by him.

B. Elshoff, for twelve years assistant superintendent of the Allis-Chalmers-Bullock Co., of Cincinnati, and for the past two years superintendent of the electrical department of the Allis-Chalmers Co., of Milwaukee, recently severed his connection with the last named company. Mr. Elshoff may eventually accept a position with an eastern firm, but for the present will remain in Milwaukee.

Prof. Charles B. Richards, for the past twenty-five years head of the mechanical engineering department of the Sheffield Scientific School, Yale University, will resign his position in June. Prof. Richards was one of the founders of the American Society of Mechanical Engineers in 1881, and is the inventor of the Richards steam engine indicator.

W. A. Garrett, former president of the Sea Board Air Line Railway, and now chief executive officer, will resign his position November 1 to become vice-president of the T. H. Symington Co., Baltimore, Md. Mr. Garrett was at one time superintendent of the middle division of the Wabash R. R., and the news that he is to leave railroad service has caused considerable surprise and regret among his friends.

John J. Harman, graduate of the Mechanical Engineering College of the University of Illinois, has been made a member of the Harman Engineering Co., 120 Fredonia Ave., Peoria, Ill. Mr. Harman has been connected with the Link-Belt Co., Acme Harvester Co., United States Geological Survey, National Tube Co., etc., in various capacities.

Dwight T. Randall, member of the American Society of Mechanical Engineers, late engineer in charge of fuel tests, Technologic Branch, United States Geological Survey, has associated himself with the Arthur D. Little Laboratory of Engineering Chemistry of Boston, in charge of the Department of Fuel Engineering. Mr. Randall, who is a graduate of the University of Illinois, was formerly connected with R. W. Hunt & Co., and Westinghouse, Church, Kerr & Co., and later in charge of the Steam Engineering Laboratory of the University of Illinois, and of Steam and Boiler Tests at the St. Louis Exposition.

OBITUARIES

William Delaven, of Springfield, Mass., inventor of the Triumph voting machine and manager of the Triumph Voting Machine Co., died April 9 aged forty-six years.

Mace Moulton, a well-known consulting engineer of Springfield, Mass., died suddenly at the Ansonia Hotel, New York, April 27, aged fifty-four years.

Benjamin F. Nichols, a prominent manufacturer of Springfield, Mass., died suddenly at the Continental Hotel, New York, April 23, aged sixty years. He organized the B. F. Nichols Belting Co., Holyoke, Mass., and later capitalized the Metallic Drawing Roll Co., of which he was treasurer and manager, until he sold the stock in 1893 in order to form the England Metallic Drawing Roll Co., Manchester, England.

Ralph Scott, a young inventor of electrical appliances and author of several works on electrical engineering, died at his home in Newark, N. J., April 25, aged twenty-six years, following an operation for appendicitis. Mr. Scott was born in Bradford, England, and came to this country with his parents when young. He was the inventor of the Scott arc light and had a remarkable record as an inventor for one so young, over forty patents on various electrical contrivances having been secured by him. Just before his death, he finished at his factory at Newark, N. J., what is believed to be the largest arc light in the world for the Lackawanna Railroad terminal at Hoboken. The light is of 1,500,000 candle-power and the globe is six feet in diameter.

H. T. T. Cedergren died in Stockholm, Sweden, April 13, 1909. Mr. Cedergren was president of Stockholm's Public Telephone Co., which he founded twenty-six years ago and

which he conducted with such remarkable success that his company not only forced the Bell Telephone Co. in Stockholm, which obtained a franchise a few years earlier, out of business, but has also held its own in competition with the Swedish state telephone service. All things considered, the telephone service in Stockholm is equal or better, and the charges very much lower than elsewhere, and this record has been due in a large measure to Mr. Cedergren's exceptional managing ability. He also founded telephone companies in Moscow and Warsaw and took a prominent part in the working out of the plans for the telephone system in Mexico installed by a Swedish telephone company.

THOMAS A. WESTON

Thomas A. Weston, inventor of the differential pulley block, the multiple disk brake, the triplex chain block and other inventions, died in New York, May 3 in the seventy-eighth year of his age.

Mr. Weston, although born in England, was a thorough American, not only in the legal sense but at heart. He came to this country when quite young, and for a time was a clerk in the old hardware house of Pratt & Co., Buffalo, N. Y. He had an inventive mind and a natural aptitude for mechanics. His most widely known invention is the differential block which in later years became recognized as an addition to the so-called "mechanical powers," that is, the elementary means whereby power applied is transformed as to time and distance in its ultimate effect or result. The differential block is an adaption of the old "Chinese windlass," and is a reduction of a mechanical principle to its simplest terms, which enables a man, without other aid to lift one thousand pounds or more, and it holds the load suspended automatically at any point. The invention was patented in Great Britain and the United States, the licensees in Great Britain being Tangye Bros., Ltd., of Birmingham, and in the United States, Yale & Towne Mfg. Co., of Stamford, Conn. The invention was immediately recognized as a most valuable lifting mechanism and soon came into general use.

Mr. Weston's next most notable invention was that of the multiple disk brake, which in various forms has since been widely used in connection with machines of many kinds in which a brake resistance is needed, especially in cranes and hoists. It consists of two series of disks alternately interposed, those of one set being connected at their centers to a spindle, and those of the other set at their peripheries to an external casing. Each unit of longitudinal pressure applied to the series thus produces a frictional resistance between each pair of disks which is multiplied by the number of disks in the series, thereby making a brake mechanism of great compactness and power.

Mr. Weston's third and last important invention is the triplex chain block, manufactured by the Yale & Towne Mfg. Co., which like his original differential pulley block embodies the automatic holding of the load at all points, thereby eliminating all danger, but which in addition possesses a very high mechanical efficiency. The principle of the differential block involved a large waste of power and very low efficiency, averaging from 25 per cent to 30 per cent, whereas the triplex block attains an efficiency of nearly 80 per cent; in other words, for each 100 foot-pounds of power applied it gives back nearly 80 foot-pounds of useful work as against only about 25 foot-pounds in the case of the differential block.

Mr. Weston made numerous minor inventions, and all of the latter part of his life was occupied in the study of mechanical problems. He was a man of culture, refinement and exceptional intelligence, whose contributions to the mechanical world in the relatively minor field above indicated were of great value and importance and will have a permanent place among the notable inventions of the past half century.

* * *

COMING EVENTS

May to November, 1910.—International Exhibition of Railway and Land Transport, Buenos Ayres, Argentine Republic, commemorating the first centennial of the Argentine Independence. The officers of the exhibition are: Alberto Schneidweind, general director of Argentine Railways, president; H. H. Loveday, general manager of Argentine Railways, and Dr. H. H. Traya, local director of Central Argentine Railways, vice-presidents; Juan Pelleschi, commissioner general; Eduardo Schlatter, secretary.

June 1.—Opening of the Alaska-Yukon-Pacific Exposition in Seattle, Washington, which is designed to call the attention of the world to the importance of Seattle as the western gate-way to the United States, and to its rapidly growing commercial importance. The exposition will include many working exhibits, among which are meat packing, watch-making, jewelry, silk-making, rope-making, telephoning, printing, etc.

June 1-5.—International Railway General Foremen's Association convention at Chicago, headquarters Lexington Hotel. E. C. Cook, secretary-treasurer, Royal Insurance Building, Chicago. The program comprises these papers: "Air Brake Equipment," "Coaling of Engines with Mechanical Devices, "How to Obtain the Greatest Despatch in Handling Engines Through Terminals." "Installation of Hot Water Washout and Filling System," "Best Method of getting Work through Shop with Economy and Despatch." "Most Approved Type of Ash-Pan Conforming with Requirements of the Interstate Commerce Commission," "Use of the Oxy-Acetylene Process of Welding Fire-boxes, Locomotive Sheets, Frames, and other Locomotive Work."

June 7-19.—Cleveland Industrial Exposition, under the auspices of the Cleveland Chamber of Commerce, Cleveland, Ohio. It is estimated that 125,000 different articles are manufactured in Cleveland's 3,500 shops, and it is proposed to display to the world at this exposition the wonderful industrial facilities of the city. The products comprise steel ships, heavy machinery, hardware, twist drills, reamers, milling cutters, wire nails, bolts, nuts, vapor stoves, malleable castings, automobiles, paints and oils, etc. William G. Rose, Cleveland, Ohio, secretary.

June 9-11.—Joint convention of the Southern Hardware Jobbers' Association and the American Hardware Manufacturers' Association at Hotel Schenley, Pittsburg, Pa. F. D. Mitchell, 309 Broadway, New York, secretary and treasurer.

June 11.—Meeting of the Internal Combustion Engineers' Association at the Sherman House, corner Clark and Randolph Sts., Chicago, to install officers for the ensuing year which were elected at the May meeting, and for the transaction of other business. Walter A. Sittig, secretary, 61 Ward St., Chicago, Ill.

June 16-18.—Annual convention of Railway Master Mechanics' Association on Young's Million Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 21-23.—Annual convention of the Master Car Builders' Association on Young's Million Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 22-24.—National Gas and Gasoline Engine Trades Association convention, South Bend, Ind. Headquarters, Oliver Hotel. Albert Stritmatter, Cincinnati, Ohio, secretary.

June 24-26.—Seventeenth annual convention of the Society for the Promotion of Engineering Education at Columbia University and Pratt Institute, in New York and Brooklyn. These dates immediately precede those of the meetings of the American Institute of Electrical Engineers, the Society for Testing Materials and the American Society of Civil Engineers, and New York City is very near the geographical center of the meeting places of these three other societies. It will, therefore, be a convenient place of meeting for all who wish to attend the convention of one of the other societies. An unusually attractive program has been arranged, which will include the report of the joint committee of engineering societies on engineering education by Dugald C. Jackson, a report of the committee on technical books for libraries by Arthur H. Ford, a report of the committee on engineering degrees by William F. M. Goss, a report of the committee on entrance requirements by Robert Fletcher, besides contributed articles. In addition a special session will be devoted to the discussion of engineering mathematics by the committee of fifteen appointed at the Chicago meeting of the American Association for the Advancement of Science, which has been requested to prepare a special report for the Society for the Promotion of Engineering Education for its meeting in 1909. Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

June 28.—Annual convention of the American Institute of Electrical Engineers at Frontenac, N. Y. Ralph W. Pope, secretary, 29 West 39th St., New York.

June 29.—Annual meeting of the American Society for Testing Materials at Atlantic City, N. J. Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Pa.

September 25-October 9. Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the Tribune Building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

Oct. 18-22.—Annual convention of American Street and Interurban Railway Association at Denver, Col. Bernard V. Swenson, secretary, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

Upper Iowa University, Fayette, Iowa. Catalogue of the university for the fifty-third year.

University of Illinois, Urbana, Ill. Bulletin No. 14 containing catalogue of the school of railway engineering and administration.

University of Wisconsin, Madison, Wis. Bulletin No. 287, containing announcement of the summer session which begins June 28 and ends August 6.

Museum of Safety and Sanitation, 29 West 39th St., New York. Circular illustrating the proposed museum designed by Whitfield & King, and containing an extract from the article in the March issue of the *Century* by Dr. W. H. Tolman on saving lives by lessening accidents.

Museum of Safety and Sanitation, 29 West 39th St., New York. Monthly bulletin No. 1, entitled Safety, a publication issued by the Museum to promote the installation of safety devices for the protection of workmen in factories, mines, mills, and other places where there is danger from machinery or other hazards.

The Ohio Society of Mechanical, Electrical and Steam Engineers held its nineteenth meeting May 21-22 at Canton, Ohio. The following papers were presented: "Heat Insulation," L. O. Hooge; "The Interpole Motor," Prof. H. B. Dates; "Hot, Soft Water for Steam Boilers," G. H. Gibson; "On the Ethics of the Society Members," H. E. Gahr; "Continuous Melting," R. H. Probert. "Lubrication of Steam Cylinders by Grease," B. Fisher; "Recent Developments in Glower Lamps and their Application to Modern Illumination Practice," A. L. Eustice; "Some Practical Points on Power Plant Piping," Julius Roemer. David Gaehr, secretary, Schofield Building, Cleveland, Ohio.

University of Wisconsin, Madison, Wis., announces the ninth session of the Summer School for Artisans, beginning June 28 and continuing six weeks. Courses are open in steam and gas engines, electricity, machine design and mechanical drawing and other subjects. There are no entrance requirements, the purpose of the school being to offer practical instruction through lectures and laboratory work to young men in the trades. Certain advanced engineering courses are offered for those who have the requisite preparation, and a general university summer session is held during the same period. New features of the coming session are courses in public utility testing and accounting. Further information may be obtained from F. E. Turneaure, Dean of the College of Engineering, University of Wisconsin, Madison, Wis.

The Air Brake Association held its sixteenth annual convention at Richmond, Va., May 11-14, at which the following papers were presented: "Pipes and Pipe Fittings for Locomotives and Cars," by J. R. Alexander; "Air Brake Instruction," by Thomas Clegg "Yard Air Brake Test Plants and Air Brake Repairs," by F. Von Bergen; "Higher Braking Power," by J. W. Kiehn; "How Can the Road Foreman of Engines Render the Most Effective Assistance to the Air Brake Service?" by John Talty; "Handling Passenger and Freight Trains with 'ET' Equipment," by H. A. Flynn; "The Engine House Inspection Repairs and Maintenance of Air Brakes," by W. D. Seeley; "The Best Arrangement of Air Pump and Main Reservoir Capacity for 100-Car Train Service," by J. P. Langan. The secretary of the association is F. M. Nellis, 53 State St., Boston, Mass.

Postal Progress League, 361 Broadway, New York, is an association formed to effect a much-needed change in the United States postal service rates. It advocates a reduction of the general merchandise rates from 16 cents per pound to 8 cents per pound, which is the old rate of 1874; in the rural service, a common tariff on all local mail matter of one cent on parcels up to 1/24 cubic foot (6 x 12 x 24 inches); five cents on larger parcels up to ½ cubic foot (6 x 12 x 12

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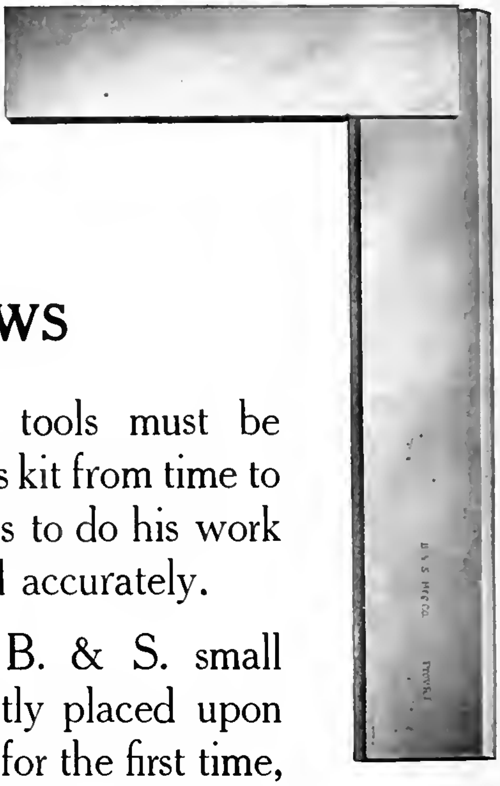

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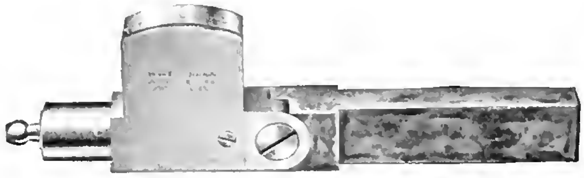

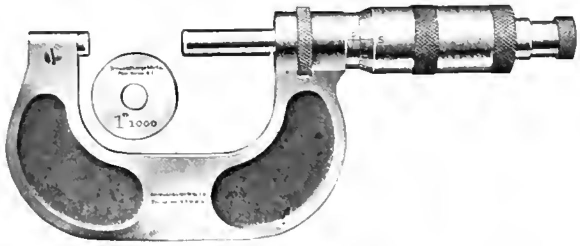

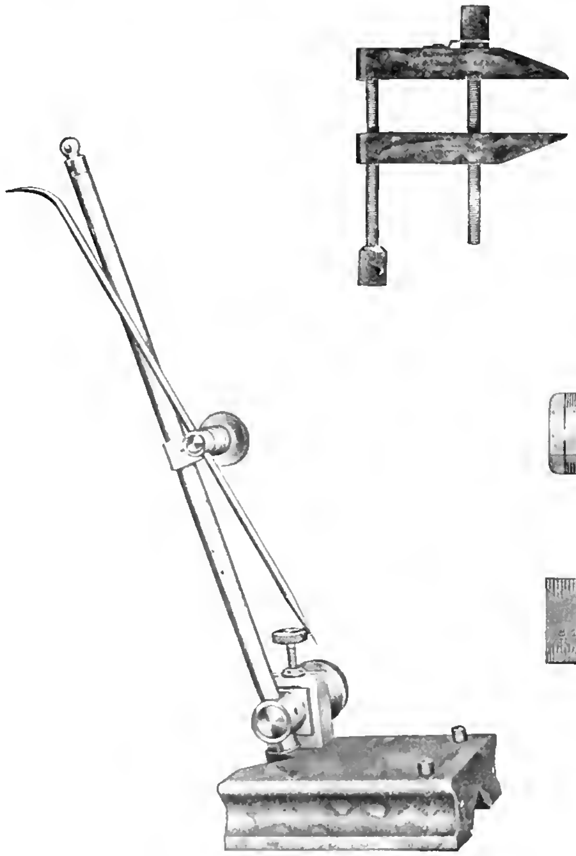

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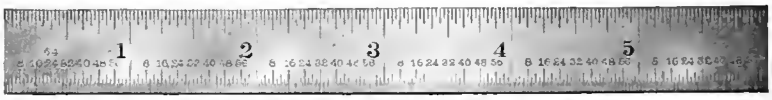

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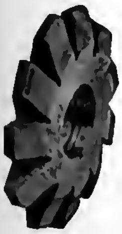

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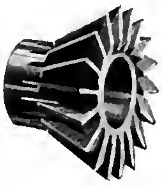
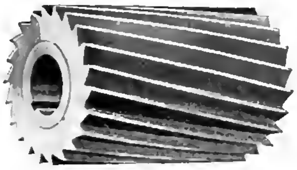




inches), ten cents on still larger parcels up to one cubic foot (6 x 12 x 24 inches). The space rate should be limited to one cubic foot, length six feet, weight twenty-five pounds. The league advocates these rates as effective means of checking the extortions of the express companies, and making the postal service self-supporting by adding millions to its revenues.

American Foundrymen's Association and American Brass Founders' Association held a joint convention at Cincinnati, Ohio, May 18-20. A fine line of foundry machinery and foundry appliances were exhibited. The following papers were presented: "The Manufacture of Brass Ingot; Its Uses and Advantages," by W. M. Corse; "The Use of Waste Heat," by F. W. Reidenbach; "The Patent Situation in the U. S. Respecting Alloys," by C. H. Clamer; "The Cost of Steel Melting in Foundries," by Dr. Bradley Stoughton; "The Side Blow Converter for Steel Castings and Its Operation," by J. S. Whitehouse; "Open Hearth Methods for Steel Castings," by W. M Carr; "Notes on Air Furnace Construction for Malleable Castings," by W H. Kane "The Use of Pulverized Coal for Foundry Purposes," by Richard K Meade; "Machine Molding vs. Hand Molding," by George Muntz; "Pattern Shop Equipment," by A. M. Spencer; "The Heart of the Foundry as Seen by the Foundry Engineer," by D. S. Hawkins; "Cores and Core Making," by F. K. Cheney; "Continuous Melting in the Foundry of the Westinghouse Air Brake Co.," by S. D. Sleeth; "Continuous Melting," by R. H. Probert; "The Permanent Mold," by Edgar A. Custer; "The Practical Value of Chemical Standards for Iron Castings," by Dr. J. J. Porter; "Pyrometry in the Annealing Room," by S. H. Stupakoff; "General Principles of Operation of Industrial Pyrometers," by C. H. Wilson. "Notes on Brass Melting," by Charles T. Bragg; "Melting of Brass Turnings in the Oil Furnace," by E. H McVeen; "Electrolytic Assay of Copper," by George L. Heath; "The Tensile Strength of Zinc-Aluminum Alloys," by W. D. Bancroft; "System of Distributing Waste Losses in Raw Materials to the Cost of the Finished Product," by L. W. Olsen; "A Comprehensive Foundry Production Tally," by C. E. Knoeppel; "Foundry Costs," by B. C. Franklin; "Modern Cupola Practice," by J. C. Knoeppel; "Notes on Steel Scrap in the Cupola," by C. R. McGahey. Richard Moldenke, Watchung, N. J., secretary-treasurer of the American Foundrymen's Association; William Corse, secretary, American Brass Founders' Association.

NEW BOOKS AND PAMPHLETS

Statistics of Railways in the United States for the Year Ending June 30, 1907. 789 pages, 6 x 9 inches. Published by the Interstate Commerce Commission, Washington, D. C.

Test of Reinforced Concrete Beams: Resistance to Web Stresses. By Arthur N. Talbot. 86 pages, 6 x 9 inches Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

This pamphlet on tests of reinforced concrete is No. 29 of the series 1907-1908. It supplies data on resistance to web stresses which has not been as thoroughly investigated as has tensile resistance of the reinforcement and compressive resistance of the concrete. The pamphlet tabulates the results of a large number of tests.

Tables of the Properties of Steam and Other Vapors. By Cecil H. Peabody. 133 pages, 6 x 9 inches. Published by John Wiley & Sons, New York. Price $1.

This well-known work which was published in 1888 has passed into the 8th edition and has been rewritten and is offered to the public by the author with confidence that the new methods of redetermining the properties of steam are such that the tables may be expected to have permanence. The temperature-entropy table gives the solution both for saturated and for superheated steam. The tables are excellent examples of fine typography.

Results of Purchasing Coal Under Government Specifications. By John Shober Burrows. 44 pages, 6 x 9 inches. Published by the United States Geological Survey, Washington, D. C.

The pamphlet reviews the results of purchasing coal under government specifications, and is accompanied by a paper by Dwight T. Randall on burning the small sizes of anthracite for heat and power purposes. The paper will be found of general interest to power plant managers and others concerned with the economical production of power.

Significance of Drafts in Steam-Boiler Practice. By Walter T. Ray and Henry Kreisinger. 61 pages, 6 x 9 inches. Published by the United States Geological Survey, Washington, D. C.

The experiments thus far made seem to indicate that it is possible to double or treble the capacity of a boiler without making radical changes in the furnaces and boilers. The experiments are of great interest to power plant managers, especially those troubled by insufficient capacity and the apparent necessity of increasing the capacity by adding new equipment.

Internal Combustion Engines. By William M. Hogle. 256 pages, 6 x 9 inches. 106 illustrations and diagrams. Published by the McGraw Publishing Co., New York. Price $3.

The aim of the author in preparing this work was to confine the treatment to the practical and applied phases of the subject, eliminating so far as practical the involved thermodynamic mathematical formulas found in other works on the gas engine. The general scope of the work is indicated by the following chapter headings: The Beau de Rochas Cycle; The Clerk Cycle; The Diesel Motor; Comparison of the Cycles; Practical Operation; Care of Engine (troubles and remedies); Starting Devices; Carbureters, Vaporizers and Injectors; Producers; Fuels and Combustion; Compression; The Indicator Card; The Cylinder; The Fly-Wheel; The Frame; Engine Foundations; The General Dimensions; The Cam Mechanism; The Valves and Ports; Crank-Shaft and Reciprocating Parts; Governing Devices; Ignition; Engine Testing; and Report of Tests.

Automatic Screw Machines and Their Tools. By C. L. Goodrich and F. A. Stanley. 255 pages, 6 x 9 inches. 284 figure numbers. Published by the Hill Publishing Co., New York. Price $2.

The wide development of the automatic screw machine makes an authoritative work on screw machine practice most welcome. The work covers the leading machines, comprising the Pratt & Whitney, Brown & Sharpe, Cleveland, Gridley, Alfred Herbert, Spencer, Acme, Potter & Johnston, and Prentice machines of the single-spindle and multiple-spindle types, illustrating and describing their constructive features. The second section treats of points on setting up and operating, speeds and feeds, spring collets and feed chucks, box tools and other external cutting appliances, drills, counterbores and other internal cutting tools, screw machine taps and dies, forming tools and methods of making them, knurling tools and their applications, why chips cling to screw machine tools, etc. The work is printed on heavy coated paper and the general typographical appearance is excellent.

Harper's Machinery Book for Boys. By Joseph H. Adams. 372 pages, 5½ x 7¾ inches. Illustrated. Published by Harper & Bros., New York. Price, $1.75.

The aim of the work is to instruct boys in the principles of machinery and the use of tools and to impress that knowledge by giving plans by which water wheels of the over-shot, under-shot and Pelton types, steam turbines, steam engines and boilers, windmills and turning lathes, pumps, force pumps, siphons, power transmission by belts, shafts and gearing, motor boats, jig saws, and a large variety of other machines of a simple nature that can be built of wood, and wood and metal in combination with the tools and supplies that are within the reach of enterprising boys having plenty of leisure and pocket money. The scope of the book is indicated by the following chapter headings: Principles of Simple Mechanics; Mechanic's Tools; Power; Power Transmission; Water Power; Wind Power; Steam Power; Electric Power; Hydraulics; Machinery; Metal-Working Machinery; Wood-Working Machinery; Stone and Marble Working Machinery; Concrete Construction and Machinery; Metal Casting and Foundry Work; Forging, Welding and Brazing; Miscellaneous Machines and Apparatus; Automobiles; Motor Boats; The Stationary Gas Engine; Shop Hints; Formulas; Tables, Gages and Measures; A Dictionary of Mechanical Terms. The book is one that will be prized by the average boy of a mechanical bent of mind. Most of the apparatus illustrated no doubt may be constructed from the sketches with fair satisfaction. Some crudity of expression is apparent, particularly in description of gas engines and metal-working tools. The fly-wheel of a gas engine is described as keeping up the motion from working stroke to working stroke "through its stored up centrifugal force." A planer is called a "bed planer," and its platen a "traveler." A knee-type milling machine is a "gear cutter and shaper," and the "bed travels carrying the work back and forth against the tool." The author evidently did not fully understand the principle of action of the milling machine. While slips of this nature are not important, in a sense, it is unfortunate that a book of instruction for the young should contain errors that tend to prejudice those who know against it. The illustrations are free-hand ink sketches and halftones. The latter are made with a coarse screen, the result being that many of the details are lost or obscured. The dictionary of mechanical terms is a valuable feature and well prepared. The book, as a whole, is one that can be commended to those desiring to place a work of this character in the hands of their boys.

CATALOGUES AND CIRCULARS

S. F. Bowser & Co., Ltd., Toronto, Canada. Circular of self-measuring oil pumps for shops, factories, round-houses, garages, etc.

C. W. Hunt Co., 45 Broadway, New York. Catalogue No. 091 of coal and ore handling machinery.

Ingersoll-Rand Co., 11 Broadway, New York. Circular No. 4010 of telescope feed hammer rock drills.

Ingersoll-Rand Co., 11 Broadway, New York. Circular No. 3001 of air and gas compressors.

American Electric Fuse Co., Muskegon, Mich. Catalogue of Allen-Bradley rheostats and electric controlling apparatus.

D. Van Nostrand Co., 25 Murray St., New York. Catalogue of scientific books recently published.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 112 of exhaust fans driven by electric motors, direct connected.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 113 of large direct current motors for direct connection.

Horace L. Winslow Co., Old Colony Building, Chicago, Ill. Catalogue of Clark blow-off system for locomotives and other steam boilers.

Warren-Webster Co., Camden, N. J. Circular announcement of the 80-page general catalogue of Webster specialties.

Dean Bros. Steam Pump Works, Indianapolis, Ind. Catalogue No. 77 of steam pumps.

Chapman Ball Bearing Co., Boston, Mass. Circular of Chapman ball bearings showing applications to loose pulleys and line-shaft bearings.

Hess-Bright Mfg. Co., Philadelphia, Pa. Sheets Nos. 35 and 36, illustrating worms and worm-wheels mounted with Hess-Bright ball bearings.

Northwestern Expanded Metal Co., Old Colony Building, Chicago, Ill. Booklet of expanded metal manufacture giving valuable data on the strength of reinforced concrete.

E. G. Smith Co., Columbia, Pa. Circular listing "Which Way" levels and Smith beam calipers sold at special prices to clean out stock.

Brown Specialty Machinery Co., Chicago, Ill. Catalogue of the Hammer core machine for making a great variety of cores with rapidity and cheapness.

Baldwin Locomotive Works, Philadelphia, Pa. Record No. 66 on smoke box superheater and feed water heaters, by John W. Converse and Lawford H. Fry, reprinted from the *Railroad Age Gazette.*

Cleveland Twist Drill Co., Cleveland, Ohio. Circular advertising "Peerless" high-speed reamers, "Perfect" double tang sockets, and "Paradox" adjustable reamers.

S. W. Card Mfg. Co., Mansfield, Mass. Booklet entitled "The Passing of the V-Thread" (see Machinery, March, 1909), giving the reasons why the sharp V-thread should be abandoned in favor of the U. S. standard thread and pitches.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet of graphite products which is a pocket edition of the general catalogue of the products of the company, listing crucibles, flake graphite, machine grease, lubricating graphite, etc.

Shepard Electric Crane & Hoist Co., 50 Church St., New York. Bulletin No. 502 of the Shepard electric hoists which are built in over four hundred types and sizes with a capacity from 500 pounds to 20 tons.

Skinner Chuck Co., New Britain, Conn. Set of four blotter advertising cards illustrating the Skinner planer chuck, combination lathe chuck, 1904 pattern individual lathe chuck, and geared pattern drill chuck.

Hannifin Mfg. Co., Chicago, Ill. Catalogue of Aero chucks, friction chucks, cost-reducing tools, air counter-shafts, gate valve seating machines, etc. This company is the successor of the Manufacturers' Equipment Co.

Nappanee Iron Works, Nappanee, Ind. Circular of the Nappanee portable cylinder boring bar for general work, which is made in three sizes. This boring bar was illustrated and described in the May number of Machinery.

Philadelphia Gear Works, Inc., 1120-1122 Vine St., Philadelphia, Pa. Match scratcher advertising cut gears and card deprecating the policy of waiting until business improves before placing orders for goods.

W. W. Oliver Machine Co., Buffalo, N. Y. Catalogue No. 17 of rolling mills, polishing machines, drop presses, draw benches, drills, foot-power lathes, bench shears, rod cutters, and other light machinery for the working of metal.

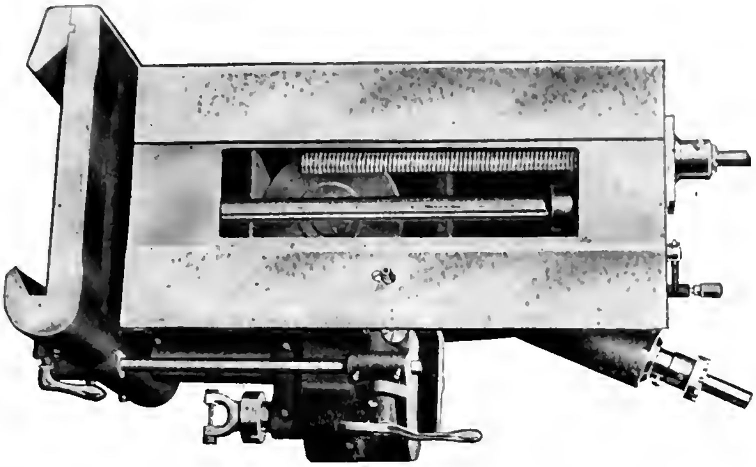
Pneumatic Nut Machinery Co., Inc., 224 High Ave., Cleveland, Ohio. Circular illustrating a nut tapping machine having a turret with six taps and six facing tools and pneumatic feed. The nuts are fed, tapped and removed by a controlled automatic system.

Webster & Perks Tool Co., Springfield, Ohio. Catalogue of grinding and polishing machinery, comprising: Bench grinders, floor grinders, edge grinders, buffing and polishing lathes, etc. The catalogue illustrates automatic oiling devices applied to these grinders for insuring copious supply of lubricant to the bearings.

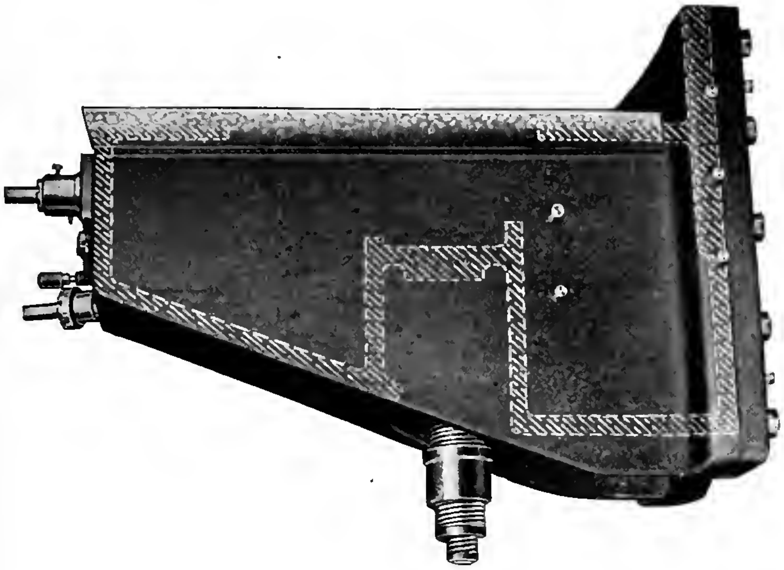
Northwestern Expanded Metal Co., 930-950 Old Colony Building, Chicago, Ill. Booklet of beam and column data compiled by Ernest McCullough, chief engineer of the company. The booklet contains a fund of valuable data on beams and columns, and advertises the expanded metal manufactured by the company.

Webster Tool & Mfg. Co., Springfield, Ohio. Catalogue of tool holders, expanding mandrels, portable stands, surfacing files, turret

Cincinnati



High Power Miller



Rigidity

The knee of a Miller is subjected principally to twisting strains due to the pressure of the cutter against the work, tending to overturn the table and saddle.

Cincinnati High Power Miller Knees are designed to resist these twisting strains. The cuts show the webbing. They are reinforced boxes, and a box will resist twisting better than any other rectangular structure.

Prove this to yourself.

Take a light box, complete with lid fastened down and note its torsional stiffness compared with a box of the same size that has no bottom and only one end made of boards twice as thick.

The complete box will win.

This is the principle on which our machines are designed throughout.

The Cincinnati Milling Machine Company

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.
AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

[illegible] bench legs, C-clamps, lathe dogs, friction clutches, adjustable shell reamers, grinders, quick-change drill chucks and collets, shapers, engine lathes, etc.

General Electric Co., Schenectady, N. Y. Bulletins Nos. 46 and 59, describing Type I ammeters, voltmeters, and wattmeters for alternating current circuits. The indications of the pointer are rendered "dead beat" and the scale extends through an arc of 300 degrees, and is practically uniform throughout. The instruments are so constructed as to be uninfluenced by stray fields.

Brown & Sharpe Mfg. Co., Providence, R. I. Booklet illustrating features of the original constant speed drive milling machine. This attractive booklet illustrates the Brown & Sharpe constant speed mechanism, the feed works and other details. It concludes with tables of general dimensions of universal milling machines Nos. 2-A, 2-A heavy, 3-A heavy, and 4-A heavy.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Circular No. 1502, containing valuable information on alternating current distribution, covering transformers, lightning arresters, insulators, cross arms, etc. The circular contains fifty-two pages of information of value to central station managers and others concerned with the distribution of power by alternating current systems.

S. Obermayer Co., Cincinnati, Ohio. Leaflet endorsing the movement to increase the available daylight hours during the summer, which was initiated in England. The leaflet advocates advancing the standard time in the United States two hours beginning May 1 and continuing until October 1. The two additional hours given in the hot season are the coolest hours of the day and are best for labor and exercise.

Armstrong Bros. Tool Co., 113 N. Francisco Ave., Chicago, Ill. Circular of the Armstrong automatic drill drift for loosening taper tang twist drills in their sockets. This drill drift requires no hammer, the handle acting as a hammer being slidably mounted on the drift and retracted by a coil spring. This tool was formerly made by the Automatic Drill Drift Co., and was illustrated in the July, 1908, number of Machinery.

Niles-Bement-Pond Co., 111 Broadway, New York. *Progress Reporter* No. 19 illustrating the Niles extra heavy driving wheel chucking lathe which has a capacity of eight pairs of driving wheels in ten hours, and the Niles standard driving wheel lathe having a capacity of five to six pairs of driving wheels in ten hours. The catalogue also illustrates the Pond car wheel lathe having a capacity under ordinary conditions of twelve to fourteen pairs of steel-tired car wheels in ten hours.

T. R. Almond Mfg. Co., Ashburnham, Mass. Quotation from the decision of the United States Circuit Court of Eastern District of New York rendered March 27, 1909, in the litigation of Jacobs Mfg. Co. vs. T. R. Almond Mfg. Co., in which it was decided that the use of a chuck wrench carrying a pinion intended to engage teeth cut in the scroll ring of the chuck by the defendant company is not an infringement. The Jacobs patent is declared invalid.

Weston Electrical Instrument Co., Newark, N. J. Post-card advertising Weston electrical instruments in a novel manner. The card ostensibly is that of the "Weston Correspondence Schools," and in a few words tells how expensive and unsatisfactory educational experience with unsatisfactory electric instruments can be avoided by purchasing the Weston instruments in which the customer gets the benefit of the best work that experience and brains have been able to produce.

Browning Engineering Co., Cleveland, Ohio. Bulletins Nos. 31, 34, and 35 illustrating the Browning lifting magnet for handling castings, scrap metals, structural shapes, etc.; the Browning automatic buckets for handling ore, coal, sand and other materials, and the Browning locomotive crane of the revolving type, operated by steam or electricity, designed for general railway work, such as coaling locomotives, light wrecking work, and for use in industrial plants, stone and brick yards, sand and gravel pits, etc.

Ingersoll Milling Machine Co., Rockford, Ill. Catalogue No. 7 of milling machines of the planer type and knee type. The company has had experience for over twenty-two years on this line of milling machines and has been a consistent advocate of the use of the milling machine for machine operations commonly done on the planer. The line is comprehensive, extending from 20 inches to 10 feet, having from one to four or more heads, arranged according to the needs of the customer. The catalogue also lists inserted tooth milling cutters and illustrates a variety of manufacturing work which these machines are doing in various manufacturing plants.

Gronkvist Drill Chuck Co., 18 Morris St., Jersey City, N. J. Circular of the Gronkvist drill chuck, made in five sizes, having a capacity from 1/32 to 3/4 inch inclusive. In this chuck the ordinary sharp steel jaws are replaced by three hardened rolls which engage the drill and hold it by pressure. The greater the resistance, the tighter the drill is held. No wrench is used, and drills may be released, gripped, tightened and centered with the machine running, it being unnecessary to stop the machine to change drills within the limits of the chuck.

Hudson-Fulton Celebration Commission, Tribune Bldg., New York. Booklet giving a brief history of Henry Hudson and Robert Fulton with suggestions designed to aid the holding of general commemorative exercises during the Hudson-Fulton celebration, September 25 to October 9. The booklet contains a list of the members of the commission and the general plan of tne celebration. The commission is raising a fund of $500,000 to cover the expenses, and contributions are solicited.

Wagner Electric Mfg. Co., St. Louis, Mo. Bulletins Nos. 82 and 83 on polyphase motors and single-phase motors. The Wagner single-phase motor is self-starting, working by repulsion at the start and induction when full speed is attained. A centrifugal governor draws the brushes out of contact with the commutator when full speed is attained, and it then operates the same as the ordinary squirrel cage form of motor. The circular illustrates the application of the motor to vacuum pumps, vacuum cleaning machines, deep well pumps, air compressors, elevators, drill presses. The motor requires no starting box, an ordinary two-pole switch being all that is required for starting and stopping.

Kinkead Mfg. Co., 7 Water St., Boston, Mass. Circular illustrating the Kinkead apparatus for aligning and leveling shafting, comprising a special architect's level and fixed and portable targets, also of special design. The portable target is supported by the shafting, having jaws that grip the shafting and hold the target center at the same distance from the center of the shafting even if it varies in diameter. Some surprising results have been obtained by aligning long lines of shafting in factories by the Kinkead method; in one case the friction load was reduced from 73 to 20 per cent. The time required by this apparatus is much reduced as compared with the common method. In some large textile mills in which the power consumption is an important factor in cost, the advent of this apparatus has enabled all the shafting to be gone over once a month and all hangers kept constantly adjusted in perfect alignment.

Gronkvist Drill Chuck Co., 18 Morris St., Jersey City, N. J. Catalogue of the Johansson combination gages. The Johansson gages are made in Sweden, and are doubtless the most accurate production in existence. They have practically absolutely flat surfaces and parallel sides. The steel of these gages is hardened and treated so that molecular changes are eliminated. The catalogue illustrates some of the combinations that can be made with these gages. With a No. 1 set, consisting of 81 blocks, the sizes vary by 0.0001 inch and a gage ten inches long can be built up, which means that the set consists of not less than 100,000 different gage sizes for internal use. By adding the standard plug gage and a holder and the same number of plugs and snap gages are obtainable. The number of combinations thus made possible are not less than 300,000. The gage is warranted accurate within one hundred thousandth part of an inch per inch.

MANUFACTURERS NOTES

Cincinnati Planer Co., Cincinnati, O., recently broke ground for an addition that will double the capacity of its plant at Oakley.

Massey Vise Co., Chicago, Ill., has removed to its new building, 208-210 Michigan St., where improved facilities have been provided for manufacturing the Massey punch, planer and milling machine vises.

Angle Steel Sled Co., Kalamazoo, Mich, manufacturer of steel sleds, chairs, stools, etc., has removed its general office to Otsego, Mich. The manufacturing plant will remain in Kalamazoo. Mr. C. E. Pipp is general manager.

Independent Pneumatic Tool Co. has removed its general officea from the First National Bank Building, Chicago, Ill., to its own new "Thor" building at 1307 Michigan Ave., where larger space and better facilities are provided for taking care of the company's growing business.

National Scale Co., formerly of Beaver Falls, Pa., manufacturera of computing scales, has been reorganized and has moved its equipment from Beaver Falls to Chicopee Falls, Mass. The capitalization of the company is $125,000, $50,000 of which was raised at Chicopee to secure the industry.

Ing. Ercole Vaghi, formerly Vaghi, Accornero & Co., Milan, Italy, has been reorganized with increased capital and a larger number of salesmen to take care of their increasing business. The Niles-Bement-Pond Co. has recently placed the agency for the Pratt & Whitney product with this firm.

Prescott Co., Menominee, Mich., saw-mill builder, under its new management has introduced a comprehensive cost system, and a number of new machine tools have been added to the shop equipment, including a large Niles crank shaper, a 42-inch Niles boring mill, Pawling & Harnischfeger drill, several lathes, etc.

Kalamazoo Steel Goods Co., of which W. H. Maxwell, formerly general manager of the Angle Steel Sled Co., is secretary-treasurer and manager, will manufacture steel furniture, chairs, and stools, and do electrical welding to order, also all kinds of special work in steel shapes.

Screw Cutting Company of America, Philadelphia, Pa., has removed from 150 Berkley St., Wayne Junction, Philadelphia, to its new factory on the corner of 17th St. and Sedgley Ave., near the North Philadelphia station of the Pennsylvania Railroad. The new plant will be in operation about June 1.

William J. Smith Co., New Haven, Conn., has appointed the well-known engineering firm of Vickers, Sons & Maxim, Ltd., 32 Victoria St., London, S. W., England, as sole agents for the sale of the Smith "one-lock" adjustable reamers in Great Britain, France, Germany, Belgium and Austria.

Arthur D. Little, Inc., 93 Broad St., Boston, Mass., announces that the business of the laboratory established in 1886 has been incorporated under the above name in order that the facilities of the laboratory may be further extended. The company is prepared through its large staff of specialists, to undertake any work involving the application of chemistry to industry.

B. C. Ames, Waltham, Mass., has moved into his new reinforced concrete factory, which has two stories and basement. The floors, walls, roof and stairs are all of concrete, the lower floor being supported by concrete pillars in the basement. The two main rooms have a clear floor space about 70 feet long each. The upper floor will be used for the manufacture of fine measuring gages, while the lower floor will be given over to the manufacture of bench lathes and general machine work.

Slack Mfg. Co., Springfield, Vt., is a partnership recently formed with W. W. Slack, president (Gilman & Son, Inc., Springfield, Vt.); H. K. Parkman, secretary (Gilman & Son, Inc., Springfield, Vt.); and G. C. Parker, sales manager (William J. Smith Co., New Haven, Conn.), for the manufacture and sale of an abrasive metal cutter. All the parties will retain their present positions with their respective companies. The sales office of the company will be at 15 Madison St., Hartford, Conn.

Valley City Machine Works, Grand Rapids, Mich., has purchased a plot of land thirty-three feet wide adjoining its factory and will build an addition 42 feet by 66 feet to provide for its increasing business in the manufacture of wood-working and grinding machinery and water motors for washing machines. This motor has been on the market about one year and has made "a hit" with the washing machine manufacturers because of its simple, compact construction and power.

Westinghouse Mfg. Co., Pittsburg, Pa., lately received an order from the City Electric Co., San Francisco, for a 15,000 horse-power Westinghouse-Parsons steam turbine. This will be the most powerful steam turbine west of the Mississippi River, its power capacity being equal to about ten of the largest railway express locomotives. A 5,000 horse-power steam turbine is being built on order for the city of Detroit and another of the same size for the Nichols Copper Co., Laurel Hill, Long Island.

H. Mueller Mfg. Co., Decatur, Ill., has increased its annual payroll $20,000 as a result of increasing wages five per cent. About seventy-five per cent of the 650 employes of the company participate in the increase, which dates back to February 4. Hereafter the date for conferring with employes on the wage question will be May 1, that date being a better time for judging the year's business than is the earlier date. The policy of the company has been to pay its employes according to the volume of the business and profits made. The pay-roll for 1908 was $371,250, and it is expected that for 1909 it will exceed $400,000.

Warner & Swasey Co. has just purchased the unoccupied half of Brown & Sharpe Mfg. Co.'s lot on Washington Boulevard, Chicago, Ill., and will at once erect a building for its Chicago offices with large showrooms for the display of its complete line of high-grade machine tools. The lot has a frontage of seventy-five feet, and the building to be erected thereon will be of the same height and general dimensions as the Brown & Sharpe Mfg. Co.'s building adjoining; it will be ready for occupancy in the Fall. The location is so near the new railroad station that many believe it will in the near future become the machine tool center of Chicago.

Miami Valley Machine Tool Co., Dayton, Ohio, manufacturer of lathes and sensitive drills, and the Dayton Machine & Tool Works, manufacturer of grinding machines, have consolidated under the name Miami Valley Machine Tool Co. Mr. David Wilson, who has been sole owner of the Dayton Machine & Tool Works, and who has had long experience in the building of machine tools, will be actively connected with the new company and will give his attention to the building of the Dayton grinders as well as the Miami Valley lathes and sensitive drills. The consolidation simply means the enlargement of two growing concerns, and the business of each will be conducted under more favorable conditions.

Reeves Pulley Co., Columbus, Ind., has published a booklet entitled "Engineering Manual," which contains the practical and tech-

MACHINERY

July, 1909

SOME MACHINERY AND METHODS OF WATCHMAKING

ETHAN VIALL*

IN going through a large watch factory there are many processes to be seen that only a skilled watchmaker could thoroughly understand and appreciate. There are, however, many things that are of intense interest to the average mechanic and which are well worth the time required to see them, but as few mechanics have either the time or opportunity to do so, the writer will proceed to describe some of the things that impressed him the most while going through the big plant of the Illinois Watch Company at Springfield, Ill. Through the kindness of President Bunn and Superintendent Johnson, the following illustrated article is given:

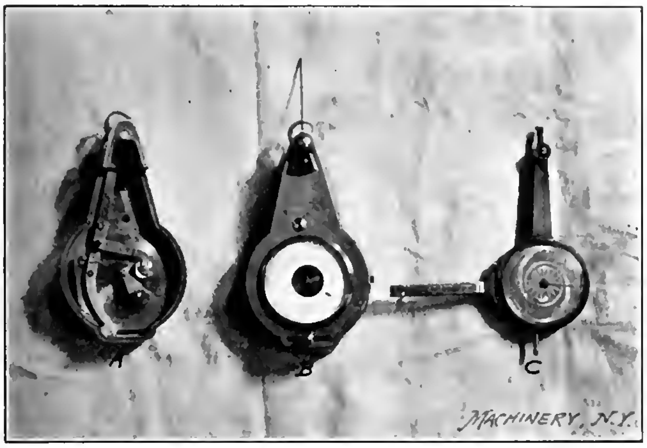


Fig. 1. Caliper Gage and Test Indicator used in Watchmaking, Illinois Watch Company

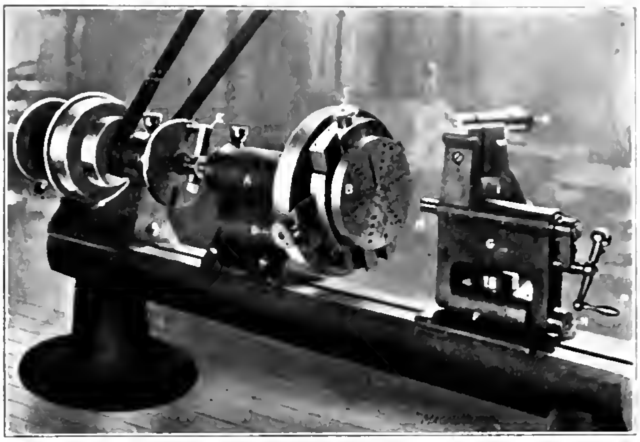


Fig. 2. Dividing Head and Tool Rest used in Laying Out and Boring Master Plates

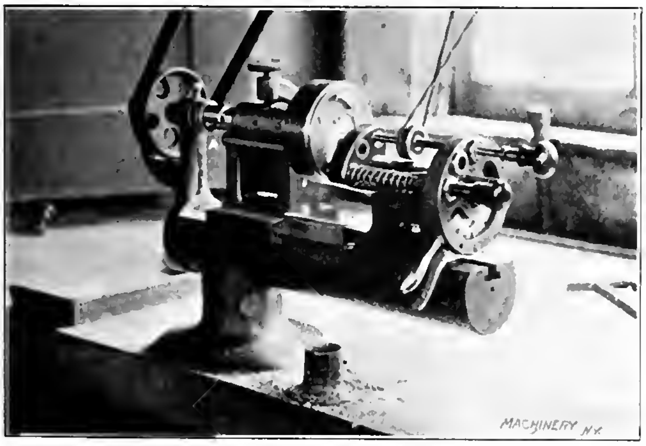


Fig. 3. Bench Lathe equipped with Quill used when Boring Center Holes in Watch Plates

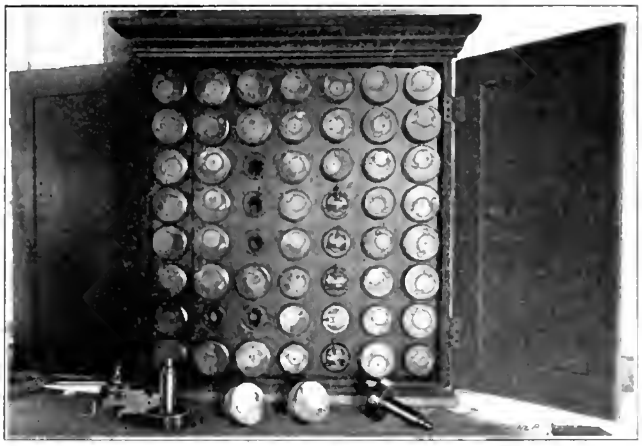


Fig. 4. A Set of Quills used for Boring the Various Holes in Watch Plates

The toolmaking work, as that term is usually understood, is, in this factory, separated into two classes and done in different departments, each in direct charge of a competent foreman of long experience. These departments are known as the machine shop, in charge of G. W. Meredith, and the punch and die department, in charge of C. H. Dockson. There is also a subdivision of the machine shop, known as the cutter making department, in charge of A. R. Mills, under the supervision of Mr. Meredith. In the machine shop proper all of the special machines, jigs, fixtures, master-plates and tools are made that are not included in the work of the punch and die or cutter-making shops. The bulk of the general machine repair work is also done in this department. The punch and die department not only includes the making of punches, dies and sub-presses, but it also includes the actual punch press work, and, consequently, in addition to its special toolroom, it has a complete battery of punch-presses in constant operation. The cutter-making department attends to the making and grinding of all mills, saws, counterbores and tools of that character used in the factory.

All of the fine caliper gages of the type shown at *A* and *B*, Fig. 1, and in detail in Fig. 5, are made in the machine shop. These gages are used in various forms throughout the factory for all the fine measuring required in turning out accurate work in quantities. At *C* this gage is shown in a modified form used for center indicating. Similar fine caliper gages are made and used in other watch factories to some extent. As will be seen from the engravings, the hand of the dial is operated by a small watch-chain or fusee-chain as it is sometimes called, which is wound around the spindle to which the hand is fastened. This spindle has a watch spring coiled around the lower end in such a way as to pull the indicator hand toward zero and keep the chain wound up as far as the caliper jaws will permit.

For laying out, drilling, and boring master plates, the special dividing-head and swing tool-carriage shown in Fig. 2 are used. The dividing head *A* consists of a false face-plate *B*, which is fastened to a cross-slide and which, in turn, is attached at right angles to another cross-slide, the guides of which are solid with the face-plate proper. The whole mechanism is mounted in a bearing of its own and is driven by means of the dog *E*, which engages a slot in the lathe face-plate, as shown. The plate *B* is graduated on its periphery in degrees, and it can be easily turned on its center and clamped at any desired angle. The cross-slides are both fitted with micrometer screws which afford quick and accurate adjust-

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* Associate Editor of MACHINERY.

ment of the plate in either direction along their line of travel. As can be easily seen, the tool carriage *F* has a part *G* which is hinged at *H* and which may be adjusted out or in by means of the micrometer head *K*, mounted in part *I*, which is solid with the base of the carriage. The center of the tool-holder or spindle *M* in which the boring tool is placed, is exactly half way between the center of the pin *H* and the center of the micrometer head *K*, so that if the micrometer screw is turned outward 0.001 inch the tool is set out just half as much, or 0.0005; in other words, the direct reading of the micrometer indicates the amount that the bored hole will be enlarged on the next cut. The tool is fed into and out of the work by turning the handle *P*.

Formerly all master plates were originally plotted out as shown in Fig. 6, all holes to be bored being figured in two directions from a central point as shown, but the method illustrated in Fig. 7 is now considered much simpler to work from and less liable to error for this class of work. In this plan all holes that are the same distance from the center point are connected by arcs and their distances from a center line marked zero are indicated in degrees. The advantage of this last method to the toolmaker will be at once apparent to anyone who has ever worked out a complicated plate by the first one.

The mounting of the dividing head of the machine shown in Fig. 2, in its own bearing, illustrates the general principle upon which all fixtures used in the factory to hold parts to be bored are made. The usual form of individual bearing, or quill as it is called when used with a separate holder, is shown in Fig. 3. The quill illustrated in this engraving is used to hold a watch-plate while the center hole is bored. The quill holder is in the form of a V-block and clamp, and the quill is

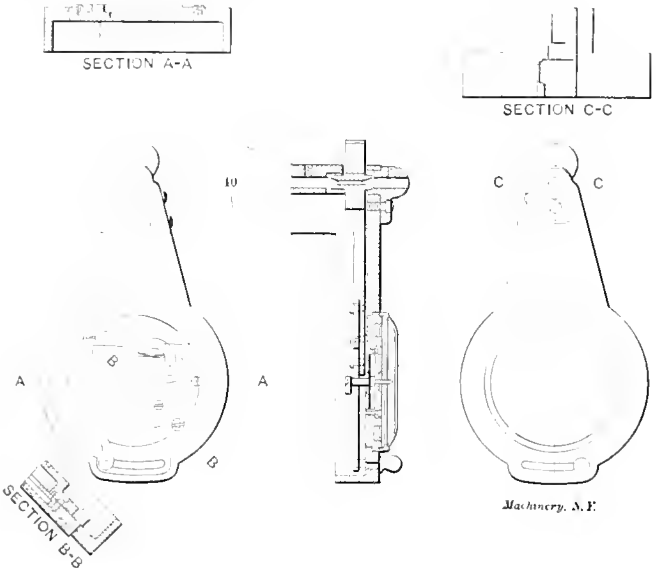

Fig. 5. Detail of the Caliper Gage shown in Fig. 1

10 Size Master Plate No. 1. Refer to Fig. 6

1. Hunting Barrel.
1. Open Face Barrel.
2. Center and Curve Center No. 3 Barrel Bridge.
3. Third and Curve Center No. 3 Train Bridge Three-quarter Plate and Barrel Bridge No. 4.
4. Fourth.
5. Escape.
6. Pallet.
7. Balance and Curve Center No. 5 Train Bridge Three-quarter Plate and Barrel Bridge No. 2.
8. Dial Foot.
9. Dial Foot.
10. Dial Foot.
11. Curve Center No. 1 Train Bridge Three-quarter Plate and Barrel Bridge No. 5 Three-quarter Plate.
12. Curve Center No. 2 Train Bridge Three-quarter Plate.
13. Curve Center No. 4 Train Bridge Three-quarter Plate.
14. Curve Center No. 6 Train Bridge Three-quarter Plate.
15. Curve Center No. 1 Barrel Bridge and No. 1 Balance Cock, Bridge and Three-quarter Plate.
16. Curve Center No. 3 Balance Cock Bridge and Three-quarter Plate.
19. Train Bridge Screw No. 1. Three-quarter Plate.
21. Balance Cock Screw No. 1.
22. Curve Center No. 1 Cock No. 1 of Bridge, and No. 5 Barrel Bridge, Bridge Watch.
23. Minute Wheel Turning.
24. Curve Center No. 2 Cock No. 1 of Bridge and No. 1 Cock No. 2 of Bridge.
25. Curve Center No. 2 Cock No. 2 of Bridge and No. 1 Cock No. 3 of Bridge.
26. Curve Center No. 2 Cock No. 3 of Bridge.
31. Case Screw No. 1.
32. Case Screw No. 2.
36. Steady Pin No. 2 Train Bridge Three-quarter Plate.

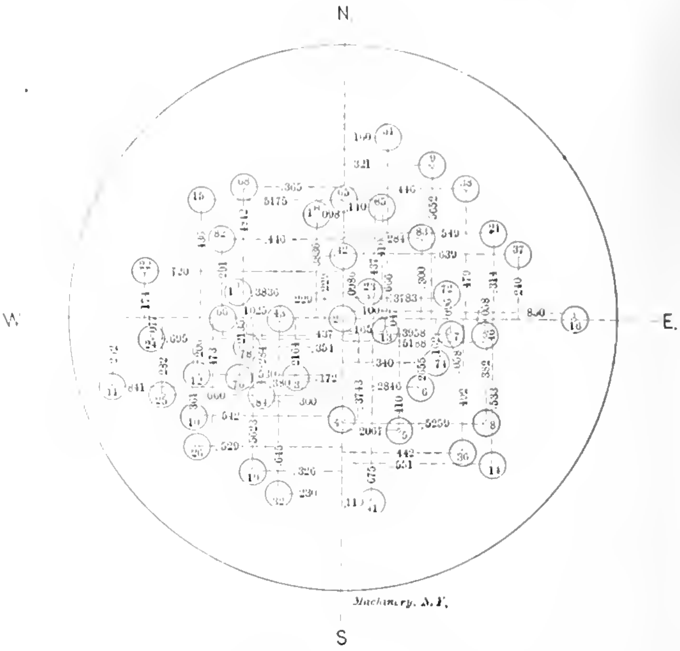

Fig. 6. Old Method of Laying Out Master Plates

37. Steady Pin No. 1 Cock.
38. Steady Pin No. 2 Cock.
41. Steady Pin No. 2 Train Bridge, Bridge Watch.
42. Setting Wheel, Open Face.
43. Setting Wheel, Hunting.
46. Hairspring Stud.
65. Winding Wheel Open Face.
66. Winding Wheel Hunting.
68. Click Screw.
72. Pallet Bridge Steady Pin No. 1.
74. Pallet Bridge Curve Nos. 2 and 4.
76. Winding Arbor Lever Screw, Hunting.

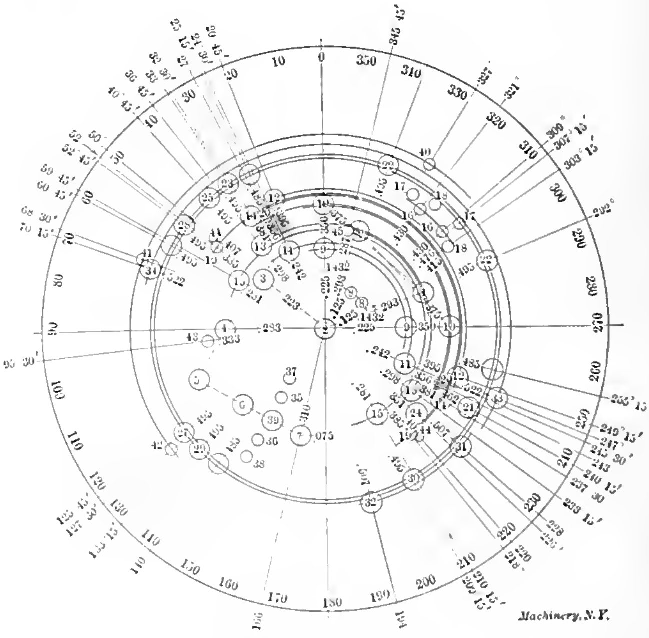

Fig. 7. Improved Method of Laying Out Master Plates

78. Crown Setting Pinion Stop Screw, No. 2. Hunting.
82. Click Pin Hunting.
83. Winding Arbor Lever Spring Turning. Open Face.
84. Winding Arbor Lever Spring Turning. Hunting.
85. Winding Arbor Lever Milling, Curve No. 1, Open Face.

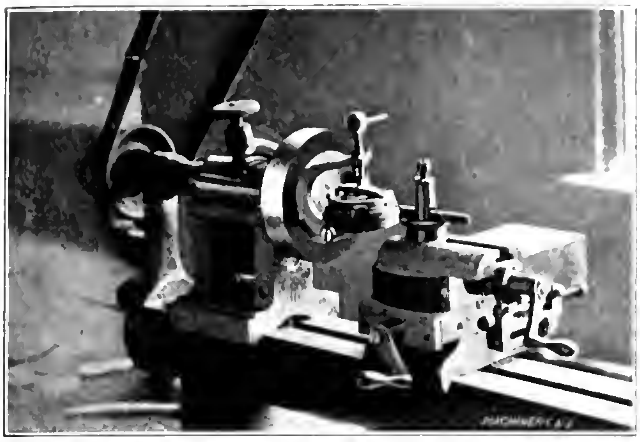

Fig. 8. Bench Lathe with Quill for Holding Works while Uprighting the Stem Holes

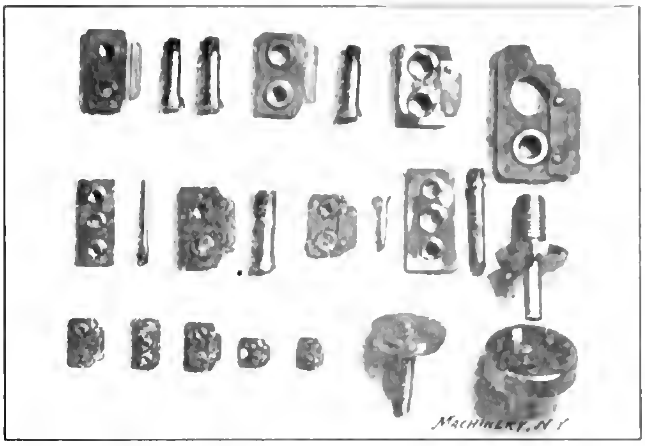

Fig. 9. Spring Chucks and the Templets used in Making the [illegible]

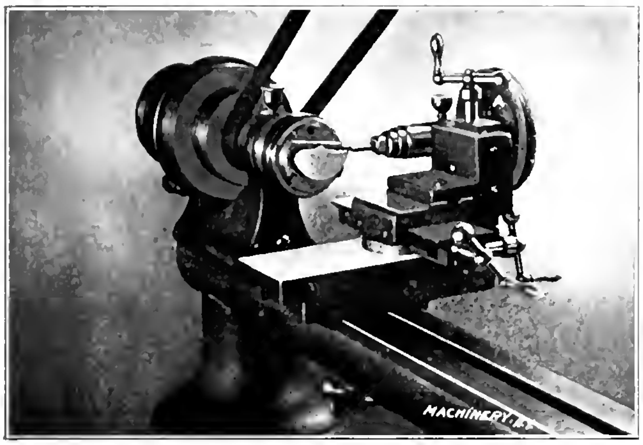

Fig. 10. Milling Attachment for Bench Lathe used for Milling Punches, Dies, etc.

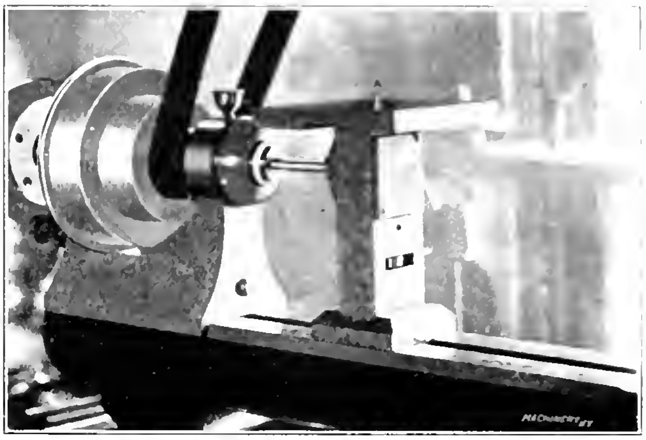

Fig. 11. Vertical Milling Attachment for Machining the Stripper Plates

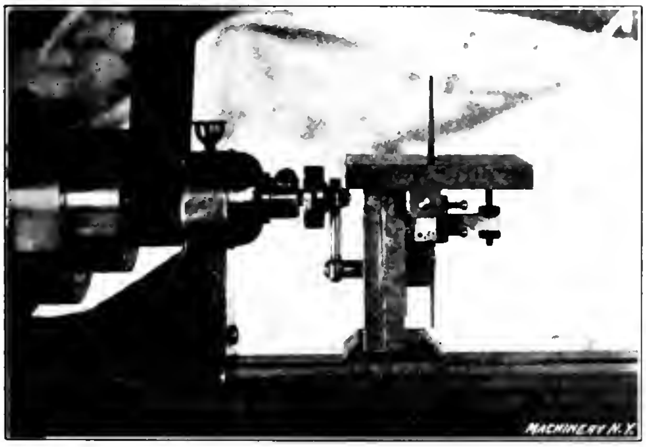

Fig. 12. Bench Lathe Filing Attachment for Filing Clearance in the Dies, etc.

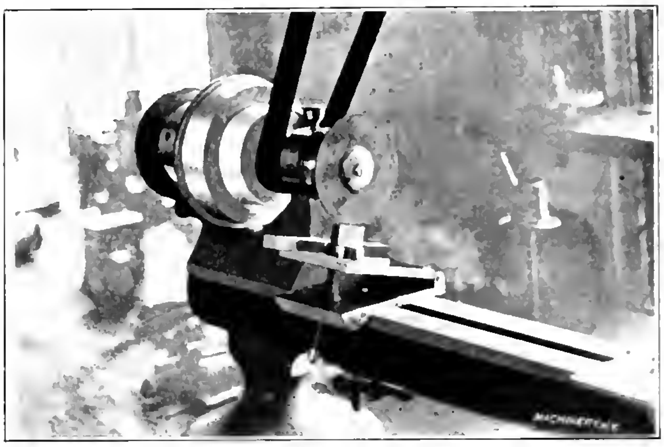

Fig. 13. Adjustable Plate for Surface Grinding on the Bench Lathe

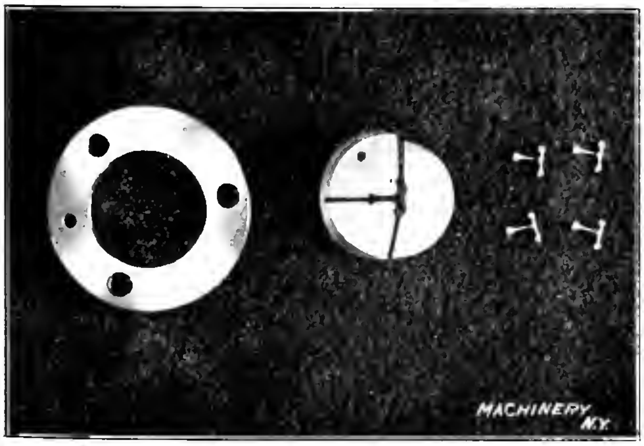

Fig. 14. Sectional Dies with Clamping Ring and Samples of the Work

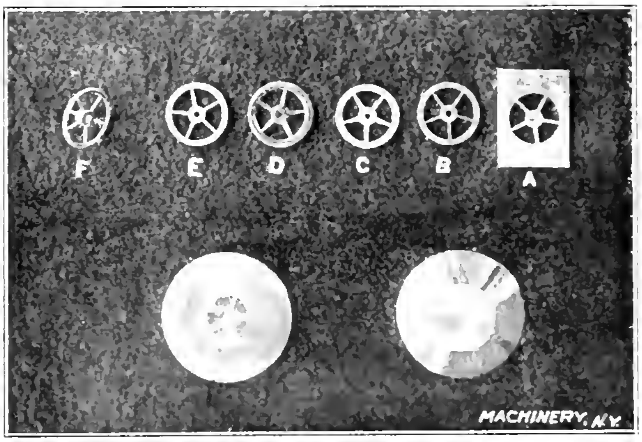

Fig. 15. Swaging Die and its Work

driven from the lathe spindle by a tongue and fork, as shown at A. Each train hole in a watch-plate has a separate quill for centering it while it is being bored out, the plate being located in the jig which holds it, by means of the dial feet holes. There are pins in the face of each quill so located that when they enter the previously drilled dial feet holes, the plate to be drilled is brought into the proper position.

The watch-plates are all first spotted for the drills, then drilled and finally bored as just mentioned. A number of these special quills are shown in Fig. 4, and also in Fig. 29, together with a few split chucks and another form of the fine gages used. Fig. 8 shows another quill fixture which is used in the factory for holding the watch works while uprighting the stem hole.

In Fig. 9 are shown a number of spring chucks and the gages used when making them. These gages or templets have threaded collars in them for the size and length of the thread, bored out collars for sizing the barrel of the chuck and pieces fastened to the side to give the length and also to hold the chuck in place while gaging the bevel.

Fig. 16. Finished Sub-press, Component Parts, and Babbitting Jig

Fig. 10 shows a milling attachment used on a bench lathe for working out slots and irregular places in small jigs, punches and the like. When using this milling attachment the lathe spindle is locked and the spindle of the attachment is driven by a round belt passing over pulley A. Several very interesting attachments for the bench lathe are to be found in the punch and die department, which have been made for the special work done there. Fig. 11 shows a table with a small end mill A in the center, which is used for some classes of die work. The milling cutter is rotated by means of a pair of bevel gears and a shaft connected to the lathe spindle. Fig. 12 shows a filing machine, the table of which can be tilted to a limited extent for the purpose of filing clearance in a hole or for other reasons. The stroke of the file is adjusted by shifting the crank-pin in the slotted plate which is attached to the nose of the lathe spindle. Fig. 13 shows an adjustable plate used when surfacing off small punches or dies with an emery wheel; this plate is extremely handy for many other light grinding jobs.


Fig 17. Thirty-three Thousand Steel Yokes Blanked Out in a Sub-press in Eight Hours

A grinder used for a number of special jobs is shown in Fig. 30. This machine has a revolving work holder with three heads. At A is a head consisting of a long V-block and clamp for holding punches or other round parts while squaring the ends. The engraving shows a sub-press piston being squared up. At B is a face-plate used for holding flat work; the third head is not visible.

Fig. 18. Thirty-five Thousand Brass Center Wheels representing the Work of an Eight-hour Day

Many of the dies made are for such small parts that it would be impossible to make them in one piece and work out the holes, so they are made in sections to facilitate their construction, as shown in Fig. 14. The outside edges of the die parts are slightly beveled and the clamping ring is bored to correspond, so that when the ring is pressed down the die parts are clamped closely and firmly together. Dowel pins in both the die and the ring insure their being replaced correctly if it is necessary to remove them from the sub-press for any reason. A die of this kind is always so divided that a possible fin or ridge on the punching would come at a place where it could be easily removed. Formerly many of the punchings were polished on the edges by hand with diamond dust, but all of this class of work is now run through a series of special burnishing dies, the parts coming out with their edges as smooth and bright as a mirror. Fig. 15 is a swaging

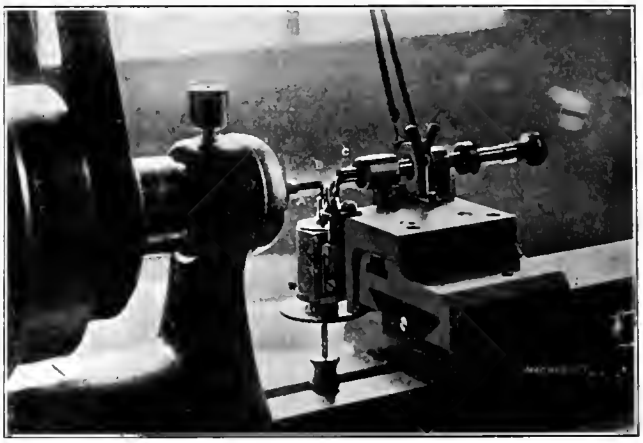

Fig. 19. Milling a Small Counter-bore in a Bench Lathe

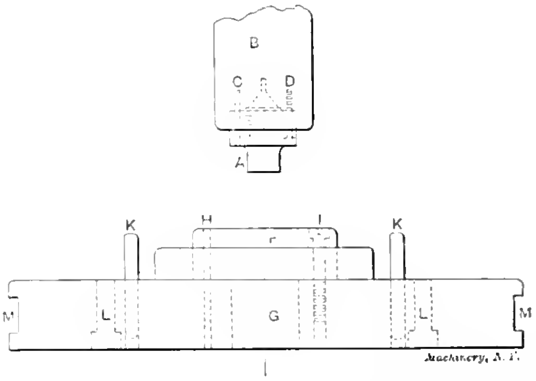

Fig. 20. Method of Fitting Punches and Dies in a Sub-press

punch and die used for rounding the spokes on some of the brass wheels. *A* shows the wheel after the first punching operation and still in the strip from which it was cut, and *B* shows it with the center hole punched. At *C* it is shown just as it comes from the swaging die for the first time. It is next annealed and again placed in the same die coming out as at *D*. The fin or flash is next taken off in a trimming die as at *E*. A completely finished wheel, after it has gone through all the various processes and is ready for the watch, is shown at *F*.


Fig. 21. Grinding the Sides of a Small Saw

The usual method of adjusting the stroke of the ram of a punch-press proved so unsatisfactory that all the presses in this factory have been fitted with a worm gear and worm adjustment, as shown in Fig. 31, in place of the regular gear and pinion-key form. In this way it is impossible for the ram to drop and spoil a die if the key happens to slip while adjusting, as it could originally; besides a more delicate adjustment can be easily made. This method of adjusting is, of course, old and presses could be bought years ago fitted in this way, but where presses of the other style are in use they can often be changed over to advantage as in this case.

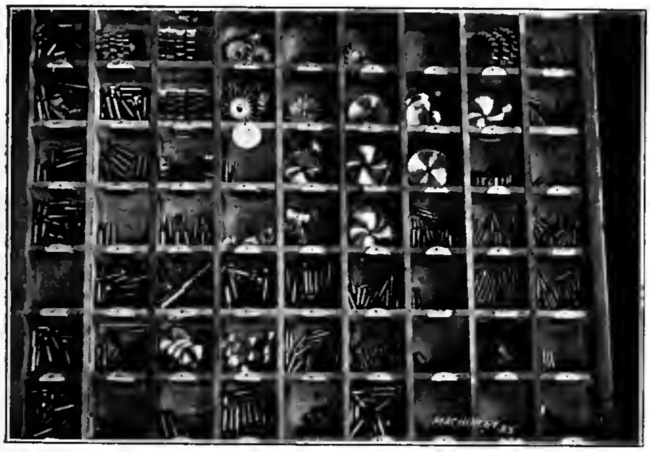
Fig. 22. Drawer Filled with Miscellaneous Tools used in Watch Construction

Making Sub-presses of the Piston Type

As the punchings turned out in this factory are all small, the largest being one ounce in weight and the smallest running 16,000 to the ounce, it is obvious that the separate punch and die system cannot be used, so all punches and dies are mounted in sub-presses of the piston type, of which there are over 800 in use. The making of a sub-press as carried through in Mr. Dockson's department, is quite an interesting process from start to finish. The casting for the upper part or body of the sub-press is first put in a lathe with the rough barrel in the chuck, the bottom faced off and the bottom or base hole bored out, as shown at *A*, Fig. 16. The body is next strapped, barrel outward, onto a face-plate, and centered by a plug which is usually a piece of brass driven into the center hole of the lathe spindle, and then turned to fit the base hole in the casting. The barrel is now turned on the outside and bored taper inside, the outer end or top being the largest. Three or four (usually three) grooves are next cut in the bore as shown at *B*, the piece is then removed from the face-plate when it is ready for the next operation, which is casting the babbitt. In performing this operation, the sub-press body is placed on the special base *C*, which just fits the bored hole in the bottom of the body. The piston *E* is then slipped into place, and is held central with the bore of the barrel by holes in the center of the special base *C* and in the cap *D*, which is next put on. It should be stated here that in actual use the special base *C* fits up into the body so that its top covers the bottom of the bored barrel in order to keep the melted babbitt where it is wanted, the base and body being held tightly together during the casting process, by two C-clamps. In taking the picture, the body was purposely set up as shown in order to give a better view of the positions of the piston and the way it is held. The piston *E* has been previously ground perfectly true from end to end and has had three grooves cut in it lengthwise. It is also well smoked before it is put into the casting jig. The babbitt, which is made up of tin, antimony and a large percentage of copper, is now poured around the piston through the opening *F* in the cap *D*. Just as soon as possible, the whole thing is cooled off in water—the sooner the better. The piston is now pressed out—and this is one of the hardest jobs of the series, for it takes a husky man at each end of an 8-foot lever on a powerful screw press, to start it. After being removed, the piston is carefully lapped with a copper ring-lap and emery, and the grooves are also lapped until the piston can be worked in and out of the barrel with some degree of ease. A collar like the one shown at *G* is next fitted on so as to hold the babbitt firmly in place, for while the taper bore of the barrel prevents the babbitt from going down, it does not keep it from being pulled up. The body and piston are then put into a punch-press and "pumped" at a good rate of speed for some time in order to wear them in, the "spots" on the babbitt being carefully scraped from time to time. When worn in a sufficient amount, the piston is removed and carefully re-centered in a lathe, a bored ring being used to hold it. The piston is again replaced in the barrel, put between centers, and the bottom and bored hole of the body carefully trued up. In this way any untruth that may have crept in is corrected and the outside of the

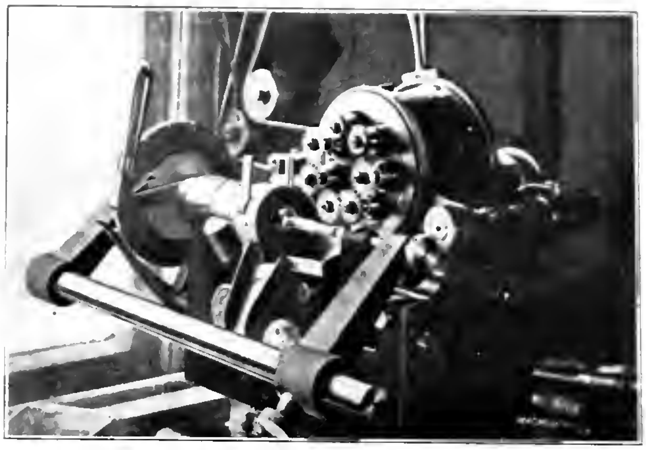
Fig. 23. Machine for Milling Steel Escape Wheels

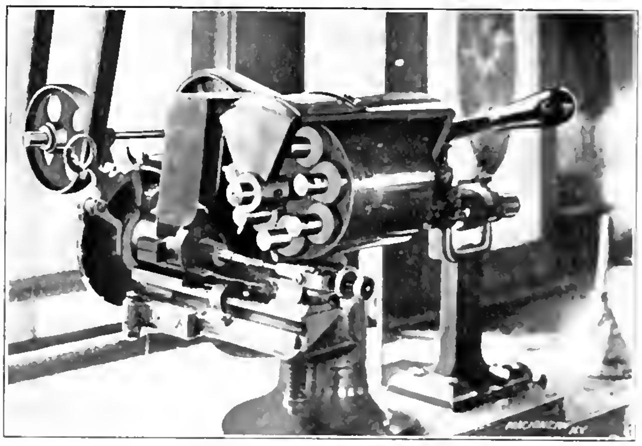
Fig. 24. Machine for Milling Brass Escape Wheels

piston its centers and the bore of the bottom of the body are made absolutely concentric. The base *H* of the sub-press is next fitted, doweled and fastened to the body by two fillister head screws. The bottom of the base is then trued up by taking a light cut over it, using the piston as a mandrel.

The idea of making the bore of the barrel of the sub-press taper, is not simply to keep the babbitt from dropping down, as a shoulder would answer for that; but the main reason is that if the piston becomes loose from wear at any time, the babbitt, which has been left high on top, as shown at *K*, can be forced downward by using a ring and a powerful press, thus taking up the wear. The retaining ring on the top of the barrel is not powerful enough to do this, as it is only intended to keep the babbitt from coming out, as stated.

The way the punches and dies are set into the sub-presses is shown in Fig. 20. In making the piston *B* a recess is bored in the end into which the punch *A* is fitted and fastened by a dowel-pin and screws. The center *E* of the piston is set in far enough so that the punch will not mar or distort it, should it be desired to put the piston between centers. In the lower part of the engraving, *F* is the die, *G* the sub-press base, *H* a dowel in the die, *I* one of the screws used to hold the die in place, *K* dowels that locate the body onto the base, *L* holes for the screws which hold the body and base together, and *M* recesses for the ends of the straps used to strap the sub-press to the bed-plate of the punch press.

Fig. 25. Screw-head Polishing Machine

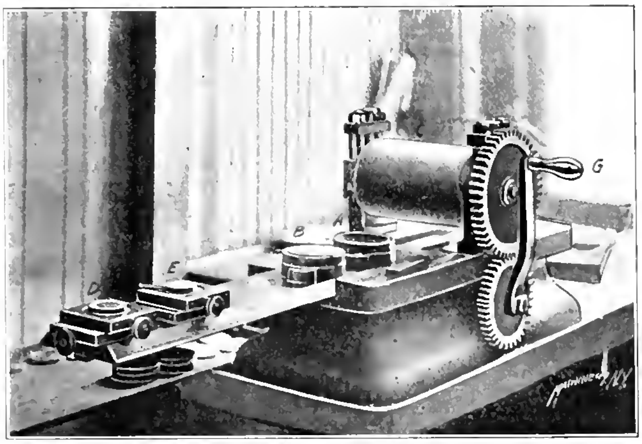

Fig 27. Machine for Figuring Watch Dials

As a general rule, in fitting a punch and die into a sub-press, the master punch is fitted into the piston as explained, and a die blank, the top of which is tinned with solder, is fitted into the base. The punch is then brought down and an impression of the outline made in the solder. The die blank is then removed and drilled out as close to the lines of the impression as it is safe to do, after which the die is slowly and carefully worked out and finished with the master punch as a guide.

Sub-presses of the type just described can be set up in a punch-press in a very short time, and the speed at which work is run through them is marvelous. In Fig. 17 is shown a pile of 33,000, number 18 size steel yokes, which were blanked out in 8 hours, and in Fig. 18 is a pile of 35,000 brass center wheels which were also cut in an 8-hour day. Some of the parts are blanked out at an average speed of over 120 a minute. As a rule it is intended to keep about 65,000 wheels of each kind in stock, ahead of the factory demand.

In the cutter making department the various tools are made in much the same way as in other tool rooms, only the machines used are much smaller. Fig. 19 shows how a small counterbore is milled. The blank, which has been turned up in a lathe, is placed in the upright chuck, as shown at *A*. The flat is milled on one side with the mill *B*, the blank is indexed half a turn and the other flat milled. Cutter *C*, which has teeth on the end only, is then used to mill the clearance on the cutting edges. Small saws are held on an expanding stub mandrel and ground by feeding a cup wheel, set at a slight angle to give clearance, straight in against them, as shown in Fig. 21. Fig. 22 is a drawer full of cutters of all kinds made in this department.

Fig. 26. Machine for Damaskeening the Works

Outside of the toolmaking departments the factory has many interesting tools and devices, only a few of which can find space in this article.

Fig. 23 shows the machine used for cutting the teeth in steel escape wheels, seven cutters being used on each tooth, and Fig. 24 is the machine used on brass escape wheels, fly cutters being used instead of milling cutters as in the previous machine.

Fig. 28. Case in which Finished Watch Parts are Stored

Small screw heads are polished by placing the threaded end in the split chucks of the machine shown in Fig. 25 and then holding a fine stone against the revolving head of the screw. The fancy spotting or birdeye ornamenting of the watch plates is done with the machine shown in Fig. 26.

Fig. 32 shows the profiling machine used for cutting out the irregular recesses in the watch plates.

Minute pinions are fastened to their staffs with the little trip hammer shown in Fig. 33, which rivets over a cup-shaped part of the staff onto the pinion.

A Transferring Machine

The figures and graduations are put on the enameled watch dials in the machine shown in Fig. 27. *A* and *E* are steel plates into which the figures and graduations have been cut;

B and *D* are dial holders and *C* is a rubber roll. Special "paint" is smeared over plates *A* and *E* and then scraped off with a thin steel knife, leaving the engraved places full. Dials are now placed at *B* and *D* and the handle *G* is turned so as to run the table under the roller. As *A* and *E* pass under, paint is left on the rubber from which it is transferred to the dials. For putting special names on dials, the press shown in Fig. 34 is used, though the process is very similar. *A* is the engraved plate, *B* the dial, and *C* a rubber pad. In using this press *A* is painted as before, swung under the rubber pad, and the pad brought down on it, receiving the lettering. It is then lifted, the dial swung under and the paint transferred to it.

All small finished watch parts are stored in glass stoppered bottles arranged in cases, as shown in Fig. 28, and in this way they are kept free from moisture and at the same time are easily accessible.

* * *

A convenient rule-of-thumb for ascertaining approximately the size of engine required to drive a direct-current dynamo is given in *Power*. To find the brake horse-power required, multiply the kilowatts of output by 1.7 for small machines, 1.6 for medium sizes, and 1.5 for dynamos of 500 kilowatts and over.

Fig. 29 Case of Watch Plate Boring Quills, Split Chucks, and Fine Caliper Gages

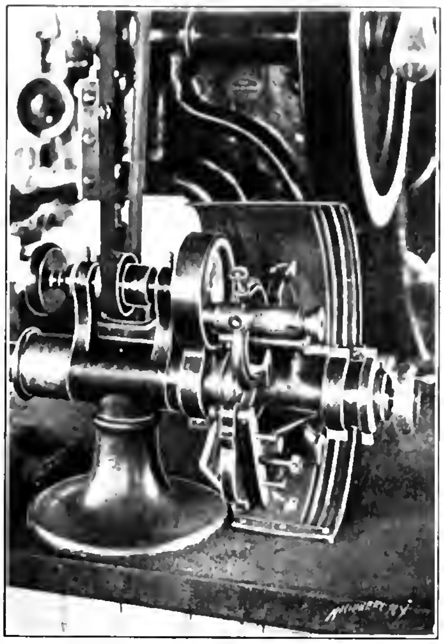

Fig. 30. Special Three-head Punch and Die Grinding Machine

Fig. 31. Punch Press with Worm Gear Adjustment

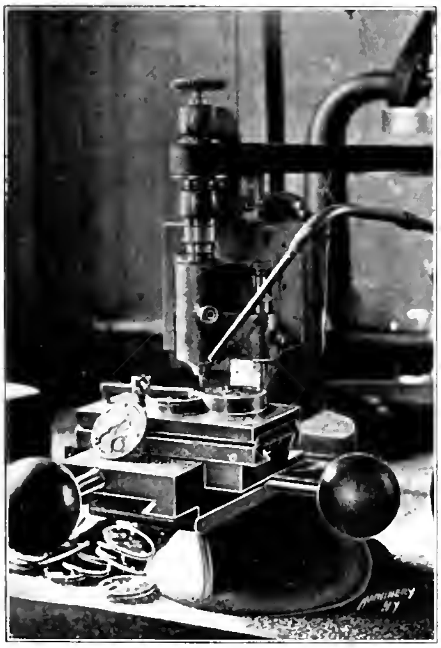

Fig. 32. Profiling Machine used for Recessing Watch Plates

Fig. 33. Miniature Trip Hammer used for Fastening Minute Pinions to their Staffs

Fig. 34 Press used for Stamping Special Names on the Dials

SOME THOUGHTS ON MACHINE TOOL DESIGN*

FORREST E. CARDULLO†

There is probably no branch of machine design in which greater changes have taken place in recent years than that of the design of machine tools. The greater part of these changes are without doubt due to the work of Mr. Fred W. Taylor, the discoverer of high-speed steel, who has more thoroughly investigated the capabilities and possible performances of metal cutting tools than any other man the world has ever known. The writer had occasion some time ago to study carefully Mr. Taylor's paper "On the Art of Cutting Metals" in the course of his lecture work on machine tool design at Syracuse University. His study of this paper, together with his own experience in machine tool design and operation, has brought the writer to certain conclusions in regard to some points in machine tool design which will be

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* For previous articles on machine tool design and kindred subjects see: Designing of Machine Frames, August, 1908; Simplicity of Machine Tool Design, August, 1908; Tumbler Gear Design, December, 1907; Faults of Iron Castings, October, 1907, and November, 1907; Unit System of Machine Tool Design, November, 1907; Feeds and Feed Mechanisms, August, 1907; Design of Bearings, December, 1906, and January, 1907, and February, 1907; Choice of a Factor of Safety for a Machine Member, January, 1906; Machine Tool Drives, October, 1906.

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of interest and value not only to those who may themselves design and build such tools, but also to everyone who has to purchase or use them.

Ratio of Speed Changes

The first point to which the writer would call attention is the necessity of a sufficient number of speed changes. Those who have read Mr. Taylor's paper will remember that he shows that there is a definite relation between the cutting speed and the length of time which a tool will last without regrinding. Should the machine be run at too high a speed, the tool will last but a short time before it will have to be reground. Should it be run at too low a speed, less work, of course, will be done, although the tool will last a comparatively long time. Somewhere there is a golden mean at which the cost of machining plus the cost of tool dressing is a minimum, and theoretically our machine should always be run at that speed. Or course, in handling materials of varying grades of hardness, and, in the case of lathes and boring mills, of varying diameters, this would necessitate a very great number of speed changes. If the number of speed changes be limited, it is apparent that the machine cannot always be working at the point of maximum efficiency. The speed of cutting which gives the maximum efficiency is shown in Mr. Taylor's paper to be that speed which will destroy the tool in from 50 minutes in the case of $\frac{5}{8}$-inch × 1-inch roughing tool, to 1 hour and 50 minutes in the case of a 2-inch × 3-inch roughing tool. These times are of course only approximations and will vary somewhat with the cost of steel and labor and the value of the machine in which the tool is used. If the machine be slowed down from this proper speed, the cost of machining will slowly increase, but if the machine be speeded up above this proper speed, the cost of machining will increase very rapidly. In his paper Mr. Taylor gives a diagram wherein it is shown that if the machine be slowed down so that the duration of the cut is increased from 50 minutes to about 4 hours and 40 minutes, the machine is then working at about 90 per cent of its former efficiency. If the machine be speeded up until the duration of the cut is decreased to about 15 minutes, the machine will again be working at about 90 per cent efficiency. This range of speed is shown by Mr. Taylor's equations to be in the ratio of $\sqrt[8]{15}$ to $\sqrt[8]{280}$ or of 1 to 1.45. Consequently, if we have a machine having several speeds with the constant ratio of 1.45 between the successive speeds, we know that such a machine may always be made to operate within 90 per cent of its maximum efficiency, and that on the average it will operate at more than 95 per cent of its best efficiency.

The following table, which is derived in the manner indicated from the diagram given in Mr. Taylor's paper, shows the speed ratios corresponding to the given average and minimum efficiencies of working:

Ratio	Average Efficiency	Minimum Efficiency
1.1	99.6 + per cent	99.2 per cent
1.2	98.7 + per cent	97.3 per cent
1.3	97.3 + per cent	94.5 per cent
1.4	95.6 + per cent	91.2 per cent
1.5	93.5 + per cent	87.0 per cent
1.6	90.6 + per cent	81.2 per cent
1.7	86.5 + per cent	73.0 per cent

From the table it will appear that even in the case of very costly machines it is of no particular advantage to reduce the ratio between successive speeds unduly. For instance, by doubling the number of speeds and reducing the speed ratio from 1.2 to 1.1, we will increase the average efficiency of the machine only about 1 per cent. It is very doubtful if the accidental variations in shop conditions would not be so great that the gain in practical work would be nothing, since the workman or the speed boss, as the case might be, would be unable to decide which of two or three speeds would be the best. The writer is therefore of the opinion that there is absolutely no practical advantage in reducing the speed ratio below 1.2 and that in the case of machines of ordinary type and cost, a ratio of 1.3 is as small as is advisable. In the case of a speed ratio of 1.3, the machine can always be made to operate at such a speed that the efficiency of working will be above 94.5 per cent and in the average case the efficiency will exceed 97.5 per cent. The 2.5 per cent loss of efficiency so caused is inappreciable as compared with other sources of loss, and it is exceedingly doubtful if the added cost of additional speed changes would not more than compensate for the possible 1 or 2 per cent of gain, entirely aside from the question of whether the extra speed changes would permit this theoretical gain to be realized.

The writer is also of the opinion that a speed ratio of more than 1.5 in the case of expensive machinery operated by highly skilled help, or of 1.7 in the case of cheap machinery operated by comparatively unskilled help is unadvisable. It will be seen that with a speed ratio of 1.5 the average efficiency of working is somewhat greater than 93.5 per cent, making the loss of efficiency in the average case about 6 per cent. It will be seen that when the rent of the tool plus the wages of a mechanic amounts to $4 a day or upward, this 6 per cent of loss means a money loss of $0.25 or more per day, or upward of $75 a year. Of course an increase in the number of speed changes and reduction of ratio would not save all this loss, but assuming that it would save half of it, and further, that the machine is operating only half the time, it is evident that we can afford to spend $150 or $200 for the extra speed changes necessary in order to bring the speed ratio down to 1.3. In the case of ratio of 1.7, the loss is 12 or 13 per cent instead of only 6 per cent, and these figures apply with greatly added force.

We are thus compelled to the conclusion that the useful range of the speed ratio in machine tool work is very narrow, ranging from 1.3 to 1.5 in ordinary cases and that a range of from 1.2 to 1.7 includes the very extremes of rational practice.

Need of Speed Changes being Easily Made

A second point in connection with the matter of the speed changes of machine tools which is of great importance is that these changes should be easily and quickly made so that the operative will have every incentive to use the proper speed. This is a matter of less importance in the case of planers than in the case of lathes and boring mills, since a planer requires a change of speed only when the character of the material which is being cut is changed, while the lathe requires a change when any great change is made in the diameter of the work operated upon.

In this respect a motor-driven tool may have a distinct advantage over a belt-driven tool. The controller furnishes a ready means for varying the speed while the shifting of a belt from pulley to pulley is not always readily accomplished, and most machinists would much rather take two cuts of differing diameters on the back-gear than shift the belt from the small to the large pulley and throw out the back-gear in order to obtain the faster speed from the open belt. This is particularly the case when the cuts are of small duration, so that the shifting would be frequent.

It will be evident to the thoughtful mechanic that it is of great advantage to have the speed-changing mechanism so constructed that the change may be made without stopping the machine. In the case of large machines it will be of great advantage to be able to effect the speed change from the operating station, which for instance in the case of a long lathe will be the carriage. To the writer's mind the particular advantage of these refinements which he suggests, and which will be found embodied in many of the designs of our best tool makers, lies not in the fact that the time required to make the necessary speed changes is shortened, but in the fact that the workman finds it just as easy to run his machine at the proper speed as at an improper one.

Ratio of Feed Changes

A matter of even greater importance than a proper series of easily-made speed changes is a proper series of easily-made feed changes. A change of speed does not mean in general a correspondingly great change in the efficiency of operation of a machine tool, but a change in feed does. Mr. Taylor points out in his paper that in general the best results in quantity of metal removed per hour are obtained when the cross section of the chip is a maximum, even though this entails a comparatively low speed. Therefore it is of importance that the machinist be able to take the heaviest cut which the nature of his work and the power and stiffness of his machine will permit. Just as the best results in the

matter of cutting speeds are obtained when the successive speeds run in geometric ratio, so the best results in the matter of feed adjustment are obtained when the successive feeds run in geometric ratio, unless the number of obtainable feeds is so great that the entire range is closely covered. For instance, a lathe equipped with the following feeds, 0.05, 0.10, 0.15, 0.20, 0.25, is distinctly inferior in productive capacity to a lathe having the same number of feeds arranged geometrically as follows, 0.05, 0.074, 0.111, 0.166, 0.25, wherein each feed is 50 per cent greater than the preceding one.

In general the best work is obtained from a machine tool when the depth of cut is made such that the total depth of metal to be cut away is removed with one or two cuts. Such being the case the depth of cut is practically fixed and not within the control of the operator, leaving the feed and speed as the variables which he must adjust. It is important therefore that the operator be able to take a cut as heavy as the nature of the work or of the tool will permit. Mr. Taylor's paper shows that the speed of cutting is approximately inversely proportional to the square root of the feed. It needs therefore only a very elementary knowledge of mathematics to see that if the feed must be reduced to say 80 per cent of its maximum value, the output of the lathe will be only about 90 per cent of its maximum value. Or in general, if the feed be reduced from its maximum possible value by any given per cent, then the output of the machine will be reduced from its corresponding maximum value by about one-half of that per cent. We may by means of this principle compute the ratio between successive feeds which will give us any required average value for the efficiency of operation of the machine. The values so found are tabulated below:

Efficiency	Ratio	Efficiency	Ratio
98 per cent	1.08	90 per cent	1.66
96 " "	1.18	88 " "	1.92
94 " ".	1.32	86 " "	2.27
92 " "	1.46		

An inspection of the table shows that when the ratio between successive feeds is about 1.1, the average efficiency of operation of the machine may be practically perfect, and that with any considerable increase of this ratio the efficiency drops off. It is the opinion of the writer that the ratio between successive feeds should always be less than 1.3 and that, more especially in the case of expensive machinery, a value of 1.2 or less is preferable.

Convenience of Feed-changing Mechanism More Important than that of Speed Changing

It has already been pointed out that the speed-changing mechanism should be of such a character that the speed changes may be easily and quickly made. In the same way it is of even greater importance that the feed changes may be easily and quickly made. In most small lathes which are now on the market quick-change gears are fitted to the screw-cutting mechanism, which are equally available as quick-change gears for the feed mechanism.[*] In most shops small lathes are not used very much of the time for screw-cutting, and in fact nine lathes out of ten are never used for that purpose, but a quick-change gear mechanism is of much greater importance when used for the purpose of obtaining feed changes than when used for the purpose of obtaining thread changes. In the average case the operator will not have to touch the thread-cutting gear once a week, while it may be advisable to change the feed every five minutes. In the case of large lathes it is advisable to have the feed changes, not in the headstock, but in the apron in order that the workman may be encouraged to use a proper feed whenever possible.

Unlike lathes, planers are generally equipped with ratchet feeds. The successive values of the feed changes in the case of a rachet feed will necessarily run in an arithmetical and not a geometric series, the successive feeds differing by some constant decimal of an inch. So long as the amount by which the successive feeds differ is small, and the range of feeds given by the mechanism is large, a ratchet feed is perfectly satisfactory. Many boring mills are fitted with a feed mechanism driven by a friction wheel of the type generally known as a brush wheel, the driving mechanism consisting of a steel disk of 12 to 16 inches in diameter geared to the table and against the face of which a much smaller wheel edged with leather is pressed. It is obvious that if the steel disk rotate at a constant speed, the speed of the driven wheel and consequently the amount of the feed may be varied by adjusting its position. When it presses the disk near its center it will revolve slowly. When it presses the disk near its edge, it will revolve at comparatively high speed. This feed mechanism has the advantage that it gives an infinite number of feed changes over a wide range, but has the disadvantage that it is not positive in its action, and lacks sufficient power for certain kinds of work. On the whole, the best feed driving mechanism is a nest of gears so arranged that any feed within the entire range may be had by the simple shifting of one or two levers.

Strength of the Feed Mechanism

In that part of his paper discussing the force required to feed the tool of a lathe or boring mill, Mr. Taylor makes the assertion that the feed mechanism should have sufficient strength to "deliver at the nose of the tool a feeding pressure equal to the entire driving pressure of the chip upon the lip surface of the tool." This would lead to the designing of a lathe or boring mill having feed gearing of equal strength with its driving mechanism. In the case of planers and other machines wherein the tool is moved at a time when it is not cutting, these statements do not apply. It is not generally the custom among machine tool builders to design machines having such strong feed works as Mr. Taylor's ideas call for, and the writer sees no reason why such strength is necessary. The amount of force required to traverse a tool in a lathe is not proportional to the width of feed, and while it may be true for fine feeds that in the case of dull tools the traversing pressure may be equal to, or greater than the downward pressure upon the tool, this is not necessarily the case with heavy feeds. As the width of the feed is increased, the downward pressure will increase almost in proportion, while the traversing pressure will increase comparatively little, so that when the lathe is taking the maximum cut which the driving mechanism is capable of handling, the pressure required to feed the tool into the work, even though it be very dull, is much less than the downward pressure. It is the writer's opinion that a feed mechanism designed to have one-half the strength of the driving mechanism is ample for large tools, while for small tools in which of course the feed will be finer, a strength of two-thirds of the driving mechanism might be preferable.

Feed Mechanism should have "Breaking Piece"

The feed mechanism should be provided with a breaking piece whose strength will be less than that of the rest of the mechanism and which may be cheaply and easily replaced. The office of this piece is to prevent the breaking of the more costly and less easily replaced parts of the mechanism, exactly as the fuse in an electric circuit prevents the destruction of any other part of the circuit. Two forms of breaking piece sometimes used for such service are, first, a soft steel pin, driven through a shaft and hub of harder steel, which shears off when the strain becomes too great; and second, a short section of shaft turned down at its center, which twists off under similar circumstances. A breaking piece must be of such a character that it will not spoil any of the rest of the mechanism when it breaks, and should not cost more than a few cents, and should be as easily removed and replaced as a common change gear.

It must not be imagined that a feed gearing designed to have one-half the strength of the driving gear will not be strong enough to meet Mr. Taylor's requirements in all likely cases. If a tool be designed to take a maximum cut of ¾ inch by ⅛ inch, it is not likely that much of its work will be done with such a heavy cut. If both driving and feed gearing be designed with a proper factor of safety, there is ample margin of strength for all usual conditions, while a breaking piece is the best provision against extraordinary stresses.

Pressure on Lip Surface of Tool and its Relation to Design

The pressure upon the lip surface of the tool is required in order that the designer may know, first, the strength required of the driving mechanism and frame of a machine; second,

the power required by the machine; and third, the strength required for the feed mechanism. The two materials upon which the vast majority of machine tools are called to operate are cast iron and steel. Taking first the case of cast iron, we find from Mr. Taylor's paper that the pressure upon the lip surface of the tool varies from 75,000 to 150,000 pounds per square inch of chip section in the case of soft iron, and from 120,000 to 225,000 pounds in the case of hard cast iron. The finer the feed, the greater the pressure per square inch upon the lip surface of the tool. Thus with an ⅛-inch depth of cut and 1/64-inch feed, the pressure on the tool is about 289 pounds, or 146,000 pounds per square inch. With the same depth of cut and ⅛-inch feed, the pressure on the tool is 1,358 pounds, or only about 86,900 pounds per square inch of chip section. Both these figures are given for soft cast iron. Mr. Taylor gives formulas for the total pressure of the work upon the lip surface of the tool, but the following table will be found more convenient for obtaining the required values, although the figures given are of course only approximations:

Feed, Inches	Pressure per Square Inch	
	Soft Cast Iron	Hard Cast Iron
1/64	140,000	220,000
1/32	120,000	190,000
1/16	100,000	160,000
1/8	85,000	135,000

In the case of soft and medium steels we find that the pressure in pounds per square inch of chip section runs from 250,000 to 300,000 pounds, being greater in the case of the finer feeds. In the case of special steels which combine high tensile strength and great elongation, it is probable that these figures would be very much exceeded. The amount of the feed and depth of cut will depend on the kind of work which is to be machined. In the case of small castings 3/16 inch is an ample allowance for depth of cut and ⅛ inch would be much more usual. In the case of very large and heavy castings the depth of cut required might run up ½ inch, and in the case of large "meaty" forgings, it may be even greater than this at some places. In those cases where the area of chip section is not fixed by the work, as in the case of stocky forgings and castings, the greatest width of feed is limited by the strength of the machine itself, which in turn is limited only by the length of the purchaser's purse. I presume it would be possible to build a boring mill or a planer capable of taking a cut an inch deep with an inch feed if anyone wished to pay for such a machine, but whether it could do the average line of work as economically as a machine taking ⅜-inch cut with ⅛-inch width feed is another matter. While there is no settled rule either for the maximum depth of cut or width of feed for any particular type of machine, the matter of the size of tool used is generally definitely known. In the case of forged roughing tools the maximum chip section will be from 2 to 3 per cent of the area of the section of the tool shank. For instance, the heaviest cut which a tool forged from 1-inch by 1½-inch stock will be called upon to take will be ¼ inch by ⅛ inch, or perhaps a trifle greater. In the case of tools ground from bar stock and held in tool-holders, the section of the chip may run up as high as 5 per cent of the section of the bar. Knowing the size of tool for which the tool-holders are designed, we may proportion our machine accordingly.

A matter which has great effect not only upon the quantity of work which a machine is capable of doing, but also upon its accuracy and length of useful life, is its stiffness. While it is true that if we know the maximum pressure upon the lip-surface of the tool we may design a machine for strength and have one which will probably never break in service, yet it is often better to add many times the quantity of metal which mere strength would call for, in order to have a machine with the maximum of stiffness. Stiffness in machine tool design has to do with two points, the first being the actual deflection of the metal of which it is composed under the stresses which come upon it in operation. The second is the play which invariably exists at all joints, more especially the slides of compound rests in lathes, and of saddles in boring mills and planers. The best remedy for actual deflection of metal is to use plenty of it, and to distribute it in such a way as to realize from it its maximum strength. The writer has found that an excellent method of designing such machine parts as require great stiffness is by comparison with existing tools whose operation is satisfactory. Let us assume for instance that we are to design the cross-rail of a planer. The rail is to be 8 feet between the housings and the overhang of the tool below the center of the rail is to be 30 inches. The cut is to be, let us say, ½ inch deep by ⅛ inch feed. Let us assume further that we have at our disposal a 4-foot planer, the overhang of whose cutting tool is 15 inches, and which will take in a satisfactory manner a cut ¼ inch deep by 1/16 inch feed. We now have sufficient data to satisfactorily design a cross-rail for the larger planer. If we assume that the deflection of the tool produced in the two cases should be identical in order to have the work equally satisfactory, we will find that the pressure upon the tool of the larger planer will be 4 times that upon the tool of the smaller; that both the bending and the twisting moments set up in the cross-rail will be 8 times as large, and that the distance over which these moments will operate to produce a deflection will be twice as great. Therefore, if the two rails had the same cross-section, the deflection of the tool of the larger machine would be 16 times that of the tool of the smaller. The stiffness of two bodies of similar section varies directly as the 4th power of the ratio of their homologous dimensions. Therefore, if we make the section of the rail of the larger machine similar in form to that of the rail of the smaller machine, each dimension twice as great as the corresponding dimension of the smaller rail, it will be 16 times as stiff and the deflections in the two cases will be identical. In case the rail of the smaller machine were not of the best form to resist the stresses which it must sustain, the form might be changed, the designer using his best judgment as to what effect such change might have upon its stiffness.

Cause of Vibration

Excessive vibration in machine tools is frequently due to the fact that the pressure upon the lip surface of the tool is not uniform and that the rapid but regular variations in this pressure coincide with the natural period of vibration of some part of the machine. Machines should be built so that the natural period of vibration of every part is very much higher than the period of these rhythmic variations in pressure. The fact that a machine tool of a certain design operated satisfactorily and without appreciable chattering with the old-fashioned carbon steels is no reason that it should operate equally well with high-speed steel since these variations will come very much more rapidly when high-speed steel is used. In order to make the natural period of a machine tool part higher, it is necessary that it be made compact and stocky. In other words, stiffness makes for a high vibration period. Hence, the advent of high-speed steel necessities the redesigning of many tools which were satisfactory with carbon steels. It is necessary that they be given increased weight and stockiness to prevent chattering, although their strength was already amply sufficient to provide for the cut which it is desired to take.

In designing for stiffness, it is, of course, essential that the number of joints between the work and the tool shall be a minimum; that these joints shall be so designed, if possible that wear shall not disturb the alignment of the mechanism; that they shall be provided with means for adjusting them when they become worn; that they shall be designed to wear uniformly; or, if this is not possible, they shall be so designed that they will wear very slowly. While we might dwell at length upon this matter of the design of joints and bearing surfaces, so much has been written upon it that a very few words may well suffice.

Importance of Protected Bearings

Joints and bearings in which the rubbing speed is high, naturally wear out the most quickly. If a bearing is copiously oiled, and dust and grit absolutely excluded from it, its life will be indefinite. The best form of oiling device for costly machine tools is probably a system of forced circulation, operated by a small pump, served from an amply-closed reservoir into which clean oil is returned by capillary drainage. The flooding of the bearings with clean oil will pre-

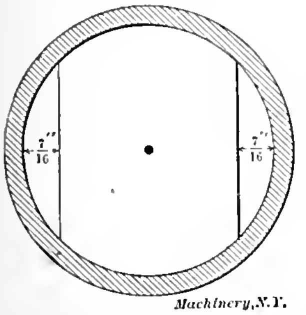
vent the entrance of grit, and absolutely prevent wear, by the prevention of metallic contact. Many bearings, particularly sliding bearings, cannot, of course, be treated in this manner, but fortunately such bearings have invariably a low speed of rubbing. Such bearings will be more durable if they are carefully scraped and fitted. They should, when possible, be so located that grit and chips will not fall upon them, or else be covered with sliding or telescoping sheet metal shields, for the same purpose. The great object to be sought is the prevention of grit on the wearing surfaces, and any scheme or appliance which accomplishes this purpose will help produce a tool which will be longer lived and more satisfactory in operation.

* * *

BADLY CHOKED EXHAUST PIPE

The illustration shows a cross-section of a badly choked exhaust pipe that was removed from an old steam engine that had been in service many years. The incident was described in the April number of *The Locomotive* as follows:

"A certain tannery in New England was fitted out, many years ago, with a small slide-valve engine, which was operated at a pressure of 70 or 80 pounds per square inch, and which proved to be adequate, until quite recently, to the wants of the plant. We do not recall the dimensions of the engine, except that the exhaust pipe was three inches in diameter, internally; nor do we know the exact date when the engine was installed. Inquiry elicited the fact, however, that no repairs had been made upon it within thirty-five years; and hence the state of affairs that we are about to describe had existed for that period, at least.



Cross-section of Exhaust Pipe Choked by Lathe False Center

"A short time ago the owners of the plant decided to throw out the old engine, and replace it with one of the Corliss type, capable of furnishing more power. Upon taking the old engine down it was discovered that the exhaust pipe was almost completely closed by means of a piece of cast iron, of the general appearance indicated by the lines shown in the accompanying sketch. On each side of the cast iron piece there was a segment-shaped space, 7/16 inch wide at its widest part; and the entire exhaust of the engine had to pass through these two openings for thirty-five years or more.

"Mechanics of the older school will see at once how the thing came about; but for the benefit of the youngsters it may be well to explain. In former years it was customary to thread all steam piping except the very smallest, by turning the threads upon it in a lathe. In order to secure the pipe properly in the lathe, it was necessary to provide a center-piece which would fit inside the end of the pipe, and in which a hole could be made, to receive the tail-center of the lathe. The center-piece was of course supposed to be removed, after the completion of the thread; but in the case now before us, this detail of the operation was forgotten, or at all events omitted, and the pipe was put in place, center-piece and all.

"The editor could use up a lot of space in trying to estimate the waste of coal that this forgotten center-piece has caused, and in comparing this loss with the cost of a good indicator; but he isn't going to. No indicator was ever applied to the engine; and we are not going to show the owners of the plant how big a mistake that omission was."

* * *

The annual prize of $5,000 instituted by King Leopold of Belgium in 1874, will, for the year 1911, be awarded for the best work in French, Flemish, English, German, Italian, Spanish or Portuguese on "The progress of aerial navigation, and the most effective means for its encouragement." The works submitted for competition must reach the Belgian Minister for Science and Art before March 1, 1911.

KNURLS AND KNURLING OPERATIONS—2

DOUGLAS T. HAMILTON*

In this second installment, which treats of speeds of knurling, number of revolutions, camming, etc., reference is made to Figs. 1, 6, 10, 11 and 12 and Table I, which appeared in the June number.

Speeds and Feeds for Knurling

When the knurl has been designed, the next thing to consider, before laying out the cams, is the speed and feed for knurling. This is a subject upon which very little has ever been published. As a general rule, a knurl can be worked at the same speed as the circular form and cut-off tools. It is good practice to feed the knurl gradually to the center of the work, starting to feed where the knurl touches the work as is shown by the distance *c* in Fig. 12, and then to pass off the center of the work with a quick rise on the cam. The knurl should also dwell for a certain number of revolutions, depending on its pitch, and the nature of the material being worked upon. Some advocate the knurl being brought into position on the center of the work on the quick rise of the cam, and then being allowed to dwell for a certain number of revolutions; but the writer has found that this does not work satisfactorily, and cannot be depended upon. It might work when using a knurl which has a very fine pitch, on large stock, but under general conditions it will be found that gradually feeding the knurl to the center of the work will work better.

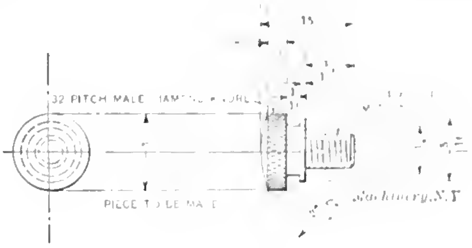


Fig. 13. Thumb-screw to be knurled

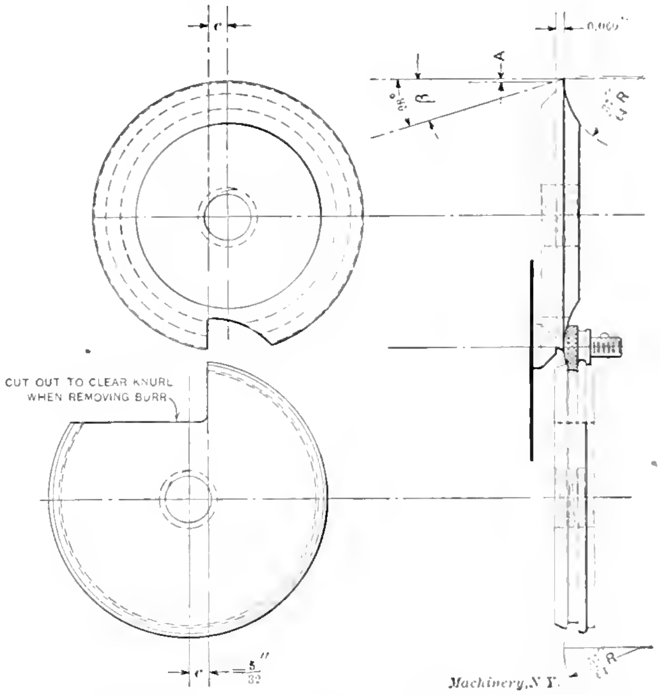


Fig. 14. Circular Forming and Cut-off Tools for Making Thumb-screw, Fig. 13

The feed required for a knurl is governed by the nature of the material being knurled, the diameter of the material, and the width and pitch of the knurl.

The surest and most practical way to find the feed required for a knurl on a certain kind of material is by experimenting. The writer has collected the results of different experiments and compiled them in Table II. This table covers practically all the different materials specified in this article, as the angle of the teeth in the knurls varies in accordance with the hardness of the material on which the knurl is used. In

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that case the feeds given in the table will be practically the same for all the materials previously specified. These feeds are only applicable when knurling from the cross-slide.

Under these conditions the depth of the tooth and the feed per revolution will govern the number of revolutions required to knurl. If in Fig. 12, R is the radius of the stock, d is the depth of the tooth, c is the distance the knurl travels at a given feed per revolution, and h equals $R-d$, then $c=\sqrt{R^2-(R-d)^2}$.

TABLE II. FEEDS FOR KNURLING

Diam. of Stock, Inches	Width of Knurl, Inches							
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2
	Feed per Revolution, Inches							
1/16	0.0010	0.0005	......	......	......	......	......	......
1/8	0.0011	0.0009	0.0005	......	......	......	......	......
3/16	0.0018	0.0012	0.0010	0.0005	......	......	......	......
1/4	0.0022	0.0016	0.0014	0.0010	0.0005	..	....	......
5/16	0.0026	0.0020	0.0018	0.0013	0.0010	0.0005		......
3/8	0.0030	0.0025	0.0022	0.0017	0.0015	0.0010	0.0005	......
7/16	0.0031	0.0029	0.0026	0.0021	0.0018	0.0015	0.0010	0.0005
1/2	0.0039	0.0032	0.0030	0.0025	0.0022	0.0020	0.0014	0.0008
9/16	0.0042	0.0036	0.0034	0.0029	0.0028	0.0024	0.0017	0.0012
5/8	0.0046	0.0040	0.0038	0.0033	0.0031	0.0028	0.0020	0.0016
11/16	0.0050	0.0045	0.0042	0.0037	0.0034	0.0031	0.0023	0.0020
3/4	0.0054	0.0049	0.0048	0.0041	0.0038	0.0034	0.0026	0.0023
13/16	0.0059	0.0052	0.0052	0.0045	0.0042	0.0037	0.0029	0.0026
7/8	0.0062	0.0058	0.0055	0.0049	0.0045	0.0040	0.0033	0.0029
15/16	0.0068	0.0062	0.0058	0.0052	0.0048	0.0042	0.0037	0.0032
1	0.0070	0.0065	0.0060	0.0055	0.0050	0.0045	0.0040	0.0035

TABLE III. DIMENSION A, FIG. 13, FOR DIFFERENT ANGLES OF CUT-OFF TOOLS

Thickness of Tool	β = 10 deg.		β = 15 deg.		β = 18 deg.		β = 20 deg.		β = 23 deg.	
	A	2 A	A	2 A	A	2 A	A	2 A	A	2 A
0.030	0.0052	0.0105	0.0080	0.0160	0.0097	0.0195	0.0109	0.0218	0.0127	0.0254
0.035	0.0061	0.0123	0.0093	0.0187	0.0113	0.0227	0.0127	0.0255	0.0148	0.0296
0.040	0.0070	0.0140	0.0107	0.0214	0.0130	0.0260	0.0145	0.0291	0.0169	0.0339
0.045	0.0079	0.0158	0.0120	0.0241	0.0146	0.0292	0.0163	0.0327	0.0190	0.0381
0.050	0.0088	0.0176	0.0134	0.0268	0.0162	0.0325	0.0182	0.0364	0.0212	0.0424
0.055	0.0096	0.0193	0.0147	0.0294	0.0178	0.0357	0.0200	0.0400	0.0233	0.0466
0.060	0.0105	0.0211	0.0160	0.0321	0.0195	0.0390	0.0218	0.0436	0.0254	0.0508
0.065	0.0114	0.0228	0.0174	0.0348	0.0211	0.0422	0.0236	0.0473	0.0275	0.0551
0.070	0.0123	0.0246	0.0187	0.0374	0.0227	0.0455	0.0254	0.0509	0.0296	0.0593
0.080	0.0140	0.0281	0.0214	0.0428	0.0260	0.0520	0.0291	0.0582	0.0339	0.0678
0.090	0.0158	0.0316	0.0241	0.0482	0.0292	0.0585	0.0327	0.0655	0.0381	0.0763
0.100	0.0176	0.0352	0.0268	0.0536	0.0325	0.0650	0.0364	0.0728	0.0424	0.0848
0.110	0.0193	0.0387	0.0294	0.0589	0.0357	0.0715	0.0400	0.0800	0.0466	0.0932
0.115	0.0202	0.0404	0.0308	0.0616	0.0373	0.0747	0.0418	0.0837	0.0487	0.0975
0.120	0.0211	0.0422	0.0321	0.0643	0.0390	0.0780	0.0436	0.0873	0.0508	0.1017
0.125	0.0220	0.0440	0.0335	0.0670	0.0406	0.0812	0.0455	0.0910	0.0530	0.1060

Let $R=0.125$ inch and $d=0.0164$ inch; then $h=0.1086$ inch. Therefore $c=\sqrt{0.125^2-0.1086^2}=0.062$ inch = rise required.

Revolutions Required to Knurl

Assume that it is required to find the number of revolutions to knurl a piece of gun screw iron, 1/4 inch in diameter, with a knurl 1/8 inch wide of 36 pitch. The included angle of the tooth for gun screw iron is 80 degrees. The circular pitch is 0.0277, and, referring to Table I, the depth of the tooth is 0.0164; the distance c, as worked out in the previous example, is 0.062 inch. Then, referring to Table II, the feed per revolution for a knurl 1/8 inch wide, knurling on 1/4-inch stock, is 0.0016 inch per revolution. Therefore, total

$$\text{revolutions required} = \frac{0.062}{0.0016} = 38.7 \text{ or, approximately, } 39$$

revolutions. In some cases the feeds given in Table II can be increased 50 per cent and still give good results.

Example of Knurling Operation

Let us now assume an example of a knurling operation on the No. 0 Brown & Sharpe automatic screw machine, and find the principal dimensions of the cam for performing same. A thumb-screw, as is shown at Fig. 13, is to be knurled with a 32-pitch knurl, 1/8 inch wide, using a cross-slide knurl-holder as shown in Fig. 1.

Total Rise on Cam

It is required to find the total rise on the cam to complete the knurling, and also to cut the finished piece from the bar. The total rise can be found by means of the following formulas, derived by the aid of the diagram in Fig. 15. This shows the knurl in position on the center of the work, and the circular cut-off tool is also shown in its relative position to the work and the knurl.

Let T = total rise on the cam,
N = rise required to knurl,
S = radius of stock to be cut off,
A = distance of bevel on cut-off tool as given in Table III,
C = total rise required to cut-off $S+0.010$ inch (to approach) $+\,0.005$ inch (to pass center of stock) $+\,A$,
E = distance from center of circular tool to edge as shown, when tool is cut down below the center,
a = radius of knurl to outside diameter,
b = radius of stock minus depth of tooth in knurl,
c = distance from cutting face to center of circular tool,
$h=a+b+c$,
X = distance from center of cut-off tool to center of knurl, when it is in position on the center of the stock,
R = radius of stock,
r = radius of knurl,
R_1 = radius of cut-off tool,
R_2 = radius of knurl holder shown in Fig. 1,
F = distance between the knurling and cut-off operations. Then

$$E=\sqrt{R_1^2-c^2};\ X=\sqrt{R_2^2-h^2};\ N=\sqrt{R^2-(R-d)^2}$$

(See Fig. 12).

$$F=X-(S+E),\quad T=N+F+C,$$

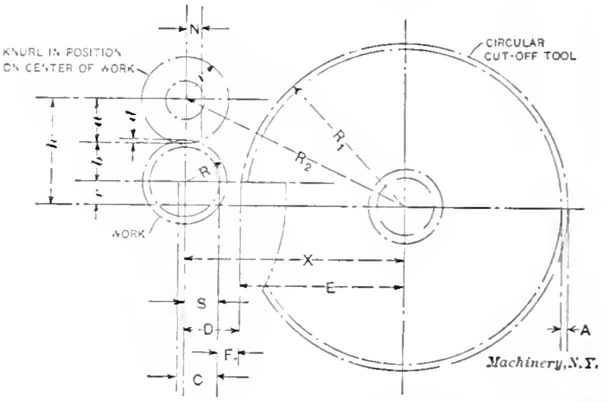


Fig. 15. Diagram for Finding Total Rise of Cam for Knurling Operation

For example, let it be required to design a set of cams to make the thumb screw shown in Fig. 13, the material being 3/8-inch round brass rod, and on which is cut a 32-pitch knurl. For the knurling operation we will use a cross-slide knurl-

CHART OF OPERATIONS AND LAYOUT OF CAMS

NAME *Knurled Thumb Screw*

MADE ON No. 0 B & S AUTO. SCREW MACHINE

MATERIAL USED. *3/8" Round Brass Rod*

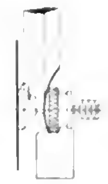
SPINDLE SPEEDS *1800* RPM FORWARD, *1800* RPM BACKWARD

1 PIECE *14* SECONDS, *2571* PIECES GROSS PRODUCT IN 10 HRS

No. *60* GEAR ON DRIVING SHAFT, ____ No. *28* GEAR ON WORM SHAFT.

No. ____ " " 1st STUD. No. ____ " " 2nd STUD.

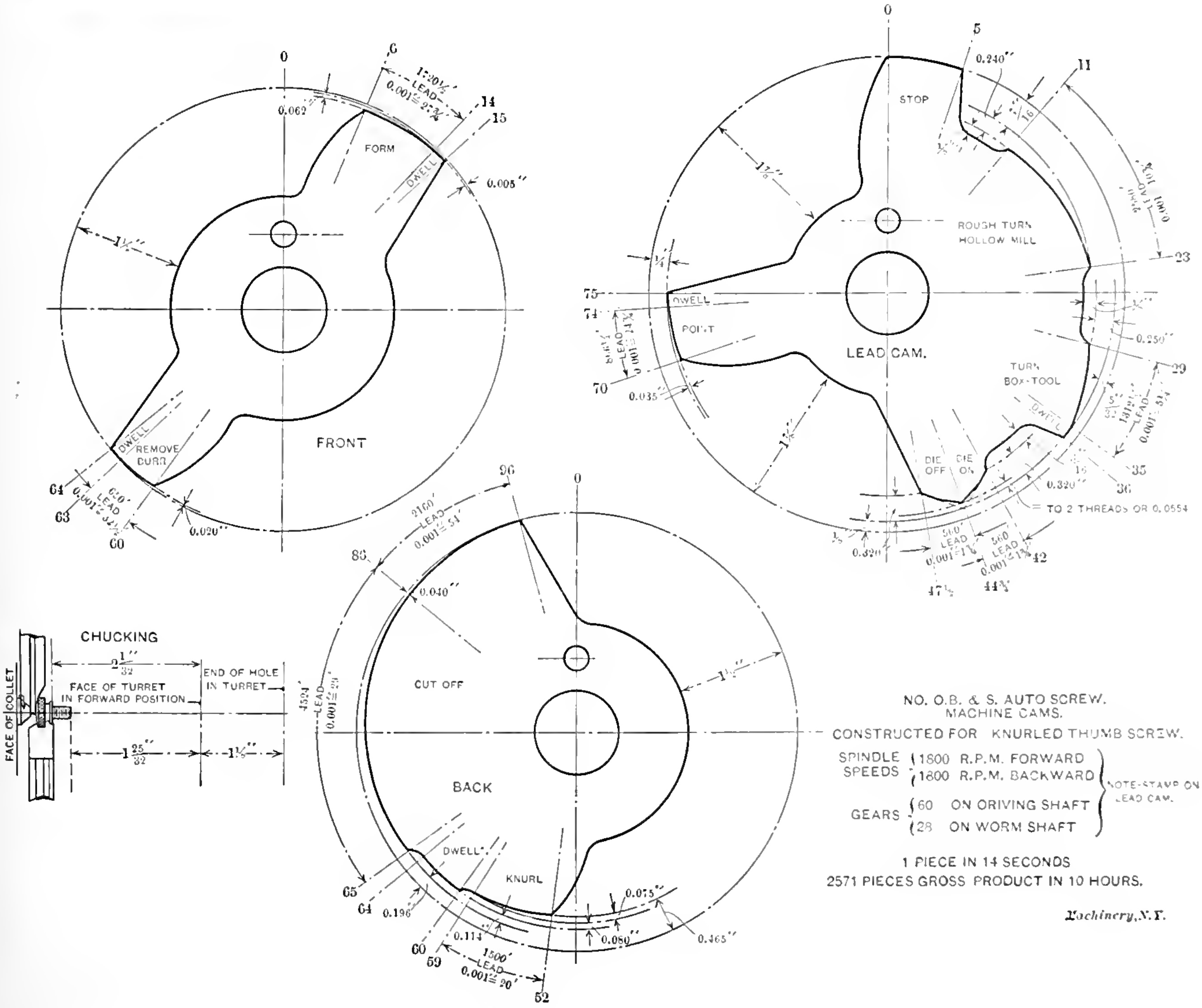
CHUCKING



DESIGNER'S INITIALS *D. T. H.*

DATE, *May 11, 1909*

DWG. No.	TOOL No.	REV.	TOTAL REVS. TO PRODUCE ONE PIECE.	HUND.	START	FINISH	RISE	FEED	OPERATIONS PERFORMED
		21.	420	5	0	5			Feed stock to stop and chuck
		25.2		6	5	11			Revolve turret
		50.4		12	11	23	0.240"	0.00476"	Rough turn (with hollow mill)
		37.8		9	6	15	0.062"	0.00184"	Form (dwell 0.01)
		25.2		6	23	29			Revolve turret
		29.4		7	29	36	0.250"	0.0099"	Finish turn (with Box-Tool; dwell 0.01)
		25.2		6	36	42			Revolve turret
		11.55		2¾	42	44¾	0.320"	0.164"x36 P	Die on } Reverse Spindle
		11.55		2¾	44¾	47½	0.320"	0.164"x36P	Die off } Reverse Spindle
		18.9		4½	47½	52			Clearance
		29.4		7	52	59	0.075"	0.00255"	Knurl on rise
		4.2		1	59	60			Dwell with knurl while removing burr and pass over Center; rise 0.080"
		16.8		4	60	64	0.020"	0.00158"	Remove burr (with form tool) dwell 0.01
		4.2		1	64	65	0.114"		Rise to cut-off
		21.		5	70	75	0.035"	0.00207"	Point Dwell 0.01 while cutting off
		88.2		21	65	86	0.156"	0.00175"	Start cut-off } Revolve Turret twice
		42.		10	86	96	0.040"	0.0009"	Finish cut-off } Revolve Turret twice
		16.8		4	96	100			Clearance
		CAMS. *Lead, Front, Back*							



NO. O.B. & S. AUTO SCREW.
MACHINE CAMS.
CONSTRUCTED FOR KNURLED THUMB SCREW.
SPINDLE SPEEDS { 1800 R.P.M. FORWARD
1800 R.P.M. BACKWARD }
GEARS { 60 ON DRIVING SHAFT
28 ON WORM SHAFT } NOTE-STAMP ON LEAD CAM.
1 PIECE IN 14 SECONDS
2571 PIECES GROSS PRODUCT IN 10 HOURS.

Machinery, N.Y.

Fig. 16. Cams used for Making Thumb-screw in Fig. 13

holder, as shown in Fig. 1. R is 0.1875 inch, r is 0.375 inch, R_1 is 1.125 inch, R_2 is 1.625 inch; d is 0.0156 inch, angle on cut-off tool is 23 degrees, and the width of the cut-off tool is 0.060 inch; then, referring to Table III, A is 0.0254 inch. The cut down below the center on the circular tool e is 5/32 inch. Then, $a = 0.375$; $b = 0.1875 - 0.0156 = 0.1719$; $c = 0.1562$; $h = 0.7031$.

$$P = \sqrt{(1.125^2 - 0.1562^2)} = 1.114,$$

$$V = \sqrt{(1.625^2 - 0.7031^2)} = 1.465,$$

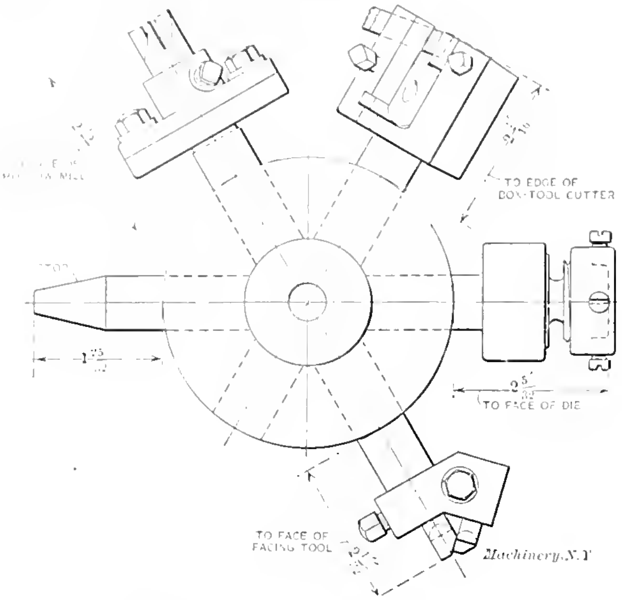


Fig. 17. Arrangement of Tools in the Turret

$$N = \sqrt{0.1875^2 - (0.1875 - 0.0156)^2} = 0.075,$$

$S = 0.1562$ inch, which is the radius of the shoulder left by the circular form-tool.

$C = 0.1562 + 0.010 + 0.005 + 0.0254 = 0.1966,$

$F = 1.465 - (0.1562 + 1.114) = 0.1948,$

$T = 0.075 + 0.1948 + 0.1966 = 0.4664$ inch, which is the total rise required on the cam, for the knurling and the cut-off operations.

Having determined the total rise required on the cam, we will consider briefly the other operations. The order of the various operations is given in the accompanying layout chart, and the position and type of tools used in the turret are shown in Fig. 17. As all the various operations are shown plainly on the chart very little explanation will be required.

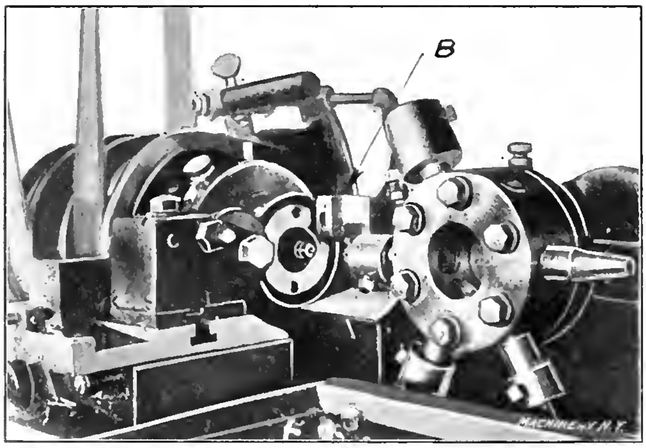


Fig. 18. Machine set up and ready for Making Thumb-nuts

Before starting to design the cams, the drawings of the tools suitable for performing the various operations are collected, using standard tools as much as possible. Then, after selecting the various tools, a lay-out of the circular form and cut-off tools, as shown at Fig. 14, is made. After having drawn the circular tools, and also laid out the turret operations as shown in Fig. 17, the order of the various operations is considered. Referring to the plan of operations shown in the chart, the work proceeds in the following order: Feed stock to stop and chuck, revolve turret, and rough turn with the hollow mill shown in Fig. 17; while the hollow mill is turning down the work, the circular form tool is brought in and forms the head; the form tool retreats so that it will clear the face of the hollow mill; then the turret is revolved and the finishing box-tool shown in Fig. 17 turns down the portion which is to be threaded. Now the turret is revolved and the die-holder is brought into position, and the work is threaded. By referring to Fig. 16, it will be seen that the highest portion of the lobe for the die is cut down equal to two threads, or 0.0554; this allows the die holder to draw out, and the spindle reverses on the tension of the spring (when a draw die-holder is used), which makes the die work easier, and does not crowd it on the work. After the die comes off the work, clearance is allowed between the knurling tool and the die holder, which should be ample so that the tools will not come in contact with each other. Then the knurl travels onto the work, and dwells for 0.01 of the circumference (which in this case is equal to 4.2 revolutions of the spindle), when on the center of the work. It is then forced off the work by the rise shown in Fig. 16, on the back cam. The circular form tool is now brought in again and removes the burr thrown up by the knurl; the form tool is cut away to clear the knurl. Finally, the back cross-slide travels in, and the circular cut-off tool shown in Fig. 14 starts to cut off the piece, but while the piece is being cut off, the pointing tool shown in Fig. 17 is brought in and removes the burr that has been thrown up by the die on the end of the screw; the piece is then severed from the bar, and clearance is allowed to let the cut-off tool return before the stock is fed out again.

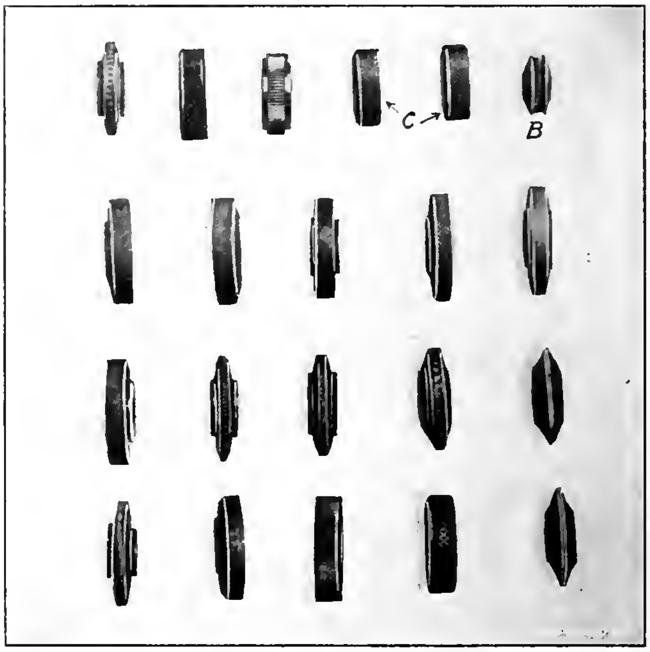


Fig. 19. A Collection of Knurls of Different Types

Cutting the Cams

After the blanks have been spaced off, they are roughed out by drilling a series of holes about 1/8 or 3/16 inch away from the finishing line or by punching, which is performed on an ordinary punch-press. Then the cam is put onto a circular milling attachment. A vertical milling attachment is used in connection with the circular attachment, and a mill of the required diameter, which depends on the size of the roll on the automatic screw machine, is used for cutting the cam. The circular attachment is graduated in degrees and minutes, and it is, therefore, necessary to find the number of minutes in the number of hundredths on the lobe of the cam to be milled.

The surface of the cam is divided into one hundred equal parts, and since there are 360 degrees in a circle, one-hundredth equals 3.6 degrees, or 3.6 × 60 = 216 minutes.

To find the number of minutes which is equal to 0.001 inch rise, divide the total number of minutes contained in the lobe by the total number of thousandths rise. When cutting the cam, the platen of the milling machine is moved till the cutter comes in contact with the edge or face of the cam; then the cutter is fed in 0.001 inch, and the circular attachment is turned the required number of minutes, which is equal to

0.001 inch rise. The milling operation is continued in this way until the lobe is completed. Milling the cam in this manner leaves a series of little steps, or rises, which can be removed with a file, and in this way a true surface is obtained.

In the half tone, Fig. 18, are shown, in position, the tools used in making a knurled thumb nut. The cross-slide knurling tool illustrated in Fig. 1 is shown at *B* in position on the back cross-slide. In Fig. 19 is shown a variety of knurls; at *B* is shown a concave knurl made by the method illustrated in Fig. 6, and at *C* is shown a pair of knurls which will produce a diamond knurl as shown in Fig. 11, when they are used in the knurl-holder shown in Fig. 10.

* * *

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—7

END CARRIAGES

R. B. BROWN

In order to calculate the strength of the end carriages, it is only necessary to find the maximum wheel pressure occurring when the crab and load are at the extreme end of the span. Take, for example, a 25-ton crane with a 5-ton crab,

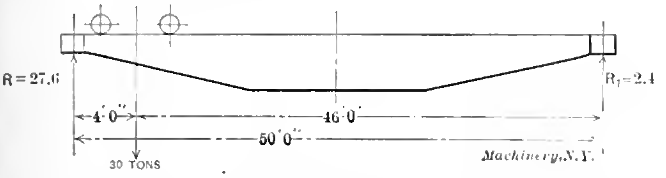


Fig. 44. Diagram for Calculating Wheel Preseure on End Carriages

where the minimum distance from center of load to center of track is 4 feet, as shown in Fig. 44.

The maximum reaction *R* from the traveling load will be $\frac{46 \times 30}{50} = 27.6$ tons, or 13.8 tons per wheel. Added to this is the wheel pressure due to the weight of girders, end carriages, etc., which is practically divided over the four wheels, and in the present case would be about 14 tons, or 3½ tons per wheel, making the total maximum wheel pressure $13.8 + 3.5 = 17.3$ tons.

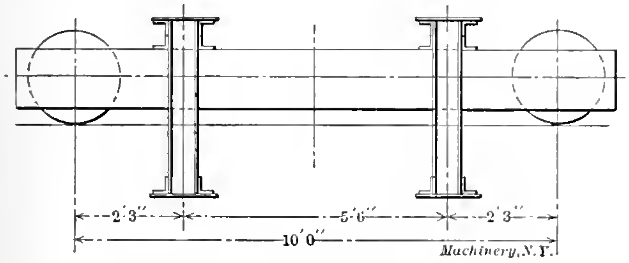


Fig. 45. Arrangement of End Carriegee of Crane shown in Outline in Fig. 44

It is also necessary to know the center distances of the main girders and of the traveling wheels. The former distance is decided by the requirements of the crab, which depend to a large extent on the height of lift, and consequent amount of rope which has to be coiled on the barrel. There is no economy in cramping this dimension, and it is always a convenience to be able to take a moderately long lift without altering the standard patterns. The centers of the traveling wheels should not be less than 1/5 of the span, for electric travelers, particularly those traveling at high speeds, this proportion having been found the most suitable to resist cross twisting.

In the example just given above, the end carriage would be arranged as shown in Fig. 45. It will readily be seen that the maximum bending moment occurs at the center of the main girders, where it is equal to the wheel pressure multiplied by the distance from the center of the traveling wheel to the center of the girders $= 17.3 \times 27 = 467.1$ inch-tons; stressing the material up to 5½ tons per square inch, giving a maximum factor of safety of 5, the modulus required would be $\frac{467.1}{5.5} = 85$.

Rolled steel channels can be used for cranes up to about 30 tons when reinforced with flange plates. When channels are not convenient, plate and angle sections are adopted, consisting of web plates and angles. Some makers substitute bracing for the webs between the girders, but it is doubtful whether any economy is effected by so doing.

The method of attaching the main girders is a detail of some importance, the various systems commonly in use being shown in Fig. 46. Type A forms a very neat connection and is particularly suited for cranes up to about 15 tons. The rail and top flange plate should be run across the top of the carriage as shown, and a substantial gusset ought to be fixed to the lower flange to stiffen the joint. The two sides of the end carriage are tied together by heavy diaphragms, as shown, and this arrangement to some extent ensures the outer member of the carriage taking some of the weight. The tendency for the inner members to take the full load is, however, one reason why this construction is often avoided for heavy cranes, in favor of the method shown as type B, which is the strongest and most satisfactory form for fixing the girders. It will generally be found in this design that the shallowest construction that can be employed at the ends of the girder is sufficiently strong to carry the whole load, even if it were concentrated at the extreme end of the girder, and this fact alone ensures both members of the end carriages getting an equal load, and at the same time does not encroach too much on the head room, for which reason the construction shown in type C is seldom adopted. The attachment illustrated in type D is strong and inexpensive, but occasionally has the fault of limiting the end travel of the crab.

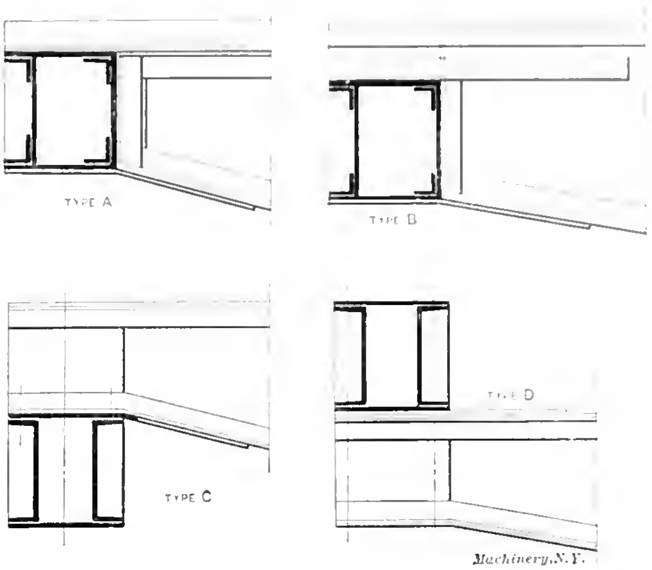


Fig. 46. Varioue Methode in Use for Attaching the Main Girders to the End Carriages

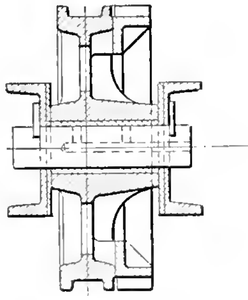


Fig. 47. Traveling Wheel with Bushing running Loose on Pin fixed to the Framing

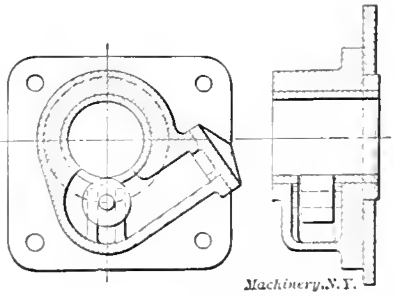


Fig. 48 Self-lubricating Axle Boxes for Crane Traveling Wheels

Wheels, Axles and Bearings

The most convenient sizes of traveling wheels taken from practice seem to be

18 inches diameter for cranes up to 4 tons.
21 inches diameter for cranes up to 7 tons.
24 inches diameter for cranes up to 25 tons.
30 inches diameter for cranes up to 25 tons and above.

The 18- and 21-inch wheels should be made of cast steel, in order to withstand the wear on the tread. The 24-inch wheels are sometimes made of cast steel also, but general practice inclines to steel-tired wheels for this and larger sizes.

The strains due to shrinking both in the tire and center appear to be very great, and it is for this reason that the centers are made heavy to avoid cracking. A very convenient position for the driving spur is to bolt it directly to the traveling wheel, and is a better arrangement than casting it on the center. Some makers key the wheel onto the axle, outside the carriage, so that it can be easily removed; this arrangement, however, rather interferes with a neat connection for the platform at the ends. When the spur is attached directly to the wheel, allowance should be made for the consequent unequal loading on the sides of the end carriages.

Some makers bush the traveling wheels and run them loose on pins fixed to the framing, as shown in Fig. 47. This method allows the wheels to be easily withdrawn for repairs, and simplifies the lubrication, which, however, should consist of grease instead of oil, owing to the fact that the latter is apt to run out when the bushes have worn slightly oval.

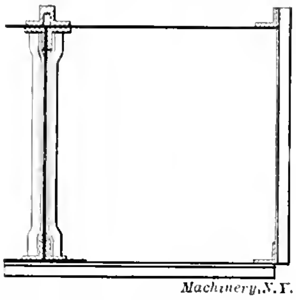


Fig. 49. Section of Girder suitable for Light Cranes of Long Spans

The diameter of the axles must be sufficient to resist bending from a distributed load, and at the same time have enough bearing area to keep the pressure below 1,000 pounds per square inch. Large cranes, and, in the case of some makers, all cranes are fitted with self-lubricating axle boxes, of the type shown in Fig. 48. The roller shown in this illustration is of cork, with a hardwood spindle. The slot in the casting requires to be well made, or occasionally the roller may become jammed and ineffective.

Platforms, Brackets and Traveling Gear

The design and arrangement of the platforms and brackets either improves or detracts from the appearance of a crane, to a considerable extent. A variety of opinions seems to exist on the question of platforms, and while one engineer requires platforms on both sides of a one-ton traveler, another may be satisfied with one platform for a 25-ton crane. In the case of light high-speed travelers, it has been found both convenient and economical to have only a small platform over the cage, to stand on when examining and oiling the crab, the longitudinal shaft and axles being oiled from below, or from a platform fixed to the shop end wall.

If, however, a platform must be fixed to cranes having light lattice or single web plate girders with over forty feet span, it will be found that the section necessary to carry the load itself, is seldom sufficient to withstand the torsional stress due to the platform without deflecting laterally. The best means of overcoming this difficulty, which practically applies to all sizes of cranes with single web girders, is to attach a light subsidiary lattice girder to the main girder by horizontal bracing, as shown in Fig. 17 (April issue). The section employed can be very light. The diagonals, or tension bars are formed of light angles in preference to flat bars, to ensure rigidity and freedom from vibration; since they are strong enough to take compression, they obviate the necessity of counterbracing the central bays.

A section of a special girder is shown in Fig. 49. This has been found eminently suitable for light cranes of long span, traveling at a high speed. In this design it will be seen that the top flange is really a chequer-plate platform, one side being riveted to the web and the other to the lattice bracing, forming the front, the lower side also being braced. The increased width of the top flange gives a lateral stiffness sufficient to withstand the most severe strains.

The various forms of platform brackets in use are shown in Fig. 50. The advantage of each type of bracket is a matter of opinion, but it is generally considered, however, that type A is the simplest and best for plate girders, and more in accordance with the type of bracket which is employed to carry the traveling motor. Type B is formed of flat bars about 3 × ¾ inch and makes a very suitable bracket for box lattice girders, where it can be bolted onto the vertical members of the structure.

Timber is generally employed as a platform, on account of its lightness and cheapness; it also gives the best foothold. When cranes are working in the presence of fire, ¼-inch steel chequer plates are generally used in place of timber, and carried on steel brackets in the same manner.

A type of platform much employed on the European continent is made up of perforated steel screen plates, usually about 3/16 inch thick, which possess the advantage of lightness and good appearance, while the cost is only very slightly in advance of rolled chequered plates. This type is, however, most suitable for those cranes having lattice braced platform girders, which give the close support a plate of this description requires.

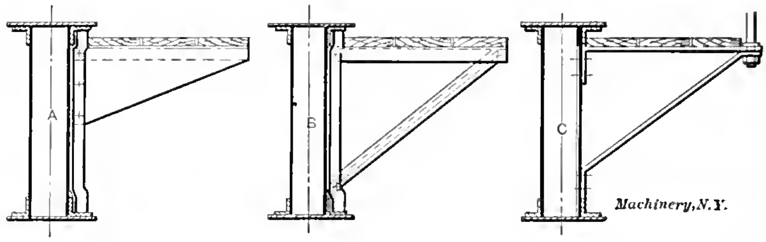


Fig. 50. Types of Platform Brackets

The traveling motor ought, theoretically, to be placed in the center of the drive. Cranes up to 50 feet span are, however, sometimes driven with the motor fixed at one end, but since it adds very little to the cost, it is best practice to place the motor in the center for all cranes over 30 feet span.

Whenever possible, the gearing ought to be confined to two reductions, and in order to do this, the motor should not be speeded above 600 revolutions per minute. Ordinary plummer blocks form a suitable type of bearing for the cross shaft. The bearings are usually placed on about 10-foot centers.

When using flanged couplings for this shaft in conjunction with timber platforms, there is always the disadvantage of either using somewhat high plummer blocks, or cutting the platform away to clear the flange, and this difficulty can best be avoided by using ordinary split muff couplings.

* * *

In 1898 there were not more than 200 automobiles made and put into use in the United States. In 1909 the total number of automobiles made and sold in the United States will approximate 82,000. The effect of the development of the automobile on the reduction of weight of prime movers may be appreciated when it is considered that less than thirty years ago prime movers weighed as much as 800 or 1,000 pounds per horsepower developed, and that the modern automobile engine has been reduced in weight to well under ten pounds per horsepower developed, and has shown its great reliability by running for days without stopping. The average horsepower of the automobiles produced in 1909 is about twenty, the 82,000 machines making an aggregate of 1,640,000 horsepower. At the beginning of this year there were in use in the United States over 184,000 automobiles, aggregating close to 4,000,000 horsepower.

* * *

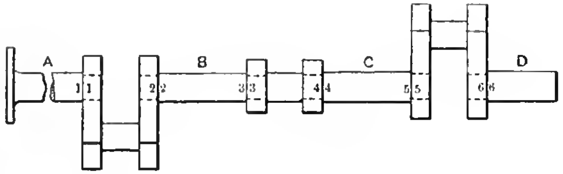
The first aerial pleasure yacht ever built has recently been ordered from the firm controlling the rights of the Parseval type of air-ships, and is being built for a customer of Berlin, Germany. The air-ship will be used for pleasure trips during the present summer.

Supplement to MACHINERY, July, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Shrinking and Forcing Fits"

SHOP OPERATION SHEET NO. 103.

W. Burns. MACHINERY, July, 1909.



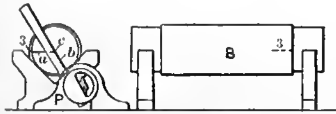


Fig. 1

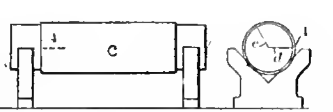


Fig. 3

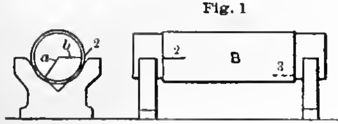


Fig. 2

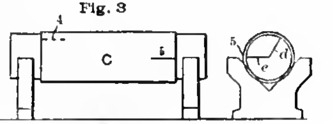


Fig. 4

Machinery,N.Y.

Assembling a Three-throw Built-up Crank-shaft.

NOTE.—The method of machining the various parts of a built-up crank-shaft was described in the Shop Operation Sheet accompanying the March issue. The following relates to laying out and setting the various parts in correct relation with one another, and shrinking them together.

1. Place section *B* (see view of the assembled shaft), which has been fitted to webs 2 and 3, in V-blocks, which should rest on an accurate surface plate. Locate the exact center c in end 2 of the shaft, and with a surface gage scribe the line *a* (See Fig. 1). Transfer this line with the surface gage to a point 3 on the other end of the shaft.

NOTE.—As there are to be three cranks in the shaft, the angle between the center lines of each will be 120 degrees. If then lines are located at points 2, 3, 4 and 5, 120 degrees apart, the cranks will be correctly set when their center lines coincide with the 120-degree points.

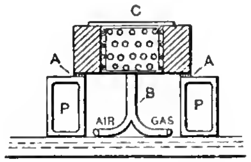
2. Set a protractor *P* to an angle of 60 degrees, and scribe the line *b*. The angle between the two lines on the end of the shaft will evidently be 120 degrees. Rotate the shaft (still keeping the surface gage at the same height) until line *b* coincides with the gage pointer and is parallel with the surface plate, as shown in Fig. 2; then scribe the line 2 which will be 120 degrees from 3.

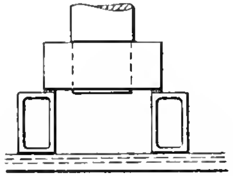
3. Place section *C* in the V-blocks, locate a center in end 5, scribe a line *d* with the surface gage, and transfer this line to point 4. With the protractor lay off the 120-degree line *e*; then turn the shaft until line *e* is parallel with the surface plate as shown in Fig. 4, and, without moving the gage pointer, locate line 5.

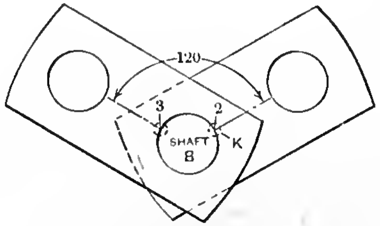
4. Fit lead center piece into the shaft and crank-pin holes of each web, locate the exact centers, and then scribe lines through these centers on the outer sides of the webs, excepting numbers 1 and 6, which do not need to be laid out.

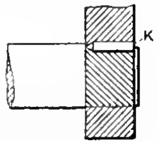
SHOP OPERATION SHEET NO. 104.

W. Burns. MACHINERY, July, 1909.









Machinery,N.Y.

Assembling a Three-throw Built-up Crank-shaft.

1. Place webs 1 and 6 (see the illustration on the preceding sheet) on parallels *P*, which may rest on any suitable table. That side of each web which was previously laid out, should be up.

2. Insert a Bunsen burner *B* in the hole to which the shaft was fitted, and connect the gas and air pipes. Any form of gas or oil burner may be used which will supply sufficient heat. Considerable time may be saved by using two burners and heating two webs at the same time. A cover plate *C* should be placed over the hole, and small strips *A* of asbestos or some other non-conductor between the webs and parallels to prevent the escape of heat.

3. After the burner is started, set a pair of inside calipers to the shaft diameter, and occasionally test the hole in the web to ascertain when it has expanded sufficiently to allow the shaft to enter.

4. Suspend the shaft over the web in a vertical position by any convenient crane, and arrange the latter so that the shaft can be lowered quickly.

5. When the hole has expanded enough to admit the shaft, remove the burner, quickly wipe out the hole; then lower the shaft into place. When the web cools, if proper allowance was made for the fit, the parts will be shrunk tightly together.

6. When webs 1 and 6 are finished, heat web number 3 and insert shaft *B*, setting it so that the center line of the web and line 3 coincide. Web 2 is next heated and shrunk on to section *B*, the two webs being set at an angle of 120 degrees, as shown in the illustration. The webs 4 and 5 are then shrunk to section *C* in the same manner.

7. To prevent the cranks from shifting, cylindrical keys *K* are fitted in all the webs as shown. These keys are made of mild steel and are driven in place by a heavy ram. Small grooves *G* are cut in on either side to permit the escape of oil and air.

SHOP OPERATION SHEET NO. 105.

W. Burns MACHINERY, July, 1909.

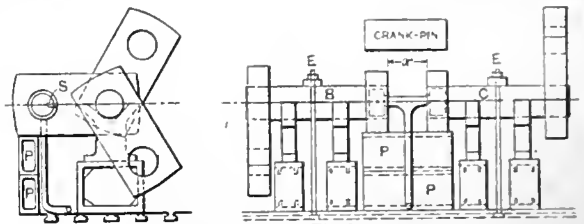


Fig. 1

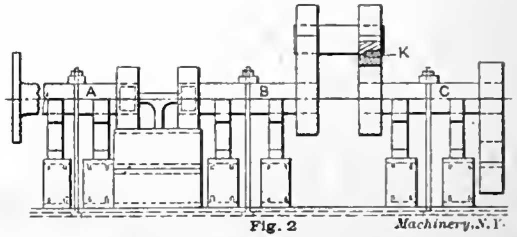


Fig. 2

Machinery,N.Y.

Assembling a Three-throw Built-up Crank-shaft.

NOTE.—The webs are assumed to be properly shrunk and keyed to each shaft section, those attached to section *B* and *C* being set 120 degrees apart. The diameters of each rough-turned section are also assumed to be the same.

1. Secure a set of four duplicate V-blocks, and mount these upon four parallels which are also duplicates and high enough to permit the webs of the cranks to clear the surface plate, as shown in the illustration.

2. Place sections *B* and *C* (see also illustration of Operation Sheet No. 103) in the V-blocks with the ends of webs 3 and 4 resting upon parallels *P*. Make provision for clamping each shaft section to the V-blocks as shown, and set the two sections approximately in line and about the correct distance apart.

NOTE.—The shaft and crank-pin holes for each crank were bored with the webs bolted together, thus bringing the holes at right angles to the inner faces and the same distance apart.

3. Ascertain the distance *x* that the webs should be apart, and, if possible, secure two parallels having widths equal to this dimension. Place one parallel between the webs at each end and clamp the latter together. Adjust the webs until a straight-edge placed through the crank-pin holes as at *S* indicates that they are in line.

4. Tighten the clamps *E*, and remove the parallel blocks from between the webs. Insert a double Bunsen burner in the crank-pin holes, as shown, and heat the webs until the crank-pin, which is a straight cylindrical piece, will enter. When the webs have been cooled, arrange section *A* on additional parallels and V-blocks as shown in Fig. 2; set the webs, and shrink in the pin as explained in the foregoing. In a similar manner finish the third crank.

NOTE.—Locking pins *K* are screwed into the webs and crank-pins to keep the latter from creeping out in case they should become loose.

V.—FORMULAS FOR STRENGTH OF FLAT PLATES

Author and Reference'	Formula as Given by Author	Safe Load at Center of Plate $W=$	Unit Stress in Extreme Fiber of Material $f=$	Thickness of Plate in Inches $t=$
Rectangular Flat Plates, Supported at all Four Edges and Loaded with a Center Load W.				
Grashof, Trautwines C. E. Pocket Book, Page 493	$f=\frac{3CWLl}{2t^2(L^2+l^2)}$ $C=2.$	$0.34\,\frac{ft^2(L^2+l^2)}{Ll}$	$3\,\frac{WLl}{t^2(L^2+l^2)}$	$1.73\sqrt{\frac{WLl}{f(L^2+l^2)}}$
Rankine, Civil Engineering, Page 543	$M=\frac{3WL^4l}{8(L^4+l^4)}$ Where L is less than $1.19\,l$	$0.45\,\frac{ft^2(L^4+l^4)}{L^3l}$	$2.25\,\frac{WL^3l}{t^2(L^4+l^4)}$	$1.5\sqrt{\frac{WL^3l}{f(L^4+l^4)}}$
Rankine, Civil Engineering, Page 543	$M=\frac{Wl}{4}$ being the same as for a plate supported at side edges only	$0.67\,\frac{fLt^2}{l}$	$1.5\,\frac{Wl}{Lt^2}$	$1.225\sqrt{\frac{Wl}{fL}}$
Rectangular Flat Plates, Firmly Secured along all Four Edges and Loaded with a Center Load W.				
Grashof, Trautwines C. E. Pocket Book, Page 493	$f=\frac{3CWLl}{2t^2(L^2+l^2)}$ $C=1.75$	$0.38\,\frac{ft^2(L^2+l^2)}{Ll}$	$2.62\,\frac{WLl}{t^2(L^2+l^2)}$	$1.6\sqrt{\frac{WLl}{f(L^2+l^2)}}$

'M = Maximum Bending Moment, Inch Pounds.
L = Long Span Between Supports.
l = Short Span Between Supports.
W, f, and t as given above

Note: Rankine gives Bending Moment M only as given in 2nd. line. Writer assumes Resisting Moment M_1 as $M_1=\frac{fLt^2}{6}$

Then $M=M_1$ or $\frac{3WL^4l}{8(L^4+l^4)}=\frac{fLt^2}{6}$ also $\frac{Wl}{4}=\frac{fLt^2}{6}$

Compiled by William F. Flecher

VI.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Circular Flat Plates, Supported All Around The Edge, Loaded With a Total Load $W=PR^2\pi$, Uniformly Distributed Over The Unsupported Surface Area Of The Plate.

Author and Reference	Formula as Given by Author	Safe Load Per Unit of Surface Area $P=$	Radius of Plate to Supported Edge $R=$	Unit Stress in Extreme Fibers of Material $f=$	Thickness of Plate, Inches $t=$	Total Safe Load $=PR^2\pi=$ $W=$	Deflection at Center of Plate $Y=$
Reuleaux, Trautwines C. E. Pocket Book 1906, Page 493	$P=\frac{ft^2}{R^2}$	$\frac{ft^2}{R^2}$	$t\sqrt{\frac{f}{P}}$	$\frac{PR^2}{t^2}$	$R\sqrt{\frac{P}{f}}$		$\frac{5PR^4}{6Et^3}$
	$t=R\sqrt{\frac{P}{f}}$			$0.314\,\frac{W}{t^2}$	$0.56\sqrt{\frac{W}{f}}$	$3.142\,ft^2$	$0.265\,\frac{WR^2}{Et^3}$
Grashof, Kent's, M. E. Pocket Book 1903 Page 900	$P=\frac{6ft^2}{5R^2}$	$1.2\,\frac{ft^2}{R^2}$	$1.095\,t\sqrt{\frac{f}{P}}$	$0.833\,\frac{PR^2}{t^2}$	$0.913R\sqrt{\frac{P}{f}}$		$0.7\,\frac{PR^4}{Et^3}$
				$0.265\,\frac{W}{t^2}$	$0.515\sqrt{\frac{W}{f}}$	$3.77\,ft^2$	$0.223\,\frac{WR^2}{Et^3}$
Bach, Hütte Des Ingenieurs Taschenbuch	$f=\frac{CPR^2}{t^2}$	$1.15\,\frac{ft^2}{R^2}$	$1.07\,t\sqrt{\frac{f}{P}}$	$0.87\,\frac{PR^2}{t^2}$	$0.93R\sqrt{\frac{P}{f}}$		$0.7\,\frac{PR^4}{Et^3}$
	$C=0.87$			$0.277\,\frac{W}{t^2}$	$0.526\sqrt{\frac{W}{f}}$	$3.6\,ft^2$	$0.223\,\frac{WR^2}{Et^3}$
Johnson, The Material of Construction, 1897, Page 73	$t=R\sqrt{\frac{P}{f}}$	$\frac{ft^2}{R^2}$	$t\sqrt{\frac{f}{P}}$	$\frac{PR^2}{t^2}$	$R\sqrt{\frac{P}{f}}$		No case given
				$0.314\,\frac{W}{t^2}$	$0.56\sqrt{\frac{W}{f}}$	$3.142\,ft^2$	No case given

E = Coefficient of Elasticity. $\pi = 3.1416$

Compiled by William F. Fischer

VII.—FORMULAS FOR STRENGTH OF FLAT PLATES.

Circular Flat Plates Firmly Secured All Around The Edge, Loaded With a Total Load $W = PR^2\pi$, Uniformly Distributed Over The Unsupported Surface Of The Plate.

Author and Reference	Formula as Given by Author	Safe Load Per Unit of Surface Area $P=$	Radius of Plate to Supported Edge $R=$	Unit Stress in Extreme Fiber of Material $f=$	Thickness of Plate, Inches $t=$	Total Safe Load $=PR^2\pi=$ $W=$	Deflection at Center of Plate $Y=$
Reuleaux, Trautwines C. E. Pocket Book, 1906 Page 493	$P=\frac{3}{2}f\left(\frac{t}{R}\right)^2$	$1.5\frac{ft^2}{R^2}$	$1.225\,t\sqrt{\frac{f}{P}}$	$0.667\frac{PR^2}{t^2}$	$0.8165\,R\sqrt{\frac{P}{f}}$		$\frac{PR^4}{6Et^3}$
	$t=R\sqrt{\frac{2}{3}\frac{P}{f}}$			$0.2\frac{W}{t^2}$	$0.46\sqrt{\frac{W}{f}}$	$4.7\,ft^2$	$0.053\frac{WR^2}{Et^3}$
Grashof, Kent's M. E. Pocket Book, Page 283	$f=\frac{2PR^2}{3t^2}$ $t=\sqrt{\frac{2R^2P}{3f}}$ $P=\frac{3ft^2}{2R^2}$	$1.5\frac{ft^2}{R^2}$	$1.225\,t\sqrt{\frac{f}{P}}$	$0.667\frac{PR^2}{t^2}$	$0.8165\,R\sqrt{\frac{P}{f}}$		$\frac{PR^4}{6Et^3}$
				$0.2\frac{W}{t^2}$	$0.46\sqrt{\frac{W}{f}}$	$4.7\,ft^2$	$0.053\frac{WR^2}{Et^3}$
Johnson, The Materials of Construction, Page 73	$f=\frac{3PR^2}{4t^2}$	$1.34\frac{ft^2}{R^2}$	$1.154\,t\sqrt{\frac{f}{P}}$	$0.75\frac{PR^2}{t^2}$	$0.866\,R\sqrt{\frac{P}{f}}$		No Case Given
	$t=\frac{R}{2}\sqrt{\frac{3P}{f}}$			$0.239\frac{W}{t^2}$	$0.49\sqrt{\frac{W}{f}}$	$4.19\,ft^2$	No Case Given

E = Coefficient of Elasticity $\pi = 3.1416$

Compiled by William F. Fischer

VIII.—FORMULAS FOR STRENGTH OF FLAT PLATES

Flat Circular Plates Loaded With a Concentrated Load W Applied At a Circumference, The Radius Of Which Is r_0.

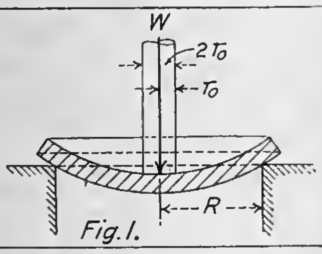


Fig. 1.

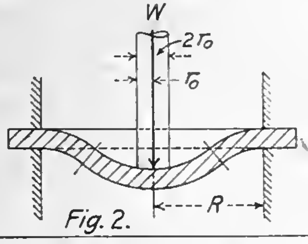


Fig. 2.

Plate Supported All Around The Edge, Fig. 1.

Author and Reference	Formula as Given by Author	Unit Stress In Extreme Fibers of Material, Lbs. per sq. Inch $f=$	Thickness of Plate in Inches $t=$	Safe Load $W=$	Deflection at Center of Plate, Inches $Y=$
Bach, Hutte, Des Ingenieurs Taschenbuch	$f=\frac{3C_1}{\pi}\left(1-\frac{2}{3}\frac{r_0}{R}\right)\frac{W}{t^2}$ $C_1 = 1.5$	$1.433\frac{W\left(1-\frac{2}{3}\frac{r_0}{R}\right)}{t^2}$	$1.2\sqrt{\frac{W\left(1-\frac{2}{3}\frac{r_0}{R}\right)}{f}}$	$0.7\frac{ft^2}{\left(1-\frac{2}{3}\frac{r_0}{R}\right)}$	$0.5\frac{WR^2}{Et^3}$
Grashof, Kent's M. E. Pocket Book, Page 284	$f=\left(\frac{4}{3}\text{Nat. Log.}\frac{R}{r_0}+1\right)\frac{W}{\pi t^2}$ $=\frac{CW}{\pi t^2}$ $C=\left(\frac{4}{3}\text{Nat. Log.}\frac{R}{r_0}+1\right)$	$\frac{CW}{\pi t^2}$ See Table Below.	$\sqrt{\frac{CW}{\pi f}}$	$\frac{\pi t^2 f}{C}$	$0.53\frac{WR^2}{Et^3}$

Table Giving Values of C. (Grashof)

$\frac{R}{r_0}=$	10	20	30	40	50
$C=$	4.07	5.00	5.53	5.92	6.22

$C=\left(\frac{4}{3}\text{Nat. Log}\frac{R}{r_c}+1\right)$

Plate Firmly Secured All Around The Edge, Fig. 2.

		f	t	W	Y
Grashof, Hutte, Des Ingenieurs Taschenbuch	$f=\frac{1}{\pi}\frac{4}{3}\text{Nat. Log.}\frac{R}{r_0}\frac{W}{t^2}$	$0.424\frac{W}{t^2}\text{Nat. Log.}\frac{R}{r_0}$	$0.65\sqrt{\frac{W\,\text{Nat. Log}\frac{R}{r_0}}{f}}$	$2.36\frac{ft^2}{\text{Nat. Log}\frac{R}{r_0}}$	$0.48\frac{WR^2}{Et^3}$

E = Coefficient of Elasticity. $\pi = 3.1416$

Compiled by William F. Fischer

PACKING MACHINERY FOR EXPORT

In this the second article on packing machinery for export (see MACHINERY, February, 1909) we illustrate the packages employed by a number of machine tool builders, which have been especially photographed for MACHINERY. We feel that the subject still is an important one, notwithstanding the depression in export trade of machinery. Even though European countries buy less and less of our machines proportionally as years go by, there is no reason for our manufacturers to neglect foreign business. With proper encouragement a machine tool trade can be worked up in other countries besides Europe. South America is a very promising field for future sales. It is a land practically untouched by American manufacturers, and now is the time when we should be doing the initial work to build up a trade that should grow with years and become as important in time as the European trade. As being of particular significance now, we quote from a book entitled "Aids to Shippers," published by Oelrichs & Co., New York:

"Commerce flows along the lines of least resistance, and those manufacturers, merchants, farmers and miners will be most successful in extending their markets, who deliver their goods to the purchaser wherever wanted. Nothing has contributed so much to the material wealth of the entire world as the tremendous strides made in transportation facilities during the last century, and transportation has become the most valuable commodity of the present day, as in nearly every instance the cost of carrying an article to its ultimate destination determines the question of its sale. Too much stress cannot be laid upon the care that should be exercised in packing merchandise exactly in compliance with the wishes of purchasers, no matter how trivial they may seem. If, for instance, a buyer should instruct a shipper to arrange his package in such a way that a certain weight or size be not exceeded, it is no doubt that the goods are to be carried on mule back or similar conveyance to the interior. A request especially from South American countries will frequently be made that but one kind of goods be placed in each package, and this also should be strictly carried out. Failure to observe this rule results in heavy fines by customs authorities, as the laws of the respective countries demand that each kind of goods imported therein must be packed in a separate package, and forbids the packing of different kinds of merchandise in one receptacle."

The packing of a milling machine for export as practiced by the Kempsmith Mfg. Co., Milwaukee, Wis., is illustrated in Figs. 1 and 2. At one time this company exported 50 per cent of its product, and its export trade now averages about 30 per cent, so that of necessity it has developed methods of packing which reduce complaint from defective shipping to a minimum. In the past five years it has received only one complaint of trouble resulting from packing.

The milling machine to a certain extent is self-contained and therefore lends itself very well to a compact substantial package, and this condition is improved for export by partial dismantling. The table is removed and placed in a low place in the case, and the knee is run down to a low position on the column. The counter-shaft is packed at the rear of the machine with the pulleys at the bottom, as shown in Fig. 1. The loose parts are carefully packed with a liberal amount of excelsior in a box within the main case. This illustration also shows the method of framing and bracing. The lumber used is white pine, as this timber does not split and is in other respects better for the purpose than hemlock or other woods. The machine is securely bolted to 6 x 8 inch skids, and the frame is of 2 x 4 inch material. The corner posts are further supported by intermediate cross and upright posts, and the top framing is placed against the overhanging arm so as to support the machine in case it is turned over on its side.

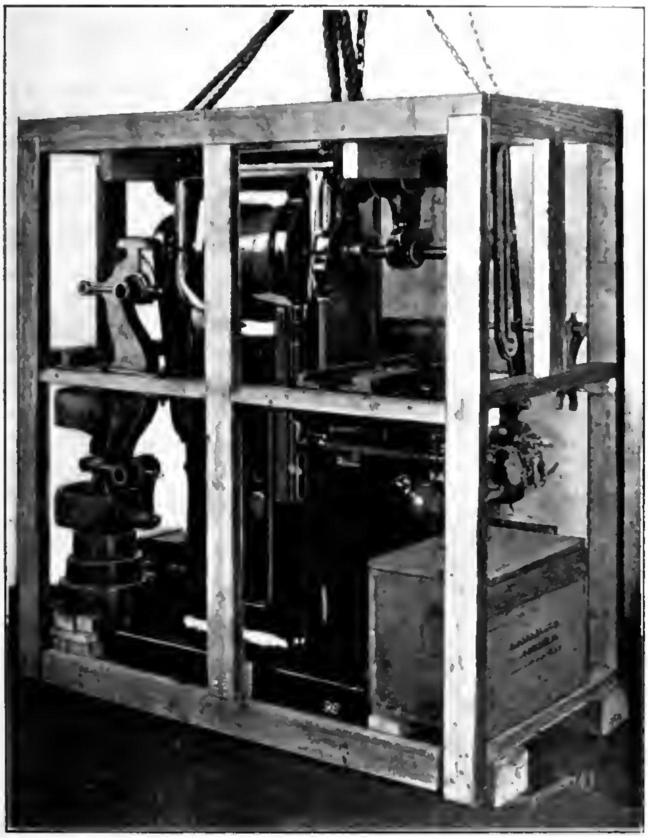


Fig. 1. Kempsmith Knee-type Milling Machine in Framework of Export Packing-case

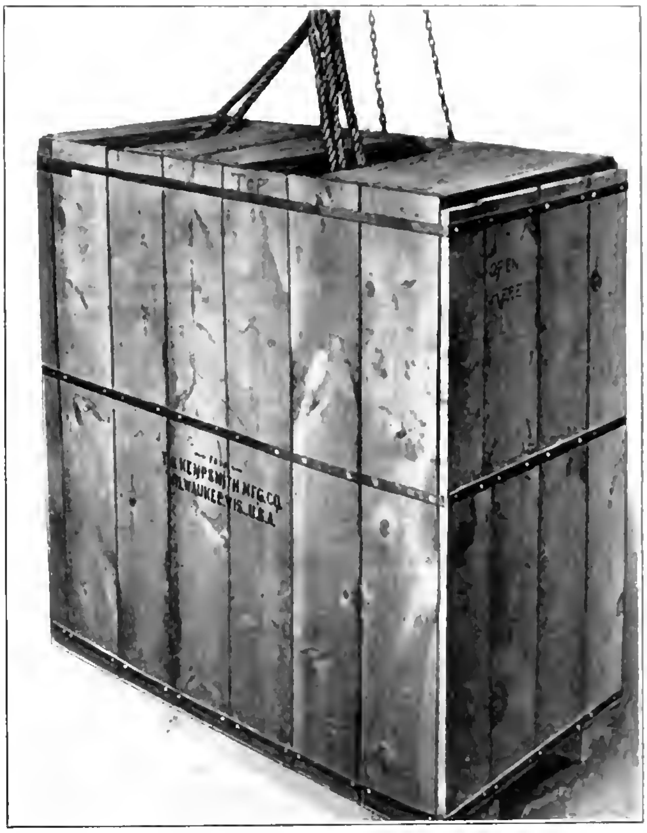


Fig. 2. View of Packing-case for Kempsmith Knee-type Milling Machine, showing Opening at Top for Handling

The sheathing is $1\frac{1}{4}$ inch lumber nailed vertically, as shown in Fig. 2. Three strips of 1/16 inch x 1 inch band iron are passed around the bottom, top and middle of the completed case. Two of the top boards of the case are screwed instead of nailed, this being done for convenience in removing them and thus providing an opening for inserting ropes or other tackle appliances for handling the machine. This feature is known to customers abroad, and facilitates the handling of the machine. An end board shown in the same illustration is provided, which is likewise screwed, with notice to the custom officials that the same is the proper place to open the case for inspection.

All finished surfaces of the machine are thoroughly slushed over both externally and internally to protect them from dampness. It is not safe to leave a finished surface on the interior of the machine, as the damp salt air can work just

[illegible] to parts on the interior as to those on the ex- [illegible] not protected. For the overhanging arm and upper [illegible] surfaces a special brand of slush is used which [illegible] seen after application. The reason for this is that [illegible] parts are subject to exposure in handling both in shipping and receiving at the other end. The hardened slush is not easily rubbed off by the use of ropes, etc., in handling, and therefore protects these parts from exposure and rust, even though subjected to considerable wear. This hardened slush is easily removed with benzine.

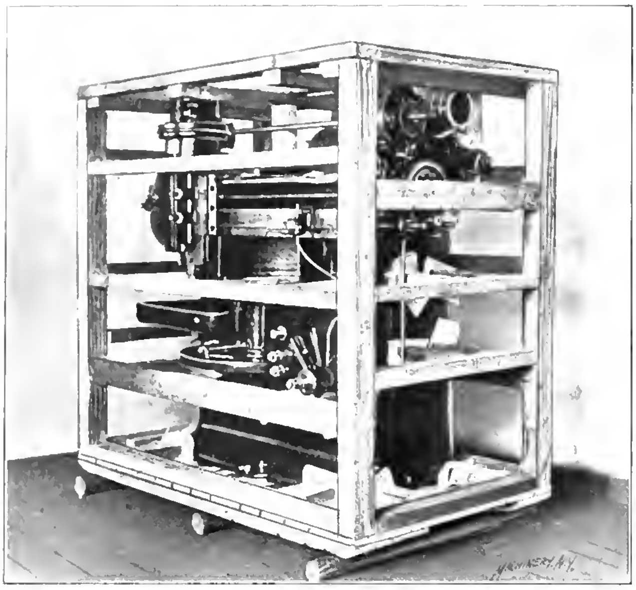


Fig. 3. Framework of Foreign Export Package for Fellows Gear Shaper

Figs. 3 and 4 illustrate the framing and exterior of the package used by the Fellows Gear Shaper Co., Springfield, Vt., for protecting gear shapers. The gear shaper, like the milling machine, is largely self-contained, and does not offer serious difficulties in the matter of substantial packing, and very little dismantling is necessary. The frame work is well braced with about 4 x 6 inch stuff and 2 x 4 inch pieces between. Substantial skids are provided, and the sheathing is nailed vertically, as illustrated in Fig. 4.

The package illustrated in Fig. 5 is a remarkable example of compact packing of a tool, which to the ordinary observer would seem quite incapable of being put in such close compass. This package is the one employed by the W. F. & John Barnes Co., Rockford, Ill., for its upright drills. The machine, which is a 25-inch drill, is packed into a case measuring 76 x 49 x 12½ inches, the gross weight of which is about 1,300 pounds. The company has lost only one of its drills thus packed for export. It will be observed that the base is removed as well as the table and packed alongside of the frame with the cones, feed gearing, etc. Other parts are packed in the interstices so that the amount of waste space is reduced to a minimum. This can be judged from the fact that the cubic contents is only about 27 cubic feet and the weight is 1,300 pounds, or 48 pounds per cubic foot. The case is built up of lumber 1¼ inch thick.

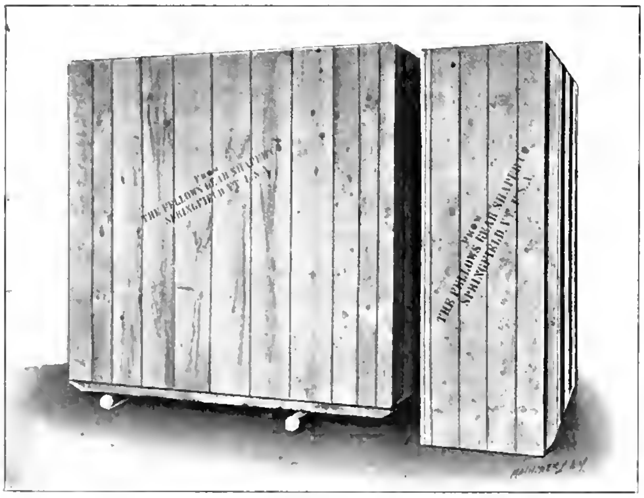


Fig. 4. The Same Case shown in Fig. 3, Boarded up

The Cincinnati Machine Tool Co. employs a very strong framework for its upright drills, covering same with six- or eight-inch wide flooring nailed about six inches apart. The company has found this style of open package satisfactory. It enables the freight handlers to see what they are handling, and if a breakage occurs between Cincinnati and New York it saves shipping the broken machine all the way to Europe. Practically no breakages are reported, but notwithstanding the satisfactory experience, the foreign dealers request closed boxes, and now the company is packing in the same way as before and closing the cases tight.

The Ingersoll Milling Machine Co., Rockford, Ill., builders of heavy milling machines of the planer type, dismantle the machines for their export trade and pack the parts in boxes made of 2 x 6 inch dressed and matched lumber, making the boxes perfectly tight.

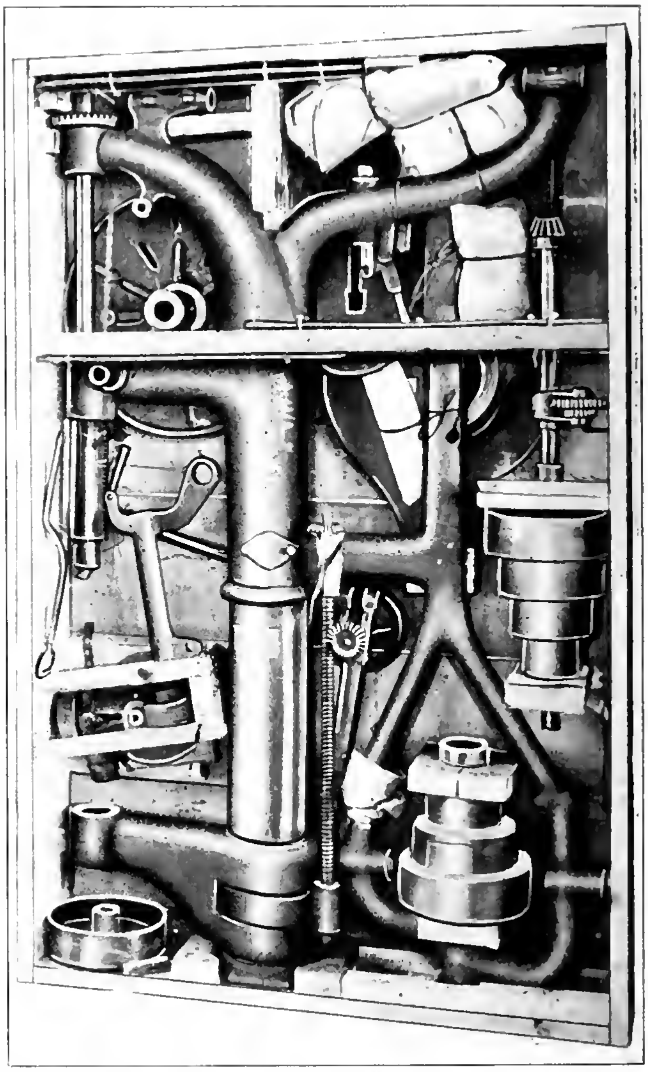


Fig. 5. Twenty-five-inch Upright Barnes Drill packed for Foreign Shipment. Note the Compact Arrangement of Parts and Little Waste Space

The Rockford Drilling Machine Co., Rockford, Ill., dismantle all its machines shipped abroad and pack in substantial boxes, bracing the large parts thoroughly. This method has the objection of requiring the foreign customer to reassemble the machine, and where this is done by users, trouble sometimes arises through improper assembling. The advantage from the point of the manufacturer lies in that the machines do not occupy so much cubic space as otherwise, and therefore the freight rates are lower.

Fig. 6 illustrates the package employed by the Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., for their long lathes. The machine in the package is the 28- and 48-inch extension lathe, ordinarily used as a lathe of 28-inch swing. In packing this machine the head- and tail-stock are put in one box, while the carriage and small parts are packed in

other boxes. The lead screw is left in place on the side of the bed, and boxed in. The illustration shows the bed upside-down. This package only partially protects the machine, the bottom being open and the frame work being held together by strong cross-ties. The upper part of the bed or finished surface is protected from dampness by boarding. In conclusion we quote again from "Aids to Shippers" on the importance of marking packages:

"It is an established fact that the marking of packages plays a considerably more important part in export shipping than most American manufacturers and export merchants are willing to credit. As an instance, we desire to call attention to the fact that several South American countries require that all marks on the packages must be stencilled, brush or other kind of marking being prohibited by law. Some countries, on the other hand, demand that the distinguishing marks and numbers, etc., be placed on the four sides of each package. Again, some demand that the net and gross weight in kilos appear on each case, together with a number, which latter must correspond with the number of the same case given in the consular documents. It is needless to observe that where the laws of the different countries demand such markings, failure to comply with the regulation always results in fines, delays and many other petty annoyances at destination, the fines, in many instances, exceeding the value of the goods considerably. In all instances every case must be distinctly marked with the port of destination in full, this requirement emanating from the steamship companies and being covered by the term 'Port Mark.'"

Fig. 6. Extension-bed Harrington Lathe packed for Export

* * *

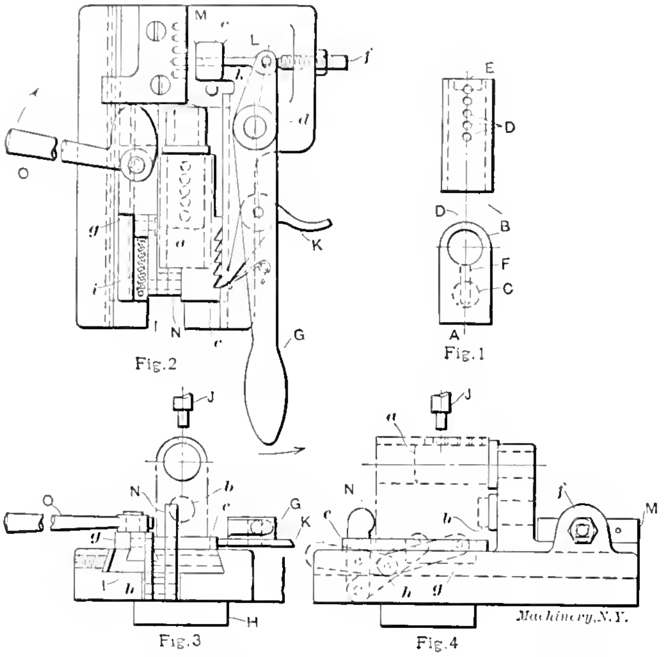
The gas pressure in the powder chamber of the Springfield rifle, model 1903, for the latest pattern cartridge, is about 49,000 pounds per square inch. What this means may be inferred from the following abbreviated directions for cleaning the arm, contained in the pamphlet issued for the instruction of army officers: "Use the cleaning rod and small patches of canton flannel and clean the bore thoroughly with patches soaked in a saturated solution of soda and water. Then thoroughly dry the bore and remove the soda solution by the use of dry patches and finally oil the bore with patches soaked in cosmic oil. Twenty-four hours after the first cleaning, the bore should be again cleaned as described above, as it has been found that the powder gases are probably *forced into the texture of the steel*, and will, if the second cleaning is not resorted to, cause rusting no matter how thoroughly the bore may have been cleaned at first."

A RIVETING FIXTURE

The accompanying engraving illustrates a fixture which was designed for use in a pneumatic riveter. The work is shown in the two views in Fig. 1, and consists of an oblong casting with a half-round top, having a hole *B* extending through it and a hole *C* in one end. The five small holes *D* were drilled in the center of the casting and about two-thirds of the way through. The side *A* is finished and the holes *B* and *C* are a gage distance from this surface. The face *E* is also finished square with *A*. In the finished piece small springs were placed in the lower portion marked *F* of the holes *D*, and it was necessary that the outer part of the holes *D* should be plugged in order to have a continuous ring of metal around the top part. Small brass disks were inserted in these holes and expanded by the riveter sufficiently to tightly fill the hole. Fig. 2 shows a top view of the fixture; Fig. 3, an end view, and Fig. 4, a side view with lever *G* removed.

The fixture consists of a cast iron base, planed off on the bottom, having a round boss *H* which fits into the bed of the riveter. The base is dovetailed, as shown, for the slide *I*, from which a lug projects upward and carries the studs *a* and *b* on which the work is placed. These studs fit the two holes *B* and *C* of the work, and have shoulders against which the side *E* of the work stops. The bottom *A* of the work rests on the hardened tool steel plate *c*. Fig. 4 shows the work in position so that the hammer *J* of the riveter, in descending, will expand the disk in the second hole in the work; when this is done, the slide *I*, carrying the work, is moved along so that the third hole will be in line with the hammer of the riveter, and so on, for the other holes. The stock left between the holes in the work, after drilling, is so small that it is very necessary that the hammer be exactly in line with the hole containing the disk to be expanded, for, if in riveting the hammer strikes the solid part of the casting, it will crack it. For this reason, it is necessary that the slide should be fed forward an exact amount each time, and that it should be properly indexed in this position. This is accomplished by the lever *G*, which is pivoted to the base of the fixture at *d*. The pawl *K* is pivoted to the lever *G*, and meshes into the rack which is cut in the plate *c* fastened to the slide *I*. To the outer end of the lever *G*, is connected the index pin *L* which has a bearing in the boss *e* on the base of the fixture. The plate *M* is fastened to the slide *I*, which car

ries the work, and has five small holes in its side, spaced the same as the holes *D* in the work, and so located that when the index pin *L* is in any one of them, the corresponding hole in the work is in line with the hammer *J* of the riveter. The screw *f* is adjusted so that when the end of the lever *G* stops against it, the pawl *K* will have moved the slide *I* such an amount that the hammer *J* will be directly in line with the hole in the work. This position is shown in Fig. 2. When the lever *G* is thrown in the direction of the arrow, the index pin enters the hole in the plate *M* on the slide, thus locating it accurately in this position. When the lever *G* moves to the end of its throw in the direction of the arrow, the pawl passes almost to the point of the next tooth. In feeding the slide forward for the next hole in the work, the lever must swing in the opposite direction a sufficient amount to move the pawl *K* from the point to the bottom of the tooth in rack *c*, before starting the slide forward; this movement is sufficient to withdraw the index pin *L* from the hole in the plate *M*, thus making sure that the index pin is withdrawn before the slide is caused to move. The mechanism to clamp the work in position, consists of a small slide *g*, dovetailed into the main slide *I*. The clamp *N*, pressing against the work, is pivoted at the center to the slide *I*, and joining the lower end of this clamp and one end of the small slide *g* is the connection *h*. The cam *O* is mounted on the slide *g*, and its face works against the surface of the plate *M*, which is fastened to the slide *I*. Fig. 2 shows the small slide *g* forced forward by the action of the cam *O* against the plate *M* which causes the clamp *N* to be pressed against the work as shown by the full lines of Fig. 4. The dotted lines show the position of clamp *N* when the cam is released. The coil spring *i* forces the slide *g* backward at this time.



Figs. 1 to 4. Fixture for Holding the Work shown in Fig. 1, and Accurately Indexing it when Riveting Disks in Holes D

The operation of the fixture is as follows: The work is placed upon the studs and the cam *O* is swung in the direction of the arrow, thus clamping the work in position. The riveter is started and the disk in the first hole expanded. The riveter is then stopped, and the lever *G*, which at this time is to the right of its movement with the index pin *L* in the first hole of plate *M*, is swung to the left until the end brings up against the stop-screw *f*. This movement withdraws the index pin *L*, and feeds the slide *I* forward by means of the pawl *K* working in the rack *c* on this slide. The lever *G* is then thrown to the right, and the index pin *L* passes into the second hole of plate *M*. The riveter is again started and the disk in the second hole is expanded. These movements are repeated until the disks in the five holes have been expanded. The cam *O* is then released, thus throwing the clamp *N* down and allowing the work to be removed. The operator, having his right hand on the lever *G*, presses against the end of the pawl *K* with his finger, thus throwing it out of engagement with the rack *c*, and, at the same time, throwing lever *G* in a direction opposite to that of the arrow until it brings up against the stop-screw *f*, thus withdrawing the index pin *L* from the hole in the plate *M*. Another casting is picked up with the left hand, and pushed onto the studs *a* and *b*, and, at the same time, the slide *I* is moved back against the stop-pin *k* which is so located that the first hole in the work is in line with the hammer *J* of the riveter. The end of the pawl *K* is now released, and the spring shown forces it into mesh with rack *c*. The lever *G* is swung in the direction of the arrow, thus causing the index pin to pass into the first hole in the plate *M*. The cam *O* is moved in the direction of the arrow, thus clamping the work in position, and the train of operations repeated.

In operation, the fixture proved to be very rapid and accurate, and gave satisfaction.

* * *

TEACHING HORSE SENSE

In a communication to the *Engineering News*, George H. Follows, Professor of Machine Design at the School of Applied Science, Carnegie Technical School, Pittsburg, Pa., expresses some ideas regarding the teaching of "horse sense" in technical schools, which are of interest to all who have given any thought to the question, and which suggest the lines along which further improvement may be made. One fault with technical instruction as usually imparted is that no "sense of values" is developed. The technical graduate, as well as the college graduate in general, has but a dim recognition of essentials and non-essentials at the time when he leaves his Alma Mater. He does not know things of prime importance from those of secondary value. He has usually an exaggerated idea of the value of his college training, and of the knowledge that he has assimilated during his years at a technical school. When engaging in practical work, he is likely not to be able to distinguish a big thing from a little thing and at first accomplishes little, because he uses up his time and energies with an unprofitable struggle with trivial matters; in other words, he lacks good "horse sense."

While it is not possible to teach "horse sense" in the abstract, it is possible to develop a sense of judgment in the student provided the instructor himself possesses the qualities necessary for imparting such instruction. This instruction of common sense can be made effective by introducing a course that does not deal exclusively with theoretical considerations but deals with engineering as it actually appears in commercial life. The students should be taught that mechanical drawing is only a means to an end and by no means the end itself. In fact, they ought to be taught that engineering itself is only a means to an end, and that unless mankind is enabled to live happier and better lives as a result of industrial and engineering progress, the object to which the engineer devotes his energies fails of its purpose. They should be given an idea of the organization of engineering concerns and be made to understand that when they first enter practical life, they will be likely to occupy very subordinate positions. Of course, with this instruction in shop organization also follows general instruction in shop management and shop systems, and efforts should be made to impress on the student the true difference between system and "red tape," that is, in other words, the difference between essentials and non-essentials. Last but not least, the student who enters practical life from a technical school needs to be given an idea of the conditions and requirements of the human element in the industries and an understanding of the fundamental principles of economics as they apply to the cooperative work of society. It is evident that it is difficult to obtain competent instructors for this kind of instruction, because experience alone would equip a man to teach successfully along these lines; but undoubtedly students who had had ideas of this kind imparted during their years at school would enter practical work with a truer conception of the conditions of life than the majority of technical and other college graduates now have.

* * *

The three-hundredth anniversary of the landing of the Pilgrims at Plymouth, Mass., will be celebrated by a world's exposition in Boston in 1920.

BORING MACHINE PRACTICE IN THE SHOPS OF THE LANDIS TOOL CO.

Anyone who has occasion (for business or other reasons) to visit any considerable number of machine shops in the course of the year, soon learns to grade these shops in his mind with respect to the interest of the work carried on, and the progressiveness and openmindedness of those responsible for the administration of the plant. There are many shops where the mechanic knows beforehand that a visit will be unprofitable, so far as mechanical inspiration is concerned. There are other shops which he has set down on his mental chart as oases in the desert, where he may expect to make refreshing discoveries in shop practice, and to come in contact with alert, intelligent workmen and shop managers. In any such classification the Landis Tool Co., of Waynesboro, Pa., must stand well toward the top. The writer found enough of interest there on a recent visit to the plant to fill many pages of MACHINERY. Much of the material collected is not of a startling or revolutionary nature, but it shows ability in the devising of manufacturing methods, and should therefore be interesting to others engaged in similar work. This material will be published as a series of short articles, each dealing with a separate subject.

One of the things that a live mechanic is always trying to do is (to quote Emerson) "to make two blades of grass grow where one grew before"—in other words, to take two or more cuts where but one was taken before. In pursuance of this idea, various standard machines have been developed into multiple spindle and multiple tool designs. We thus have the multiple spindle drill, the multiple spindle screw machine, the lathe with several carriages and tool rests, and numerous other developments of the same character. It has remained for this firm, however, to devise a multiple spindle boring machine. This was accomplished, as shown in Figs. 1 and 2, without making any change in the ordinary single spindle boring machine other than to provide it with suitable boring bars and driving heads for taking multiple cuts.

Fig. 1 shows a Lucas boring machine, rigged for machining holes in the gear-driven head-stock of the Landis grinding machine. These holes are being bored in a jig built in accordance with the now well-established principle of guiding the boring bars in bushings, so that they are independent of the alignment of the machine spindle. A base is provided for the jig having clamping surfaces identical with those of the work-table on the finished grinder. At each end of this base is clamped a bracket, having bushing holes accurately spaced to the dimensions desired for the holes in the finished headstock. The head-stock casting is clamped on the base between these standards by the same means and in the same way that it will be clamped in the finished machine. When a jig made in this way is accurately constructed and properly used, assurance is given that the holes bored in the work will be in proper alignment and proper position irrespective of the accuracy and alignment of the boring machine.

The particular feature of interest in this operation is, of course, the multiple spindle drive, which permits the boring of all three holes simultaneously. This is a very simple contrivance, as may be seen. It consists merely of a casing having three spindles spaced to agree with the holes to be bored in the work, all connected by means of suitable enclosed gearing. The central spindle is lined up with the spindle of the machine and is connected to it with a flexible coupling which permits the bars to guide themselves in their bushings without reference to the spindle. As the main spindle of the machine is fed forward, it presses against the multiple boring head and feeds the three bars simultaneously through the cut, so that three chips are taken where but one was taken before.

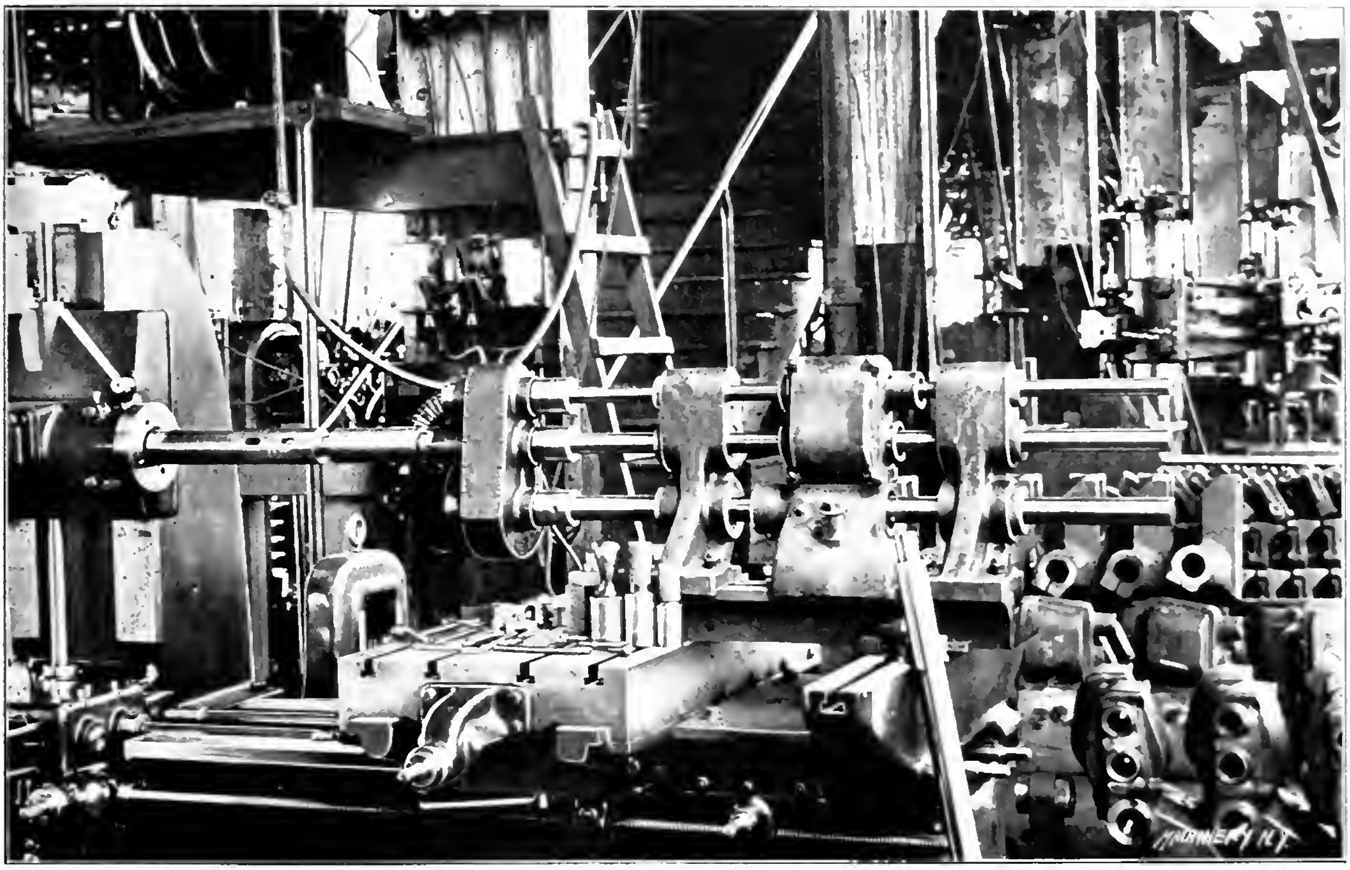


Fig. 1. Lucas Boring Machine with Special Head for Driving Three Bars

A somewhat different arrangement for doing similar work is shown in Fig. 2, where the tail-stocks are being bored for the dead center spindle. Here it is not a case of boring two or more holes in the same casting, but of boring two castings simultaneously. A double base-plate is provided, having ways on each side identical with those provided on the work-table of the grinder. To these ways, as in the previous case, are bolted brackets carrying guiding jig bushings, between which are clamped the tail-stock castings to be bored.

A construction for the boring head different from that in the previous case is required on account of the fact that two spindles instead of three are used. Where three spindles are employed and the drive is led direct to the middle one, the thrust of the cut is approximately balanced, so that there is no tendency to throw the boring bars and the head out of line; but where two spindles are used, one of them driven direct

[illegible] connected by gearing, the thrust of the cut for the cutter is out of line with the spindle of the machine which furnishes the pressure for feeding. There is thus a tendency to twist the boring head around and cramp the bars. In the [illegible] shown this difficulty is avoided by mounting the boring head on ways, machined on an extension of the base plate on which the work is mounted. These ways serve to keep the boring head lined up properly with the boring bars, even under heavy eccentric pressure from the cut. The feeding of the main spindle of the boring machine moves the head along the ways on the base-plate, and thus feeds the boring bars through the work.

The pair of tool heads shown on the platen of the machine in Fig. 2 are of considerable interest. They are of the split variety, making it possible to mount them on the bar without dismantling the setting or removing the bars or the bushings. The construction is more plainly shown in Fig. 3, which illustrates the head shown at the right-hand corner of the platen in Fig. 2. The body of this tool is composed of two members, *A* and *B*, bored to fit the bar and pivoted to connecting link *C*. The side opposite the link is machined with tapered lips as shown, to receive the binding clamp *D*. This is drawn down over the lips by a screw *E*, fitting in a hole tapped into the split between *A* and *B*, being formed half in one member and half in the other. The combination of the screw and wedge action, it will be readily seen, gives a tremendous grip on the boring bar. The screw *E*, of course, fits into its hole loosely when *A* and *B* are tightened on the bar, so that it is not held by the clamping action. To give further assurance of a positive drive, the cross pin *F* is provided in the bar; this drives the head by means of notches fitted to receive it, as shown.

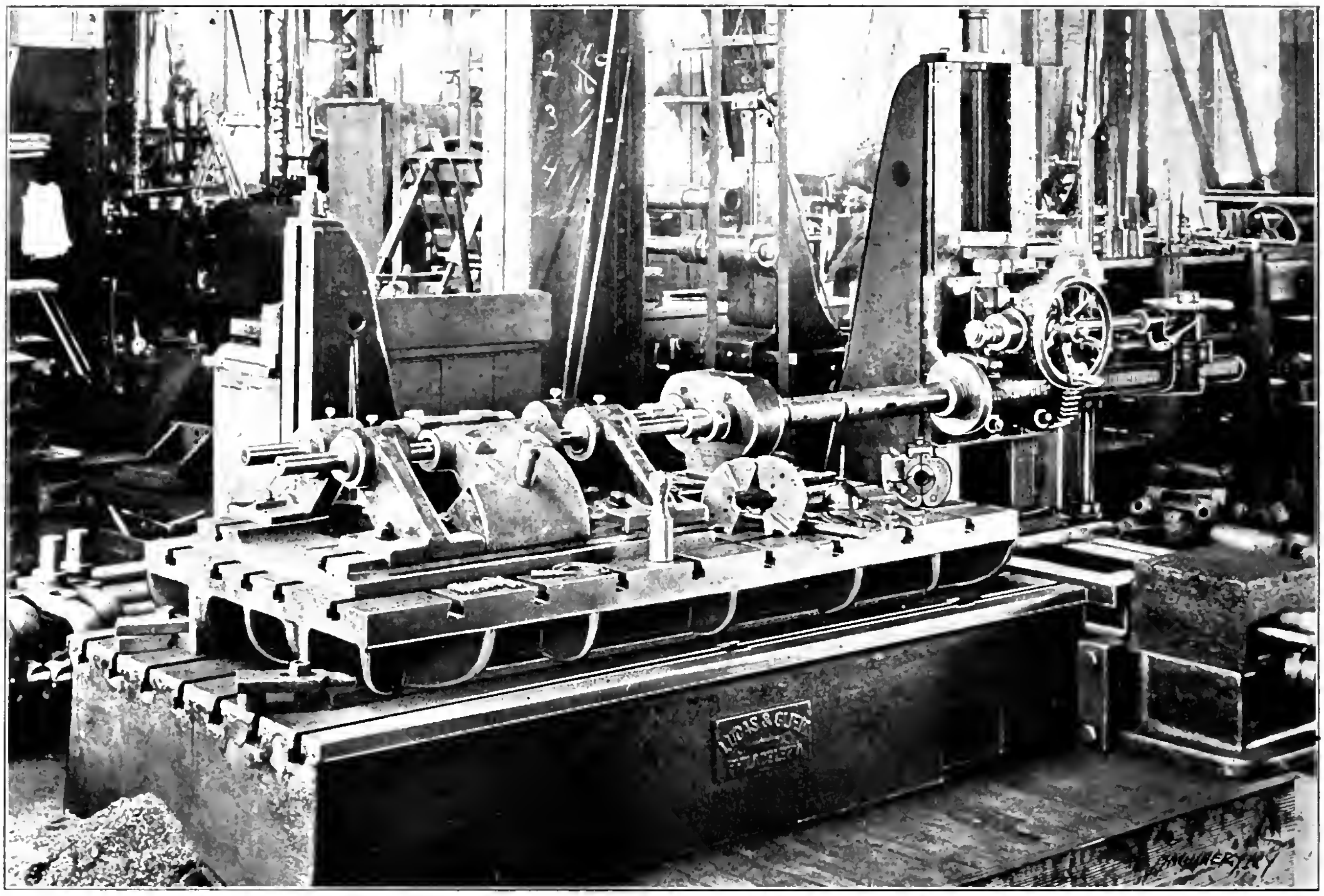


Fig. 2. Boring Two Pieces at once with a Double-spindle Head Guided by Ways on Fixture

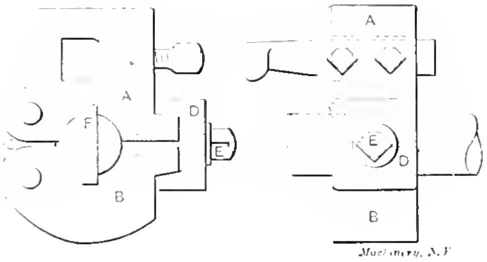


Fig. 3. A Simple and Convenient Split Boring-head

The tool head shown in Fig. 3 is intended for turning the outside of the foot-stock spindle boss. The turning tool used is shown in place at the right of the engraving. Another head of identical construction, but provided with facing cutters, is also shown on the platen of the machine in Fig. 2. This is used for finishing the ends of the bosses on the work.

This combination of double spindle boring attachment, and quickly changed, solidly held tools, makes the operation of machining these castings a very expeditious and accurate one.

* * *

A press report from Dysart, Iowa, states that Nathan Wilson has invented a process for welding copper and steel. He exhibited a hammer which is composed of a copper head and steel face, and he claims that his process of welding is the first in history to prove successful. This is an obvious error. The welding of copper to other metals is a process that has been developed both in Europe and America. By this process, not only can steel be faced with copper, but also with aluminum and other metals that do not weld under ordinary conditions. At the present time the Westinghouse Machine Co. is using steam turbine buckets composed of a steel core and a copper jacket so intimately united that a piece can be drawn in a drawing die and reduced to whatever size and shape required. The metal is received by the Westinghouse Machine Co. in rods and bars and is drawn to shape in ordinary drawbenches. The copper and steel draw uniformly, the relative thickness of the two metals remaining practically the same even with great reduction of cross section area.

* * *

A press message was recently sent by the *New York Times* to the *Chicago Tribune* by means of wireless telegraphy from New York to Chicago. The difficulties involved in sending the message, owing to interference of currents, showed that wireless telegraphy in its present state is not a serious competitor of ordinary wire telegraphy for transmission of messages over land.

A REMARKABLE PROPELLER SHAFT REPAIR

F. E. S.

Did you ever work in a tool-room with one of those chaps who knows it all, who always will take the opposite side of any subject simply to argue, who always can cite without hesitation something that he has seen and done that makes the topic under discussion look like "thirty cents," who is never wrong, who will argue until cornered and then take the opposite side and swear up and down that this (the opposite side) was his point of view from the start of the argument, who will argue over the definition of a word and when the dictionary is produced to prove his argument wrong, will claim that Webster made a mistake? Well, we had one of these individuals in our tool-room, and it happened to fall to the lot of Davey, our apprentice, to actually "take a fall out of him," and he did it to the queen's taste. This "know-it-all" had traveled all over the United States and foreign countries. He had worked five years here and seven years there, was superintendent in Georgia three years, and so on. The total made his age to be about eighty-five years, according to his own tales. He was always able to mention incidents bearing on any subject that had come under his observation in this country or that, and was a veritable walking encyclopedia of wonderful experiences and observations.

One noon hour he was under exceptionally high pressure (hot air), and started off telling a thrilling tale of experience, assuming that all-important "big I and little you" air: "I tell you, boys, you do not have the mechanics to-day that we used to have. To-day the men in the shops cannot do what WE were obliged to learn when I was serving my apprenticeship. I remember one time when I was sailing from Africa to this country and when out about a week the propeller shaft broke clean straight across. We were in a sorry predicament. We did not have a lathe on board and, of course, the ship drifted helplessly. After two days and no signs of a vessel to rescue us, we decided to do something to repair the shaft.

"Say, how did you get the right- and left-hand thread in that big nut?"

"The shaft was twelve inches diameter, and almost everybody on board had some crazy suggestion to make as to the best way to repair the break. Well, sir, there happened to be just *one* mechanic on board, and do you know how he repaired that shaft? Well, I will tell you in a few words. This mechanic took a piece of soft wire and wound it around the shaft in a helix, measuring off the right pitch from coil to coil and putting a drop of solder here and there to hold the wire in place. On the other part of the broken shaft he did the same, only making the helix left-hand instead of right-hand. Thus he laid out left- and right-hand threads on the broken ends.

"Now this mechanic was ready for operations and everybody crowded around wondering what he was going to do next. Giving two men a three-cornered file each he started them to work on the ends of the broken shaft filing a thread guided by the wire that he had carefully wound around. It took just a day to file these threads and then we secured the broken ends of the shaft with a big nut and that shaft is working on that boat to-day!"

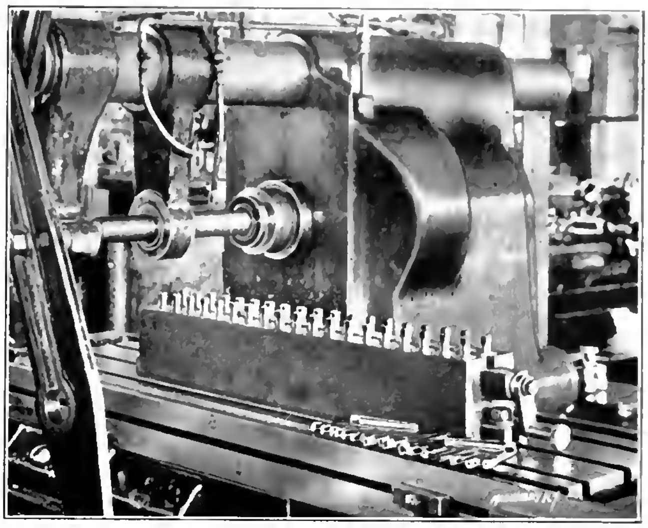
Davey, the apprentice, was first to speak, and he said "Say, how did you get the right- and left-hand thread in that big nut?"

"Why," said one of the boys, "while the two men were filing the thread in the shaft, that wonderful mechanic was gnawing out the nut with his teeth!"

* * *

MULTIPLE INDEXING FIXTURE FOR MILLING SQUARE HEADS

The illustration shows a fixture designed for milling square heads on 38 screws or taper pins at one time. Each piece is held in an individual work-spindle, these being arranged in two rows as shown. The fixture, when filled with work, is fed past two sets of straddle mills on the cutter arbor of the milling machine, which finish two sides of each head at one passage. By turning the crank shown at the end of the fixture, all the work-spindles are then indexed one quarter revolution, and fed past the cutters again, thus completing the square head.

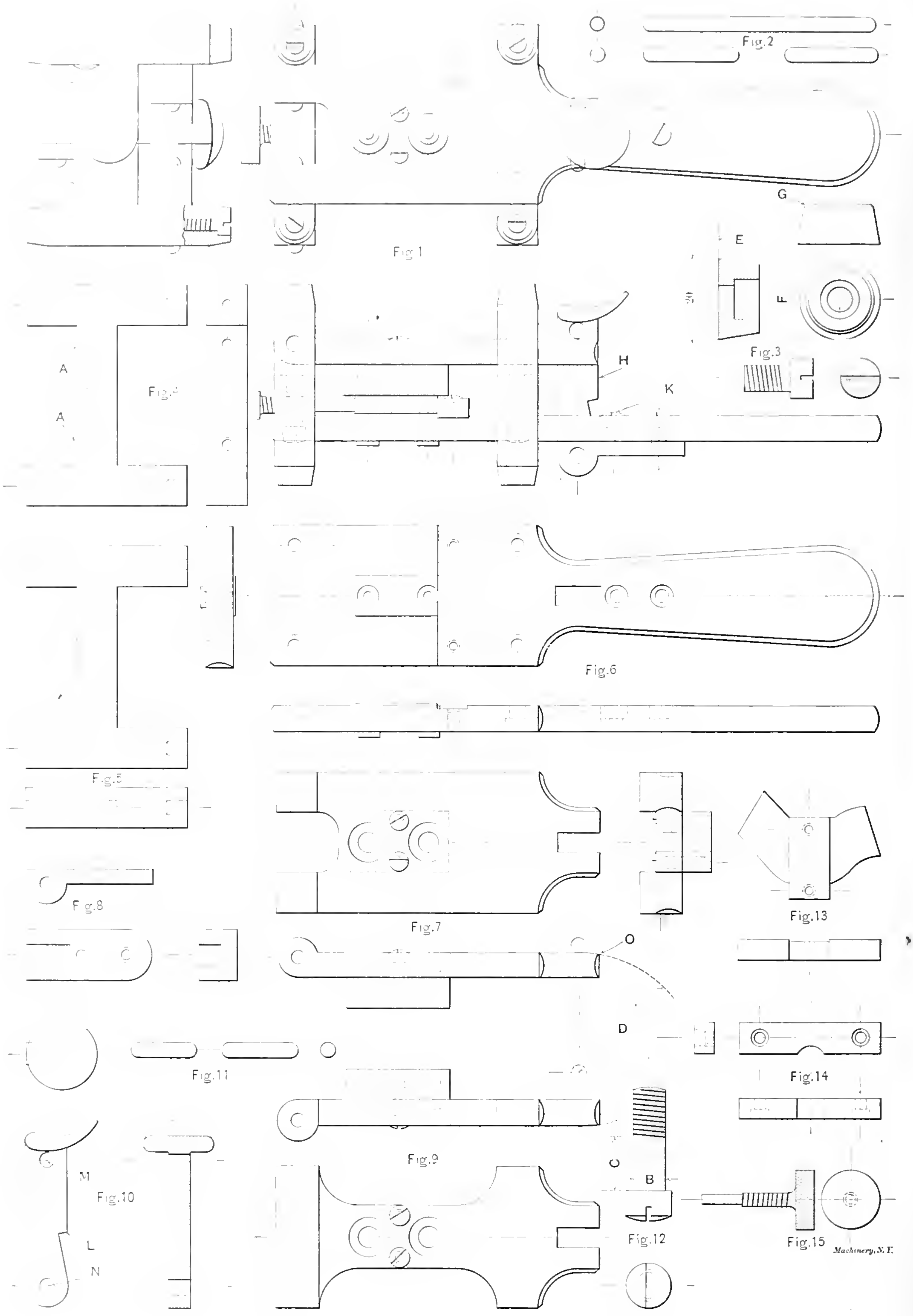


Fixture for Holding and Indexing simultaneously Taper Pins or Screws while Squaring the Heads

The construction is very simple. Each work-spindle has keyed to its lower end a worm-wheel, meshing with a worm running the full length of the fixture, and connected with the crank handle shown. Six revolutions of the latter index the work spindles simultaneously one-quarter revolution. The crank handle has an index pin for locating it in a holder provided in the base of the fixture. Bushings in the work spindles are changed to agree with the parts to be squared. For taper pins simple taper bushings are provided, into which the pins are tapped firmly enough to hold them. After the heads have been squared they are easily removed with a small wrench. Collar screws are firmly screwed into tapped bushings. After the heads are squared they also are easily removed with a wrench. This fixture is in use in the shops of the Landis Tool Co., Waynesboro, Pa.

* * *

The advantages of small additions of vanadium in cast iron are referred to by Mr. J. Kent Smith in the *Foundry*. Small additions of about 0.2 per cent of vanadium are advocated, and examples are quoted showing the increase in tensile strength due to this addition. It also appears that the material does not become harder, but that the increase in strength is obtained without sacrifice of the ease of working the metal. It is mentioned that a locomotive valve bushing of vanadium cast iron which had been in heavy service for twenty-two months showed no signs of abrasive wear, and the original tool marks were still in evidence. A pair of chilled rolls having 0.22 per cent vanadium, showed a wearing life three times that of ordinary rolls made by the same firm without vanadium.

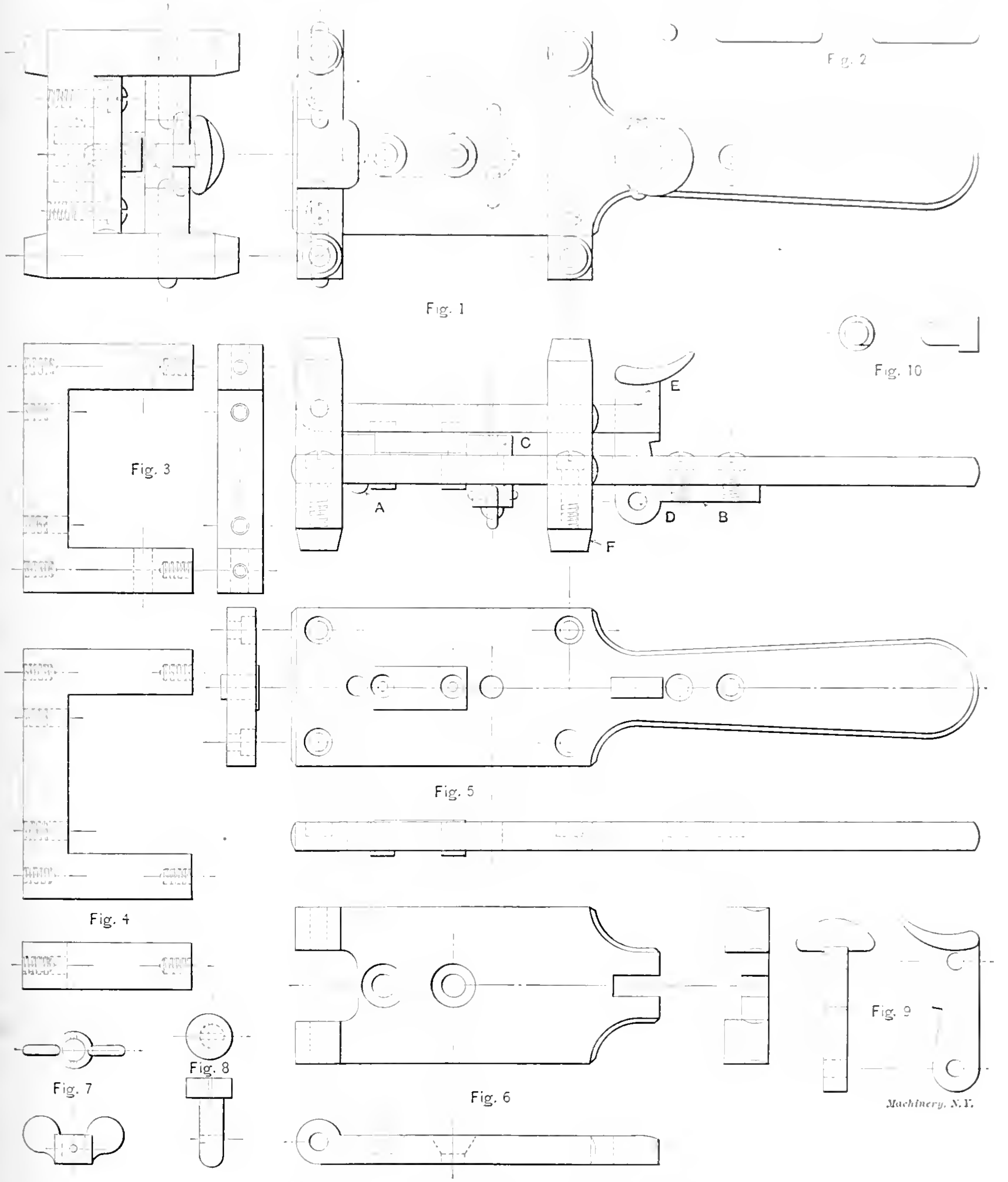


Standard Jig Design No. 1 for Manufacturing Small Interchangeable Parts

STANDARD DESIGNS OF JIGS AND FIXTURES FOR THE MANUFACTURE OF SMALL INTERCHANGEABLE PARTS—1*

FRANK P. CROSBY†

It is a fact well known to most tool designers and toolmakers that no two tool designers usually develop a special tool in the same manner. But little has been done in the way of standardizing the general outlines of jigs and the methods of clamping and locating the work. In the manufacture of large machinery, such standardization is difficult to secure, but in the case of small interchangeable parts it is possible to standardize the design of jigs and fixtures to a considerable extent. In the present series of articles the author will endeavor to show a number of examples of designs of jigs where most of the general features of the jigs are laid out according to a definite standard. The illustrations accompanying the articles will show the jigs referred to both assembled and in detail, and the experienced tool designer will find it more profitable to study the drawings directly than to have to follow a lengthy description of the devices. The descriptions will, therefore, be made as concise as possible, being confined to the most essential points.



Standard Jig Design No. 2 for Manufacturing Small Interchangeable Parts

Design No. 1

Design No. 1, shown in the accompanying full page illustration, is a drill jig for drilling and counterboring a needle bar

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* The following articles on the subject of jigs and fixtures have previously been published in MACHINERY: Milling Fixtures, November, 1905, to February, 1906; Drill Jigs, November, 1906, to January, 1907; Jigs and Fixtures, April, 1908, to April, 1909. See also MACHINERY'S Reference Series No. 3, Drill Jigs; No. 4, Milling Fixtures; and Nos. 41, 42, and 43, Jigs and Fixtures.

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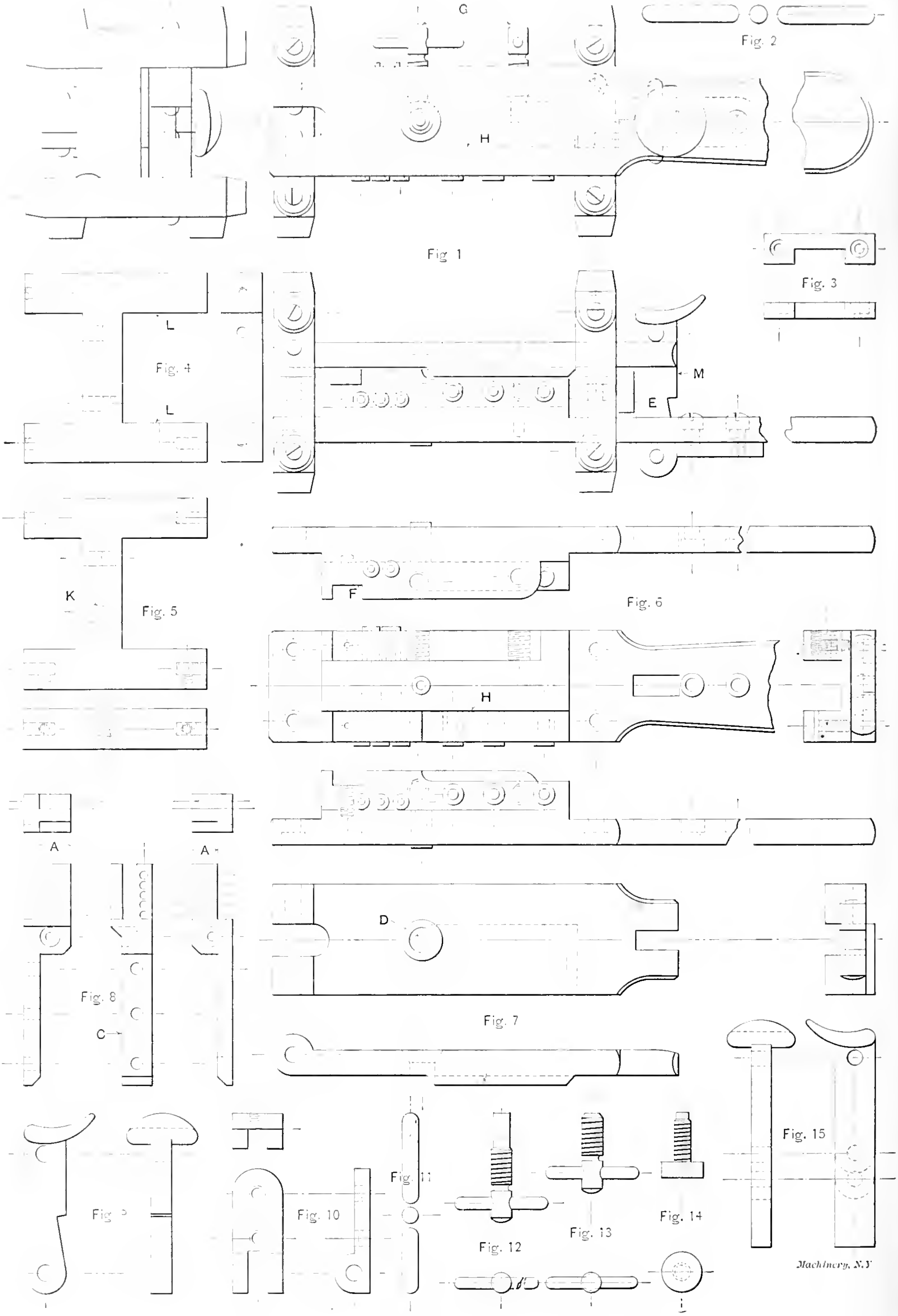

Standard Jig Design No. 3, for Manufacturing Small Interchangeable Parts

cam for a sewing machine, the cam being shown in detail in Fig. 13. It is required that the rivet holes in this cam be drilled and counterbored.

Fig. 1 shows a plan view, elevation and end view of the assembled jig. The jig is shown closed, ready for operation, with the work placed in position. Fig. 4 shows the standard H-shaped frame which can be employed for a great variety of small details of different shapes. The frame has holes tapped for the screws holding the feet, and is provided with the required drilled and tapped holes for the adjusting screw, the frame screws *A* and the hinge pin. The frame screw holes are reamed to a depth of one-half of the thickness of the frame cross-bar. Fig. 12 shows the frame screws in enlarged detail; the diameter at *B* should fit accurately the holes in the lower plate, Fig. 6, and also the reamed part of the holes in the frame, Fig. 4. By making the screws in this manner they serve the purpose of both screws and dowels. The dimension *C* of the screw, Fig. 12, should be a trifle less than the whole distance through the plate and one-half the distance through the frame, in order to permit the screw to bind properly. The diameter of the body part *B* of the screw is 0.005 inch larger than the outside of the threaded portion. The frame shown in Fig. 5 is an exact duplicate of that shown in Fig. 4, with the exception that no holes for the hinge pin and adjusting screw are here required. In Fig. 3 is shown an enlarged detail of the washers serving as feet for the jig, and also of the screws holding the washers to the jig. These parts are made of machine steel and case-hardened. The depth *E* is, on all sizes, made one-half of the diameter *F* and the corner *G* is chamfered to prevent scratching the drill press table. The counterbore in the washer is made a trifle deeper than the length of the screw head, to prevent the head from projecting outside of the counterbore.

Fig. 6 shows the lower plate, firmly held to the frames by the four frame screws already referred to. This plate contains the jig bushings which are shown in place. Fig. 7 shows the top or hinged plate, which is provided with a case-hardened bearing which holds the work against the lower plate by the pressure of the clamp latch *H*, Fig. 1. The arc with the radius *D* is struck from the center of the pin about which the clamp swivels. In Fig. 9 is shown a modification of the hinge plate. The construction is lighter, which in some cases is desirable. The plates are provided with ample clearance holes for drills and counterbores. In Fig. 2 are shown the hinge pins for both of the styles of upper plates. These pins are made from drill rod. In Fig. 8 is shown the latch holder which is attached to the bottom plate by two screws, as shown at *K* in Fig. 1. The latch itself is shown in Fig. 10. It has a notch cut at *L* to allow it to swivel so that its binding pin can clear the end *O* of the hinged plate. The latch can be made up as a standard part except for the pin hole *N*; the pin hole *M* only is drilled, and the hole *N* is left until the dimension from the center of *M* to *N* is known for any particular jig being made. This piece is case-hardened after it has been fitted. In Fig. 14 is shown the stop for the work which is attached to the lower plate and enters a slot in which it is held by two screws. In Fig. 15 is shown the adjusting screw which is also a standard detail. The pins in Fig. 11 are for the latch; these are made from drill rod and hardened.

Design No. 2

Design No. 2 shows a jig for drilling the same part as in Design No. 1, with a slight variation in details. Here also an assembled drawing consisting of plan view, elevation and end view, is shown. In this case both the upper and the lower plates of the jig are placed on the same side of the cross bar of the frame. This permits the plates to be set as close together as required for any piece of work to be drilled in this style of jig. Figs. 5 and 6 show the details of the lower and upper plates, respectively, and Figs. 3 and 4, the details of the frames. In Fig. 9 is shown the latch which is of the same kind as that shown in the Design No. 1. Fig. 7 is a wing nut with the threads removed and is also one of the standard parts used. In Fig. 8 is shown an eccentric cam which may be used in a great many different jigs, and which provides for a convenient means for clamping the work in place. This eccentric cam is turned by means of the wing nut, which is pinned to its stem as plainly indicated in Fig. 1. The stop shown in Fig. 10 is placed at the end of the work opposite the cam, and the work is held between this stop and the cam. The stops can be made standard. They should be made to the same dimensions as the screw heads so as to suit the holes made by the screw head counterbores. The other parts required for the jig, the hinge pins, Fig. 2, the pins *E* and *D* for the latch, as well as the bracket *B*, and the feet, are standard parts of the same dimensions as used in Design No. 1.

Design No. 3

The jig designated as Design No. 3 is used for drilling the two pieces shown in Fig. 8. The only difference between the two pieces is the variation of the width *A*. These pieces are drilled from three sides. In Fig. 1 is shown the assembled jig with the work in position, in Fig. 6 the lower plate with all the bushings in place, and in Fig. 7 the upper plate which is fitted with a projection which clamps the work on the side *C* in Fig. 8. The upper plate is also provided with a clearance hole at *D* for the counterbore. Fig. 3 shows the stop against which the work is held by the binding screw *E*. This stop is made from machine steel and case-hardened and fits into the recess shown at *F*, Fig. 6. The clamping screws *G*, Fig. 1, hold the work firmly against the wall *H*. In Figs. 4 and 5 the frames are shown; both of the frames are alike with the exception of the binding screw hole at *K* in Fig. 5 and the hinge pin holes at *L* in Fig. 4. The upper plate or leaf is held in position by the latch *M*, Fig. 1, which is shown in detail in Fig. 9. Figs. 12, 13, and 14 show the binding screws in detail. Fig. 15 shows the method of making up the standard latch for different jigs, the dotted lines indicating how the latch is finished to different lengths required.

General Remarks

Upon examination of the illustrations shown as Designs 1, 2 and 3, the tool designer will be surprised to find to how many small parts these general designs can be applied, and he will realize that with slight modifications, a variety of jigs can be made up from parts most of which can be kept in stock. The drawings have been made in the same manner as they would be made for shop use, with the exception that dimensions have been left off. Complete details are shown, as this is most essential to the proper making of the tools. It is a great mistake not to show the work in detail, as is sometimes the practice in jig and fixture work, because but little extra time is required in the drafting-room, and that time is more than made up for by the ease with which the tool-maker can understand the construction of the tool. The liability of mistakes is also largely eliminated and there is no need of verbal explanations as is otherwise often the case.

* * *

LIGHT GASOLINE MOTORS

In the July, 1908, number of MACHINERY there appeared an illustrated description of the Adams-Farwell multiple-cylinder gasoline engine built for an aeroplane flying machine that is remarkable for extreme lightness. It has a capacity of 36 horse-power (figured by the A. L. A. M. rule) with a weight of only 97¼ pounds. The weight per horse-power, therefore, is only 2.7 pounds. To produce one horse-power or the equivalent of lifting 33,000 pounds 1 foot high in one minute with a dead weight of only 2.7 pounds was and is a most remarkable achievement. Whether the flying machine ever develops into a commercial possibility or not, the fact that experimental work on it has enabled us to develop power with such remarkably light engines, means much for many other businesses in which light motors are desirable. It is interesting to compare the weight of this motor per horse-power with the massive engines constructed in the time of James Watt. Then, and many years later, it was the common belief and practice that great weight was essential in large engines. The development of the marine engine did much to show the fallacy of this idea, and the later development of the automobile engine still further discredited it. The airship motor is the last word to date.

TRUING A BENCH LATHE BED

WALTER GRIBBEN*

The bed of the lathe that is much used naturally wears hollow just in front of the head-stock, and this is particularly the case with a bench lathe, as this type is used largely for chuck work. Such a lathe had been in almost constant use for nearly twenty years, so it was thought advisable to true up the bed. A cast iron templet of the shape shown in Fig. 1 was first made. The length of this templet was about two-thirds that of the lathe bed, and two V grooves were planed in it that were duplicates of the grooves in the bottom of the tail-stock. The templet was made in the form shown so that it would resist bending or torsion, and yet not be very heavy.

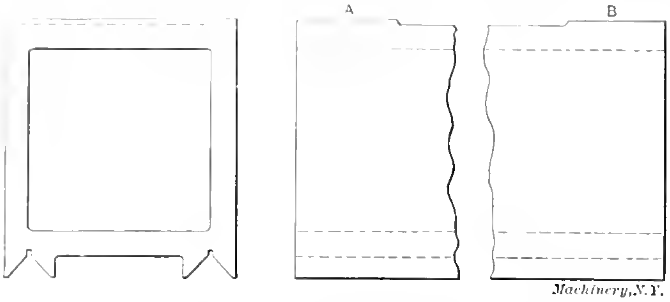

Fig. 1. Master Surface Plate used in Scraping the Ways of the Lathe Bed

The distance between the V's of the lathe bed was determined by means of a microscope held vertically in the slide rest as shown in Fig. 2. A brass block *A* was made with a V groove in the bottom to fit the V's on the lathe bed. On the top of this block two fine lines were scribed, one being parallel to the lathe bed, and the other at right angles to the first, but not quite touching it. This second line was to ensure the observations both being taken at the same part of the first line, in order to eliminate any error that might arise from want of parallelism between this line and the bed. The block *A* was first laid on the front V and the microscope sighted on the marks on its surface, which appeared through the microscope as shown at *B*. As indicated, the eye-piece of the microscope has cross lines arranged like the letter X. By adjusting the cross feed-screw and the block *A* along the bed, the intersection of these lines was made to coincide with one edge of the longitudinal line at a point opposite the transverse line. When the block and microscope were set, the reading of the cross feed micrometer was noted. The block was then placed on the back V of the lathe bed, after which the cross slide was moved until the intersection of the cross lines again coincided with the line on the block as before. The reading of the cross feed micrometer was again taken, and a comparison of the two readings noted, allowance being made for the number of complete turns that had taken place. By this method the distance between the V's from apex to apex was obtained. A gage with hardened and lapped ends was then made, of 5/16-inch drill rod, to exactly this dimension. This gage was enclosed in a wooden jacket as shown in the end view at *A*, Fig. 3, to prevent changes in its length from the heat due to handling. The lower side of the jacket, and also the side against which the strip *a* is screwed, were both made parallel to the length of the drill rod, so that when the enclosed gage was laid on the cross rail it would be parallel with the latter.

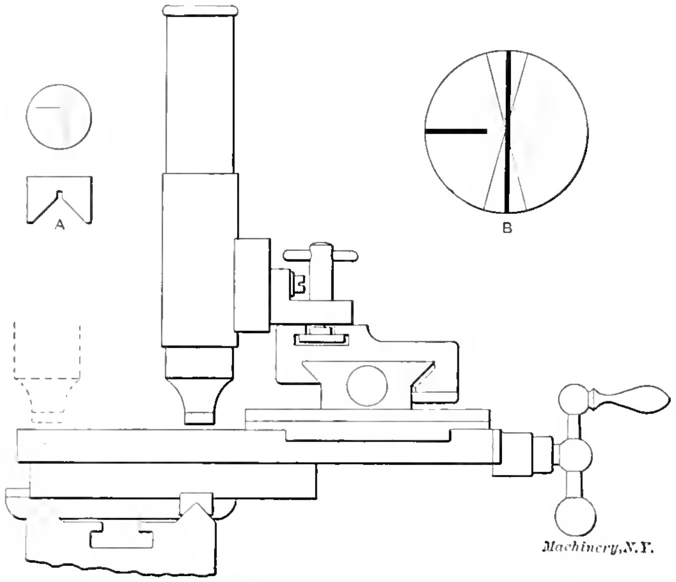

Fig 2. Obtaining the Distance between the Ways by the Use of a Microscope

The templet casting was first placed on the planer in the position shown in Fig. 1, and the feet *A* and *B* planed. Care was taken not to clamp the casting down any tighter than was necessary during this operation. It was then turned over so that the planed surfaces rested on the platen to which red-lead had been applied in order to determine if both feet touched it throughout their entire area. This was found to be the case, so the V's of the templet were next planed. The dial indicator *B* was clamped to the cross rail of the planer as shown in Fig. 3, and the saddle brought into contact with it while planing one V. The gage *A* was then interposed between the saddle and the indicator while planing the other V, the saddle being so adjusted for the finishing cuts that the indicator read the same in both cases. When the head was swung over to plane the other slope of the V's, of course the indicator had to be moved to a new position on the cross rail. The same scheme was also used to space the two positions of the parting tool that was used to cut out the bottom of the grooves, preliminary to planing the V's.

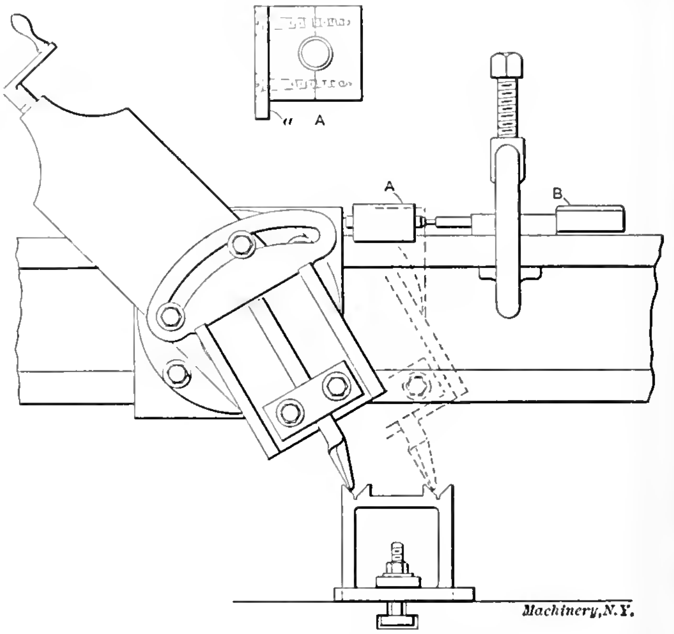

Fig. 3. Planing the V's in the Master Surface Plate or Templet

After finishing the planer work on the templet, it was tested with a spirit level both for wind and straightness. Two pieces of 3/8- by 5/8-inch rolled brass were drilled, tapped, and the face *a* (Fig. 4) carefully turned at one chucking; these pieces were then screwed on the chuck. The finishing cuts for both pieces were taken with the same setting of the milling cutter so as to make them exact duplicates in regard to the location of the V-surfaces in relation to the faces *a*. The method of testing the templet for wind is shown in Figs. 5 and 6. The templet was supported on the bench by three leveling screws, *C* and *D* being at one end while *E* was at the other. The two brass pieces *B* were then laid in the V grooves near one end of the casting, and a ground spirit

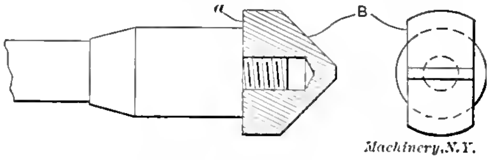

Fig. 4. Method of Machining the Small V-blocks used as indicated in Figs. 5 and 6

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level laid on top of them as shown. The screws *C* and *D* were then adjusted until one end of the bubble coincided with one of the marks on the vial. Then the blocks *B* were moved to the other end of the casting, and the level applied as before. The bubble moved to the mark with which it coincided before, thus showing that there was no wind in the V's that could be detected with that particular level. It was not a precision level, but was a great deal better than the ordinary blown level. The vial was ground true on the inside, while the outside was marked transversely by lines about 1/10 inch apart, the curve of the vial being such that the travel of the bubble from one mark to the next represented a change in direction of the base, amounting to .012 inch per foot. By using a magnifying glass, much smaller variations than this could be detected. As an accurate straight-edge of sufficient length was not available for testing the straightness of the V's, they were verified by using the spirit level and the blocks *B* as shown in Fig. 6. The blocks were first placed near one end of the casting, and the screw *E* adjusted until one end of the bubble coincided with one of the marks of the vial. The blocks and level were then moved to different positions along the length of the groove, and as the bubble remained in the same position, it was assumed that the planing was straight enough for the job in hand. In order to true up the V's of the lathe bed, a thin layer of Prussian blue was applied to the V grooves of the templet which was then moved along the bed to transfer the coloring matter to the parts that needed scraping down. After a sufficient amount of scraping, the V's on the bed showed a bearing throughout their entire length when the templet was applied.

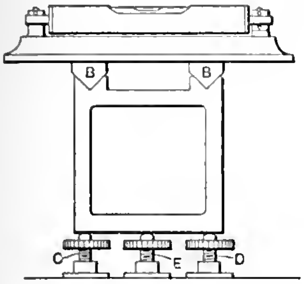


Fig. 5. Testing the Ways to see if they are in the same Horizontal Plane

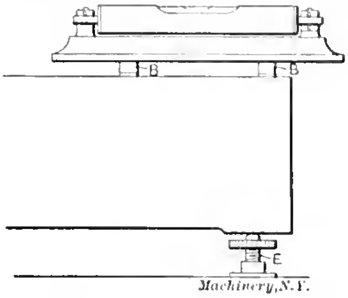


Fig. 6. Testing the Straightness of the Ways

* * *

Most of the penny-in-the-slot machines are worked by "victimized power"; that is, power derived from the patron or "victim." The patron furnishes the muscle that works the mechanism as well as the cent that releases the operating machinery. Strange to say, the element of action on the part of the user is an important factor in the success of some of these machines. It appears that many of the users of these machines enjoy pulling a lever; they somehow feel that they are getting more for their money than if they simply pressed an electric button. A certain fortune-telling machine was first put out with an electric motor driving the machinery. The patron only had to deposit his coin and place his hand on a slab in which there are many projecting studs to have his fortune told. The machine did not prove to be a "money puller." The motor was discarded and a long lever was substituted, which must be pulled each time a fortune is told. This machine yields a handsome income. The experience adds to our knowledge of the curious phases of human psychology.

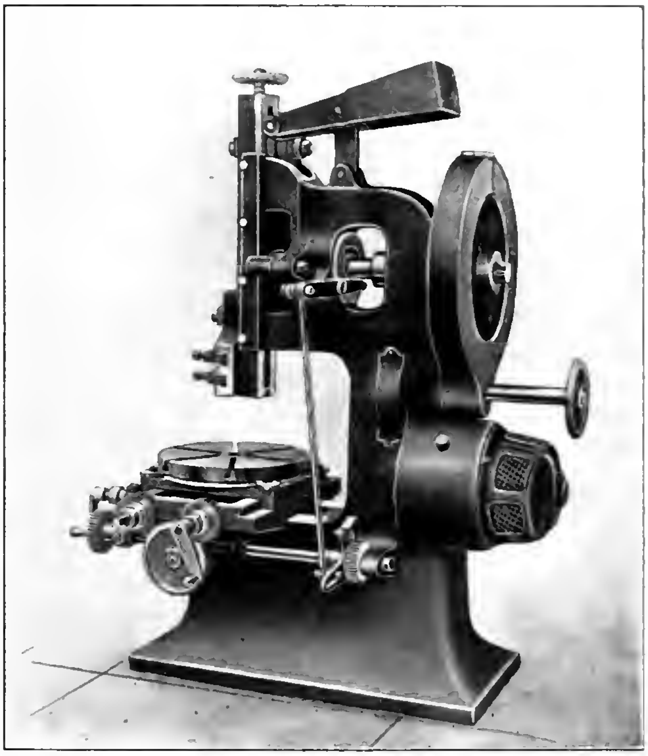
* * *

The "bleeding" of pine trees for their resin has generally been regarded as injurious to the timber, and in the specifications of many architects and railway companies, the "bled" timber is excluded. Investigations have been undertaken by the Forest Service of the United States Department of Agriculture in order to ascertain to what extent such timber is injured. The results of these tests indicate, however, that the "bled" timber is as strong as the "unbled" if of the same quality otherwise; that the weight and strength is not affected by the "bleeding"; and that the durability is the same of "bled" as "unbled" timber.

ENGLISH TYPE OF ELECTRICALLY-DRIVEN SLOTTER

JAMES VOSE

The slotter illustrated herewith is one of the line built by John Stirk & Sons, Halifax, England. The distinctive feature of this machine is the motor drive which, as will be seen, forms an integral part of the design. Incidentally this feature has proved of value in an unexpected direction as under the revised tariff of one of the British colonies, if a motor forms an integral part of a machine, as in the present case, the duty on the electrical portion is on a lower scale than if the same size motor was applied as an attachment. The motor for this machine may be of the direct-current, constant-speed, shunt wound, or direct-current, variable-speed, interpolar type. The motor being built into the machine economizes space and adds to the rigidity of the design. The number of strokes arranged for varies from 20 to 60 per minute, a gear box being used in conjunction with the constant-speed motors. The length of the stroke ranges from 6 to 24 inches. The table diameter is 24 inches, and its longitudinal and transverse movements are 12 and 15 inches, respectively. The machine will take work up to 46½ inches in diameter on top of the table. Both longitudinal, transverse and rotary power feeds having a wide range, are provided. The size of machine shown is equipped with a 2½ H. P. motor. The complete weight of the slotter is approximately 5,500 pounds, and the price F. O. B. is $735.00.



Electrically-driven Slotter with a Motor which forms an Integral Part of the Machine

[There are doubtless advantages in having the motor an integral part of an electrically-driven machine, but it has been demonstrated by American machine tool builders, that what is gained in the way of compactness and rigidity is more than offset by the disadvantages of such design. In event the motor of a machine, of which it forms an integral part, is incapacitated by the burning out of an armature or otherwise, the machine will have to remain idle until repairs can be made, unless, as is not probable, the defective motor can be replaced by another. If, however, the machine were driven by a standard motor, which was simply bolted to the frame, the latter could easily be removed and replaced by another if necessary. In a shop where electrically-driven machines are in use, it is more than probable that such a motor would be available, and, consequently, it would not be necessary to keep a valuable tool idle.—Editor.]

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* Address: 328 Moss Lane East, Manchester, England.

ROLL GROOVING MASTER TOOLS*

M. B. STAUFFER†

The method of making the master tools which are used to make the cutting tools for grooving flour-mill rolls, is described in the following (since a large per cent of mill rolls are 9 inches in diameter, I shall treat that size tool):

The blanks are first made as shown in Fig. 1, the outside being rough turned. They are then gashed, as shown in Fig. 2, with the proper number of teeth, which ranges from eight to twelve. After keyseating the blank it is placed on the milling machine arbor in proper relation to the cam *D*, as shown in Fig. 3. It is desirable to have the cam operate as shown, as the tool will then be positively withdrawn from the work and interference will be avoided.

The circular attachment is placed on the milling machine table and set so that its center line coincides with the center of the blank *A*.

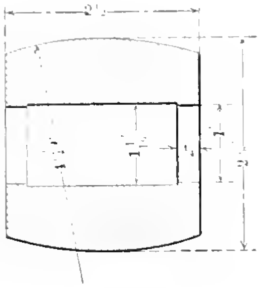


Fig. 1. Rough-turned Cutter Blank

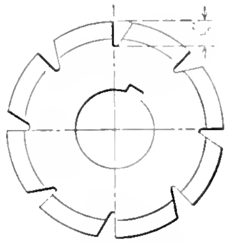


Fig. 2. End View of the Gashed Blank

On the circular attachment is placed the auxiliary tool slide *B* which should be arranged with a positive stop. For the finishing cut, the point of the turning tool must be 4½ inches from the center of the attachment. The feed screw nut must be disengaged from the feed screw and a spring or weight attached to the table to keep the stop *C* against cam *D*. The tool should be set to the same height as the center of the arbor.

We are now ready to proceed with the finish turning and simultaneous relieving of the lands. After turning the blank, the tool shown in Fig. 6 is inserted in the slide. This tool must have enough clearance to allow for the advance of the cam. The first serration should be to the full depth, as shown in Fig. 4, and the positive stop should then be set. It will be understood that when the tool just touches the blank it must be 4½ inches from the center of the attachment. The indexing is done by use of the dial on the hand-wheel shaft of the circular attachment. It is imperative that the indexing be accurate or the cutting tools will not work well and may break the corrugations on the rolls.

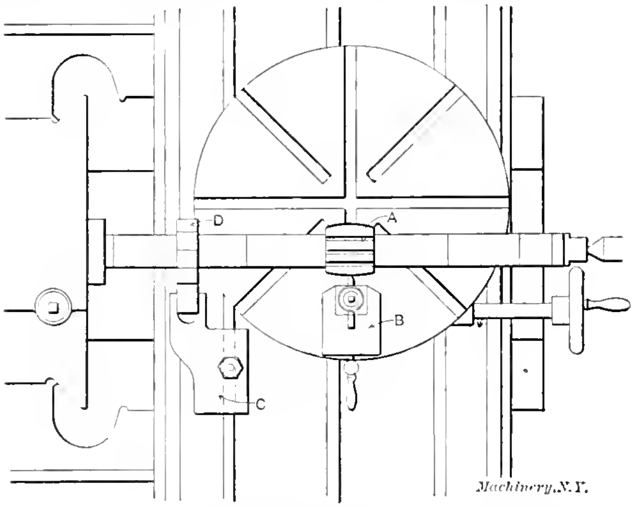
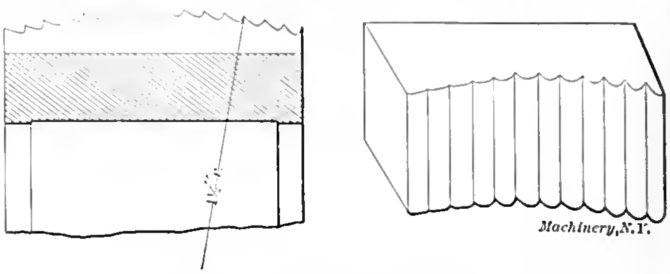


Fig. 3. Milling Machine arranged for Finish Turning and Serrating the Cutter

The depth of the serrations depends entirely on the style of corrugation. The one shown is commonly called the "saw tooth" corrugation and is 1/16 inch deep when standard, having 1/16 inch pitch.

The clearance will not be ideal but near enough for all practical purposes. The tools will be superior to the old style tools which were made without clearance, and which burnished the metal into shape instead of cutting it. When finished, the cutters look like the one shown in section, Fig. 4.



Figs. 4 and 5. Section of the Cutter, showing a Serrated Tooth, and One of the Grooving Tools

A convex cutter without serrations will be found very useful for milling the cutting tools, Fig. 5, concave. The cutters may be hardened in oil and need not be drawn to more than 400 degrees Fahrenheit. They must be carefully handled and should be used only on well-annealed stock, or the sharp points will be quickly destroyed.

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* For additional information on this subject, see MACHINERY, May, 1906, "Grooving Chilled Floor Mill Rolls," and June, 1906, "Roll Corrugating Device."

† Address: Scottdale, Pa.

* * *

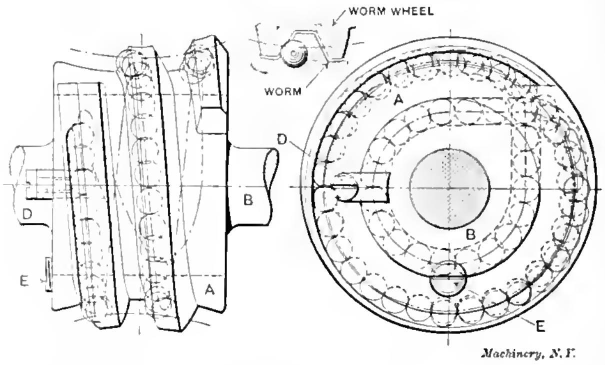
A BALL-BEARING WORM

Some years ago there was described in the various technical papers a ball-bearing nut, designed by the Sprague Elevator Co. for use in passenger elevators. A helical row of balls was interposed between the threads of the nut and those of the screw, to receive the thrust of the load. A suitable transferring tube led the balls from the top of the nut back to the bottom (or *vice versa*) where they again entered the space between the nut and the screw. The balls thus followed through their path in a continuous stream furnishing a rolling contact between the screw and the nut to take the pressure of the load.

Fig. 6. Tool for Serrating the Cutter Teeth

In the accompanying illustration, taken from *Le Genie Civil*, is shown a worm which is a counterpart of the Sprague Elevator screw. The acting face of this worm is channeled to form a race for an endless row of hardened steel balls, which are led at one end of the thread through an internal return duct, re-entering the race again at the other end of the thread. The construction is plainly shown in the engraving.

The worm is of the globoid or Hindley type, with a concave or "hour-glass" shape. The threads are cut on a shell *A*, which is mounted on a body *B*, to which it is held by screw *E* which prevents it from moving and thus as well from turning. A channel of such shape as to retain the balls is cut in the acting face of the worm. A corresponding reversed helical groove is cut in the periphery of the body *B* to lead the balls back again, suitable connecting holes being drilled between the grooves in *B* and those in the teeth in *A*. The channel is filled full of balls through an opening, closed by a cover and screw at *D*.



A Worm whose Contact with the Wheel is made on Ball Bearings

This ball bearing worm is built on what is known as the Système Parrouff et Arlaud. The scheme is interesting, but it appears that there would be a sliding movement in a direction radial to the axis of the worm which the ball bearing will not take care of. It must be admitted, however, that the construction shows great ingenuity.

* * *

AUTOMATIC MILLING MACHINE ATTACHMENT FOR MANUFACTURING INTERNAL GEARS

In the *Zeitschrift des Vereines deutscher Ingenieure* of March 20, 1909, is described a slotting attachment for the milling machine, particularly adapted to cutting the teeth of internal gears, and for doing internal slotting in general which requires the indexing of the work. Fig. 1 shows the attachment applied to a milling machine, while Fig. 2 gives the details of its construction.

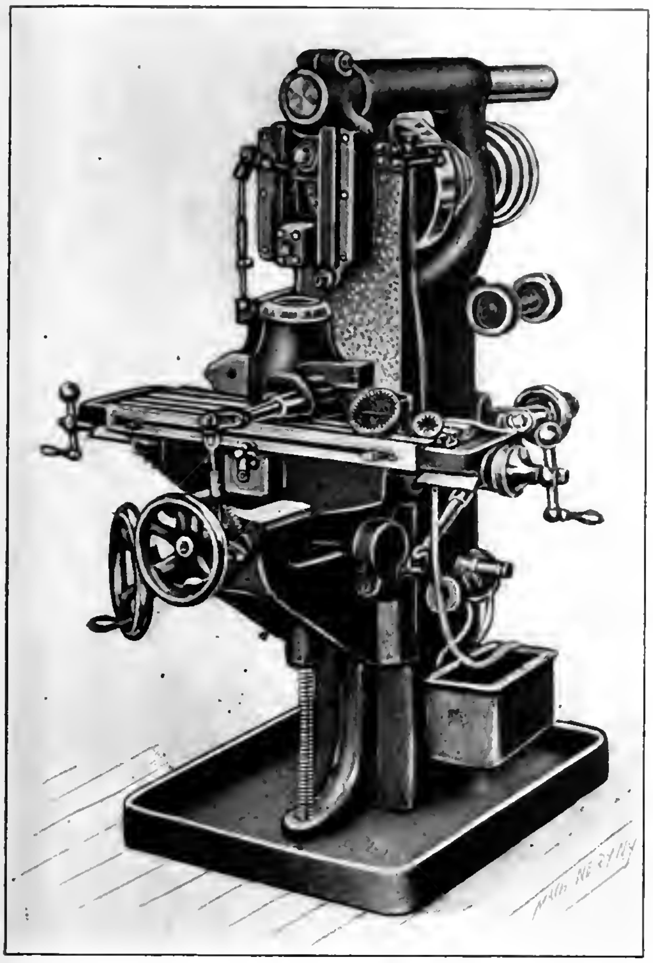


Fig. 1. Slotting Attachment to Milling Machine for Cutting Internal Gears in Quantities

This device consists of two parts—the slotting attachment proper, and the work holding and indexing device. The slotting attachment consists of a ram *A*, which slides in ways in the body of the device, and is driven by a crank-pin attached to the milling machine spindle. The length of stroke is adjustable. The body of the device is fastened to the supporting arm of the milling machine, and is screwed to the column as well, to prevent motion sideways. The work *M* is gripped in a chuck *H*, bored to receive it, and held by dowel pins and screws to the spindle *S*. The work is indexed at each stroke of the tool on the up movement of the ram. This is effected by stud *B* on the ram *A*, operating through the connections *C* and *D*. The vertical plunger *E* has rack teeth cut in it, engaging the teeth in the gear *F*, which in turn meshes with pinion *G*. The latter engages the rack teeth of the horizontal plunger *I* and is thus moved positively forward at the end of the up stroke of the tool. It is drawn back again by the spindle as soon as the tool slides forward to descend. Connection is made by the rack *I* and a lock bolt *N*, so that the latter is withdrawn as *I* moves forward, leaving locking wheel *L* and index ratchet *K* free to revolve the work spindle and the work. A dog on rack *I* engages a stop, not visible in the illustration, which turns the index ratchet *K* and at the same time the chuck *H* and the work. At the conclusion of the movement locking bolt *N*, under pressure of spring *P*, slides back, locking the spindle and the work in the new position. Lock disk *L* and ratchet *K* must have the same number of teeth as the gear to be cut.

When a complete revolution of the work has been made by the means described, the saddle is moved outward slightly along the slide, thus setting the work for a new cut. This is effected by lever *W*, shown in dotted lines, which is pressed upward by dog *R* on a plate keyed to the spindle. By this means, through rod *V*, the arm *U* is operated, and the ratchet wheel turns the cross feed screw slightly, thus setting the work to depth for a new cut. Adjustable dog *T* limits the amount of feed. Provision is made throughout this attachment, by adjustable connecting rods and universal joints, for setting the machine up for work of widely varying dimensions.

This method of cutting internal gears has some advantages over the method of cutting them with an internal attachment in the automatic gear cutter. The drive for the cutter by the latter method is far from satisfactory, and it is necessary always to provide in the work a large clearance space for the cutters to run out into. Using the slotting attachment shown herewith, a narrow groove will suffice to give clearance. The indexing of the work at every stroke, and the provision for stopping the feed when the proper depth of cut has been reached, make the device automatic, so that the operator is free to attend to other work. There remains only the necessity for occasionally cleaning the work of chips, where the clearance space provided is unusually small.

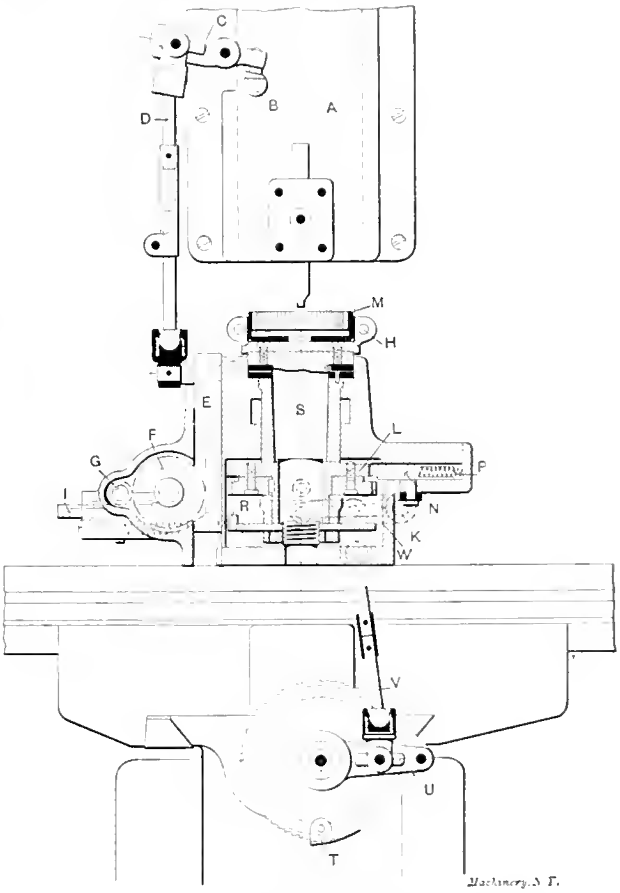


Fig. 2. The Mechanism of the Automatic Slotting Device for Internal Gears

* * *

The total exports of machine tools from Germany in 1908 amounted to 58,522 metric tons, and the total imports in the same year to 5,843 tons. The exports increased by 500 tons, while the imports decreased by 2,300 tons, from the previous year. Germany's best customer for machine tools is Italy, with Austria-Hungary a close second. France, Belgium and Russia also take a great deal of their machine tool supply from Germany. Of the imports of machine tools, more than 50 per cent came from the United States.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

LIMITATION OF MACHINE CAPACITY

The improvement in machine tool capacity during the last few years, since the introduction of high-speed steel, apparently has brought designers in sight of the ultimate limit of profitable capacity on certain machines which require manual operation. When the efficiency of the machine reaches the point where the handling of the product to and from it requires as much time as the actual operation, the opportunity for profitable increase of mechanical efficiency has become small, and it soon vanishes beyond that point. Further gain can only be made by dispensing with the operator, making the machine automatic, and the moment this is done an entirely new set of conditions is created.

To illustrate the point, take the case of high-speed drilling. Several months ago we referred to a drilling machine that on test had make the remarkable record of drilling cast iron with a 1½-inch high-speed drill at the rate of 29 inches per minute. So rapid was the downward travel of the spindle that it was necessary to set the feed throw-out stops before starting in order to prevent drilling into the platen underneath, even when the work was raised an inch above it! Suppose this piece had four holes, 4 inches deep, to be drilled. Then the actual drilling time required would be, say, 34 seconds. The time for lifting the casting upon the machine, adjusting the drill to the drilling positions and its removal would be, say, one minute, the best that could be done. That is, the handling time is nearly double the drilling time, and the actual drilling time bears a smaller and smaller relation to the handling time as the mechanical efficiency is increased, soon becoming so small a fraction of the operator's time after even time is passed, as to make further increase of mechanical efficiency unprofitable.

In the case of driving-wheel lathes, the production has reached the figure that makes the labor cost of handling the wheels greater than the operator's wages. Further improvement must be in the direction of reducing this labor cost, or, to put it more plainly, after a certain degree of mechanical efficiency is attained, it becomes more profitable to make further improvements outside the machine to reduce the labor and time of handling the material by devising extraordinary means for handling the work with speed. There is, however, the possibility of so highly developing a machine and its attendant features as to throw the shop out of balance because of lack of coordination of other departments. Often in such cases the highly developed machine cannot be profitable to the shop until the other parts are brought up somewhere near the leader's productiveness. There is the fact to be considered in all cases, that greatly increasing mechanical efficiency means a large increase of investment and consequent interest and depreciation charges. These at some point become so great that further increase of labor-saving capacity is actually unprofitable.

* * *

HIGH-GRADE STEEL FOR STAYBOLTS

The recommendation of Mr. H. B. Wille in his American Society of Mechanical Engineers paper, "A New Departure in Flexible Staybolts," to use small diameter spring steel stem staybolts instead of the large diameter iron bolts commonly used, is one that should receive the attention of locomotive builders and all concerned with the difficult problem of locomotive boiler upkeep.

It is evident to anyone who has studied the problem that the iron staybolt cannot withstand the severe service imposed on it, because the elastic limit of the material is constantly being exceeded. There apparently is no practical way to avoid it, notwithstanding the activity of inventors of flexible staybolts. The difference in temperature between the outer and inner plates of the firebox section of the boiler may sometimes be 300 degrees F. or more. Using the proper coefficient of expansion, a simple calculation shows that the deflection of two adjacent staybolts four inches apart is $0.0000066 \times 300 \times 4 = 0.0079$ inch total movement, which, equalized on two bolts, makes 0.00395 inch movement imposed on each staybolt perhaps only four inches in length, or less, rigidly secured in opposite plates. Often the total movement of the inner plate is all in one direction, thus throwing the total deflection on each. Experiments have shown that the best one-inch iron staybolt subjected to the vibratory test, wherein one end is rigidly secured and the other is revolved at the end of a radius of 3/32 inch and under a tension load of 4,000 pounds, breaks with about 6,000 vibrations.

It is no wonder then that staybolt breakage is a common trouble in locomotive boilers. The elastic limit of the material is exceeded whenever a boiler is cooled off for washing or repairs, and doubtless many times every day under heavy steaming. Observation has shown that the fire-box sheets are in continuous motion relative to the outer sheets, because of the varying temperature.

The recommendation to use spring steel stems with soft ends that can be riveted over, appears to be a common-sense solution of the problem. These bolts with 7/16-inch stems have a tensile strength of 32,000 pounds, and withstand vibratory tests of 500,000 to 1,000,000 vibrations.

Steel of high elastic limit and tensile strength can be used in many places where no other material will be successful. The automobile has shown constructors and designers the need of such materials, and the growth of the use of high-grade alloy steel as a consequence is one of the best evidences of increasing expert metallurgical knowledge and production. In steam engine construction, the use of spring steel piston rods and connecting-rods would undoubtedly lessen failures, balancing troubles, friction, and to some extent, condensation of steam on the piston rods because of reduced diameter.

* * *

Realizing the importance of water power, the United States probably will withdraw some of the land under public domain on which are valuable water power sites. Mr. George O. Smith, director of the United States Geological Survey, has recommended to the Secretary of the Interior that 236,365 acres of public land be withdrawn which are located in Utah, Colorado, Wyoming, Montana, Idaho, and Oregon. Various powerful corporations have been acquiring valuable water powers in the west with a view of monopolizing these natural power privileges which with the development of long distance transmission, have acquired in recent years values almost undreamed of a generation ago.

THE PRESERVATION OF IRON AND STEEL

The present age of iron and steel is one of great waste, particularly of so-called permanent structures, because of the rapid deteriorating effect of rust. The great problem for the metallurgical engineer is to find some means for protecting iron and steel from the corrosive tooth of time. Our great steel bridges, instead of being permanent, are rapidly decaying, as no satisfactory means have been found to stop the insidious action of rust. In great cities, particularly in Pittsburg, may be seen buildings sheathed with sheet steel in an advanced state of rust, great holes having appeared in roofs and sides. A few years more of decay will cause the buildings to tumble into ruins. It is a startling fact that the durability of wooden and steel structures is in favor of the wooden structures, barring the liability of the latter to be destroyed by fire. A paper on the preservation of iron and steel was read by Mr. Allerton S. Cushman before the British Iron and Steel Institute, in which the importance of the subject was impressively worded, and we quote from it as follows:

"Increasing consumption of the world's supply, and constant decay of materials menace the future of the human race. It is evident that carbon from which we derive energy, and iron which provides the possible means of providing energy are the materials which should particularly engage the attention of those who are studying the problems of conservation. The annual production of pig iron in the United States alone grew from 13,789,242 tons in 1900 to 25,307,191 tons in 1906, and while for the year of 1908, owing to industrial conditions, it decreased to about 16,000,000 tons, it seems sure to again show an increase in the near future. How much of this enormous and constantly increasing world's product of iron and steel is wasted for the lack of adequate preservation? Where will the growth of the demand stop, and how many years will the world's ore supply stand the drain upon it? These questions are of vast importance, and the answers can only be vaguely guessed. One thing seems certain: civilization must learn to conserve more efficiently its store of iron and steel already manufactured, and seek methods of preventing the almost resistless tendency of iron to return to its union with oxygen from which it was won only by the vast consumption of quantities of the fast dwindling coal supply. It is not generally realized that about four tons of coal or its equivalent is used for making one ton of finished steel from the ore. If steel could be by any means whatsoever ennobled, and thus protected from decay due to corrosion, future conditions for all years to come could be viewed with complacency. There exists in Delhi, India, an iron monument that since the beginning of history has been exposed to the weather without the result of decay, and yet this column has been provided with no protective coating other than that which the atmosphere has itself formed upon it. It is probable that with all our boasted knowledge we could not build its like. Yet the art is not necessarily lost forever. It is simply a case of whether or not it is worth our while to rediscover it."

* * *

THE MORSE DRILL TAPER SHANK TANG

The number of methods of restoring broken tang twist drills to a new period of usefulness that have been devised within the last few years is good evidence, though none was required, of inherent weakness in the Morse taper shank. The tangs on the large sizes of drills cannot long withstand the heavy torsional stress imposed by the powerful drilling machines of the present time, and large numbers of drills are damaged by twisting off the tangs in heavy drilling. The need of means for restoring such damaged drills to service has been commonly felt, but notwithstanding the fact that hundreds of concerns were throwing thousands of drills away as scrap, practical methods were not provided to check the waste until lately.

The weakness of the Morse shank made so apparent in recent years emphasizes the great advance made in the power of the present-day machine tools. Years ago when the Morse twist drills with taper shanks were brought out, machine tools rarely had sufficient power to twist off the tangs of drills in regular work, such accidents being the exception rather than the rule. If tangs were twisted off the fault was generally in poorly-fitted shanks and defective collets. The use of machine steel for collets was productive of a large number of failures of this character, and probably defective collets are largely responsible for damaged drill shanks now, but in the rush of modern manufacturing, it seems practically impossible to keep all drill press equipment always up to the mark. The enlarged tang and other means for increasing the torsional strength of the twist drill shank have come as a matter of necessity.

The manufacturers of machine tools and of twist drills should agree on a set of new standard drill shanks with enlarged tangs, and while conferring on this matter, they will find the time opportune to consider the advantages of the "Jarno" taper of 0.600-inch taper to the foot, over the mixed common tapers of approximately ⅝ inch per foot. But, while the manufacturers are influential in bringing about needed changes of this nature, the users are to be reckoned with; and their present equipments are a formidable obstacle to a common standard, no matter how advantageous it may be. A change in tapers and tangs can be brought about only by concerted action of the leading makers and users, and no doubt even then it will be slow.

* * *

CORPORATION TAXATION

At the annual banquet of the Ilion Board of Trade, Ilion, N. Y., Mr. Fred J. Miller, assistant to the president of the Union Typewriter Co., New York, spoke on "Corporation Taxation" in part as follows:

"Without having especially looked into the matter, I take it for granted that Ilion has encouraged the growth of manufactures within her boundaries; that she has endeavored in all proper ways to encourage those of her citizens who have endeavored to do things calculated to build up and develop the town, and one of these ways is by the proper handling of taxation. In these days taxation of industrial enterprises is attracting a good deal of attention, and with your permission we will consider briefly some of the things which a community can do, by means of taxation, to encourage manufacturing enterprises.

"It ought to be obvious that a town which aims to grow should encourage as much as possible those things which cause growth, and discourage as much as possible those things which retard growth; to encourage the workers—the doers of beneficial things, and to discourage drones or those whose influence is adverse to healthy growth. This can be done by means of taxation. We often hear of towns which offer, as an inducement for the location of new manufacturing establishments, exemption from taxation for a term of years. This is, however, sometimes objected to by already established industries, especially when engaged in the same line of business, and which are often taxed heavily—I think properly objected to.

"Taxation, it seems to me, should not be levied upon the commonly accepted, but nevertheless socialistic principle, that the amount paid should be in proportion to ability to pay, but should rather be levied in proportion to the direct pecuniary benefits received by the taxpayer from the community or from the governmental organization for the support of which taxes are collected. In too many communities the opposite course is followed with the result that those who are doing most to build up the town are the most heavily fined for doing it, while those who are doing nothing to build up, but are reaping the pecuniary benefits of others' efforts, are most lightly touched by taxation.

"Such is the effect of levying comparatively heavy taxes upon factories and their equipment, upon business buildings and the goods within them, and upon the houses and furniture of citizens, while at the same time levying taxes proportionately much lighter upon vacant lots and unutilized land which is being merely held at prices that more or less completely anticipate future development and the demands of population.

"Let me not be misunderstood. I refer in a general way to the principles that should govern in a town which wishes to grow, and call attention to the fact that by assessment and taxation those things which do most to build up a town can be discouraged or encouraged, and that those things which do most to retard its growth can also be discouraged or encouraged."

The principle of promoting manufacturing industries by equitable distribution of the tax burden, making the land the basis for all assessments, is one of undeniable importance to manufacturers wherever located, and we think that whatever be their politics or creed, practically all will agree with Mr. Miller's sentiments, even though the basic idea is the fundamental one of the Henry George single tax theory.

* * *

The experiments undertaken by the Pennsylvania Railroad with concrete telegraph poles have been so successful that an increase is to be made in the use of these poles on the company's lines.

A NEW DEPARTURE IN FLEXIBLE STAY-BOLTS*

There is practically no literature on the subject of stay-bolts, and in particular, none on flexible stay-bolts. The increasing size and pressure of boilers make this subject of vital importance to railroads and to those responsible for the management of that type of boiler in which the firebox is stayed by a large number of bolts. The boiler of the consolidation locomotive, now the prevailing type in freight service, contains about 1,000 bolts less than 8 inches long and about 300 of greater length. The large types of Mallet compound locomotives now meeting with much favor have a much larger number, there being 1,250 short and 300 long bolts in locomotives recently constructed.

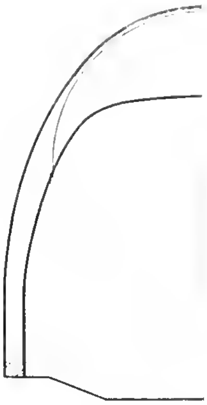

Fig. 1. Section of Firebox, showing Center-lines of Stay-bolts

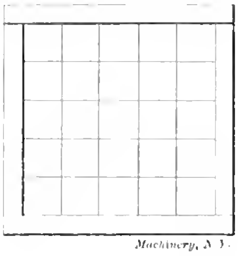

Fig. 2. Faggott Piling of Iron for Stay-bolts

In recent years some form of flexible stay-bolt, that is, one having a movable joint, has been very extensively used in the breaking zone of locomotive boilers, but their high cost and the difficulty of applying them, the binding at the joint caused by rust and scale, and the fact that their use throws an additional service on the adjacent bolts because of lost motion, has militated against their more general use.

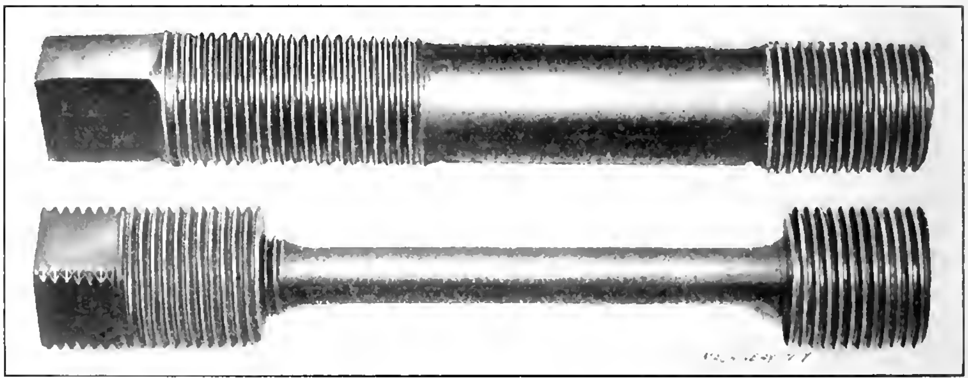

Fig. 4. Spring Flexible and Regular Iron Stay-bolts of Same Tensile Strength

It is well known that stay-bolts fail, not because of the tensional loads upon them, but from flexural stresses induced by the vibration resulting from the greater expansion of the firebox sheets than of the outside sheets, but notwithstanding the general acceptance of this theory, engineers have designed stay-bolts solely with respect to the tensional loads. It is quite general practice, it is true, to recess the bolts below the base of the thread, and this has effected a slight reduction in the fiber stress, but practically no effort has been made to design a bolt to meet the flexural stresses or even to calculate their magnitude. This is surprising in view of the simplicity of the calculations to which the ordinary formulas for flexure apply.

Fig. 3 Flexible Spring Steel Stay-bolt

Let F = fiber stress,
E = modulus of elasticity,
I = moment of inertia,
D = diameter of bolt,
N = deflection,
L = length of bolt between sheets,
W = load.

We then have

$$W = \frac{2FI}{DL} \qquad (1)$$

$$N = \frac{WL^3}{3EI} \qquad (2)$$

Substituting W in (1) in equation (2) we have

$$N = \frac{2FL^2}{3ED} \qquad (3)$$

$$F = \frac{3EDN}{2L^2} \qquad (4)$$

This formula shows that the stress increases in direct proportion to the diameter and decreases as the square of the distance between the sheets.

The application of the formula to service conditions gives the following stresses:

Conditions: Bolt spacing, 4-inch centers.
Assumed expansion, 0.04 inch.
Length of bolt, 6 inches

Type	Diameter of Bolt	Flexural Stress
Iron	1⅛ inch	51,500
Iron	1 inch	45,000
Iron	⅞ inch	39,400
Spring steel	1-inch ends, 7/16-inch stem	19,700

Iron is universally employed in the manufacture of these bolts and it is not good practice to exceed a fiber stress of 12,000 pounds per square inch. It is apparent that stay-bolts in the zone which meets the expansion of the sheets are stressed above the elastic limit and must necessarily fail from fatigue. Fractures always originate at the outside sheet at the point where the bending moment due to the movement of the furnace sheets is greatest. The fractures usually start from the base of a thread and gradually extend inward. Manufacturers of stay-bolt material have endeavored to minimize failures and to meet the unusual conditions of an iron stressed beyond its elastic limit by the supply of specially piled iron arranged with a view to breaking up the extension of the initial fracture. For this reason iron piled with a central section of small bars and an envelop of flat plates has met with much success for this class of service. In a further effort to secure an iron specially adapted to this class of work various forms of shock, vibratory and fatigue tests have been imposed. No design has yet been produced, however, which permits the employment of material of elastic limit sufficiently high to resist the flexural stresses, although a large class of material particularly adapted to the purpose is available. It is obvious that the remedy does not lie in the use of a slow-breaking material, but in the employment of material of sufficiently high elastic limit to meet the conditions of service. It is also possible to reduce the diameter of the bolt greatly by the use of such a material, thus proportionately reducing the fiber stress in flexure.

Stay-bolt material, however, must possess sufficient ductility to enable the ends to be readily hammered over to make a steam-tight joint and to afford additional security against pulling through the sheets. To meet these conditions the bolt illustrated in Fig. 3 has been designed. The stem is of the same grade of steel as that used in the manufacture of springs. It is oil-tempered and will safely stand a fiber stress of 100,000 pounds per square inch. Its high elastic limit makes

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* Abstract of paper by Mr. H. V. Wille, read before the May meeting of the American Society of Mechinical Engineers, at Washington, D. C.

it possible to reduce the diameter to 3/8 or 7/16 inch or even less. The ends are of soft steel, and it is thus possible to apply and head up the bolt in the usual manner.

The employment of a stem of the diameter indicated reduces the fiber stress in flexure to less than one-half that in the ordinary type of bolt. It has hitherto been impossible to employ in stay-bolts any of the steels containing chromium, nickel, vanadium, etc., possessing properties especially adapted to this class of work, but these steels can readily be used in the stem of the bolt described. This stem can be flexibly secured to the end in one of the customary ways, but the flexibility of the bolt does not depend upon a flexible connection. A type of bolt with a relatively inflexible connection, usually one in which the stem screwed into the ends with a running fit, has met with the most favorable consideration. Such a bolt is flexible as a spring is flexible, in that it can be deflected to meet the requirements of service without exceeding the elastic limit. In fact the stem may be of a number of pieces, either of plates or small rods, thus increasing its flexibility.

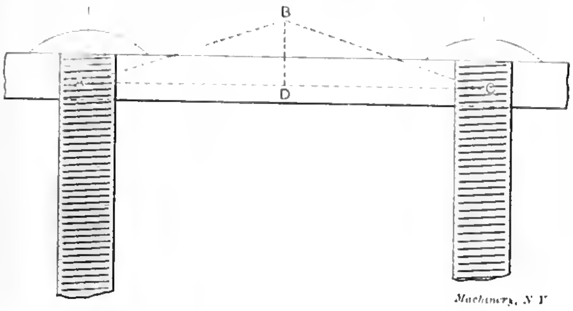

Fig. 5. Manner in which Plates Buckle with Rigid Stays

The actual breaking strength of the bolt sizes ordinarily employed is shown in the following statement. These bolts were recessed to the base of the thread and tested in the same form as that in which they are employed in service. For comparison, the approximate weights of the usual length of bolt are also given. These weights are for bolts over the entire length, including the squared ends for screwing the bolts into the sheets.

ACTUAL BREAKING STRENGTH OF STAY-BOLTS

Type	Nominal Diameter	Actual Breaking, Pounds	Weight, Ounces	Vibrations
Iron...............	1 inch	32,500	20	6,000
Iron...............	$\frac{7}{8}$ inch	24,500	15	5,200
Spring steel stem..	1 inch ends, $\frac{7}{16}$ inch stem	32,000	10	500,000

The vibrating test was made by clamping one end of the bolt in a machine and revolving the other end through a radius of 3/32 inch, the specimen being 6 inches long from the end of the right head to the center of the rotating head. A tensional load of 4,000 pounds was also applied to the bolts. The best grades of iron bolts break on being subjected to from 5,000 to 6,000 rotations, whereas the spring steel bolts were vibrated 500,000 times without failure, and on some of them the test was continued without failure to 1,000,000 vibrations. These tests demonstrated that the bolt is not stressed beyond the elastic limit under these severe conditions, and that the probability of its failure in less severe conditions is very remote.

The extent of the expansion which can take place in the fire-box of a boiler can readily be calculated:

Distance between stay-bolts, 4 inches.
Temperature of inside sheet, 400 degrees F.
Temperature of outside sheet, 100 degrees F.
Coefficient of expansion, 0.0000066.

Then the expansion between two bolts will equal: $0.0000066 \times (400 - 100) \times 4 = 0.0079$, and each bolt will deflect 0.00395 inch. It has been shown that this amount of deflection will stress the usual type of bolt (about 6 inches long) beyond the elastic limit. In practice, however, one bolt may hold rigidly, throwing the entire deflection on the adjacent bolt, or neither bolt may deflect and the sheet will then buckle. Under this condition the neutral axis will assume the form *ABC*, Fig. 5, and the length *AB* will equal 2.00395 inches and the sheet will buckle to an extent, $BD = \sqrt{2.00395^2 - 2^2} = 0.125$ inch. It is obvious that the repetition of a force sufficient to buckle a sheet $\frac{1}{8}$ inch must ultimately lead to a crack in the furnace sheets. If, however, the bolt deflects, allowing the sheet to normally expand, the latter will be relieved of these extraneous loads.

A bolt of sufficient flexibility to deflect under the forces following expansion, and of material which will not be stressed beyond the elastic limit in resisting these forces, will greatly assist in reducing the cost of boiler maintenance by eliminating broken stay-bolts and reducing the stresses in the furnace plates. If in addition the bolt has a smaller diameter, the life of the furnace plates should be further increased, as such a bolt will interpose less obstruction to the circulation of the water in the water legs.

* * *

HORSE-POWER FORMULA FOR AUTOMOBILE ENGINES

In the August, 1907, issue of MACHINERY, engineering edition, a horse-power formula for gasoline engines, adopted by the Association of Licensed Automobile Manufacturers, was given. This formula is

$$H.\,P. = \frac{D^2N}{2.5},$$

where D = diameter of cylinder in inches,
N = number of cylinders.

According to a paper read by Mr. James L. Miller before the Glasgow Technical College Scientific Society, this formula gives, however, in general, an underestimate, especially for the larger sizes, and the following formula, which gives better results, is recommended:

$$H.\,P. = K \times D\,(D - 1) \times (R + 2) \times N.$$

In this formula

K = constant = 0.197 for commercial and touring cars and 0.33 for racing cars,
D = diameter in inches,
$R = \frac{\text{stroke in inches}}{\text{diameter in inches}}$ = ratio between stroke and bore,
N = number of cylinders.

Applying this formula to a four-cylinder engine with four inches diameter of cylinders and five inches stroke gives 31 H. P., which could be obtained from such an engine at quite moderate speeds. The Automobile Manufacturers' formula gives in this case only 25.6 H. P.

* * *

CHILLED CAST IRON LATHE TOOLS

A contributor to the *Mechanical World* mentions that he has tried chilled cast iron tools with considerable success when turning plain work. The shank of the tool was about ten inches long by two inches square, and the cutting portion was made of the ordinary round-nose shape, suitable clearance being provided, but no top rake employed. The required hardness of the tool nose was obtained by a chill-box. The molten metal which enters the chill-box is rapidly cooled, and when removed from the sand the tool nose is extremely hard. All that is necessary is to grind it, and it is ready for use. A decided feature of its characteristics is its ability to cut cast iron which has been chilled through being poured into damp molds. Tools of this kind, it is stated, have, in a number of cases, saved partly machined work from being scrapped, when the best brands of high-speed steel were unequal to machining the cast iron. Tools of this type are handy to have around for occasional jobs which show themselves unamenable to ordinary methods. The use of chilled iron tools dates back many years. Its use at Lister's Works, Darlington, England, to turn chilled iron rolls, was mentioned in Moore's Guide, a heterogeneous collection of receipts and formulas for mechanics, grocers, lawyers, doctors, etc., published a long time ago. Some chilled rolls had been made so hard that carbon steel tools could not be used. One of the workmen suggested that if the chilled iron was harder than hardened steel, it might be found that a chilled iron tool might be made to cut as it could be made as hard or harder than the roll. The suggestion was successfully followed.

A SPRING WHEEL FOR THE AUTOMOBILE

In order to avoid the trouble and expense connected with the pneumatic tire, a number of wheels of different types have been constructed, all with the object in view of obtaining a resiliency equal to that of the pneumatic cushion, by the use of springs. Practically all of these spring wheels have employed radial springs, spring spokes or hub springs, and the objection has been that all of the load at a given time is concentrated on a few of the springs. With the springs arranged radially, there is also a tendency for the wheel to "dish," because of the lack of rigidity against lateral shocks. The American Spring Wheel Co. of Cleveland, Ohio, has placed upon the market a wheel which is both novel and ingenious in its construction, and one which, judging from its design, and the results of the tests, is applicable not only to pleasure, but also to commercial vehicles.

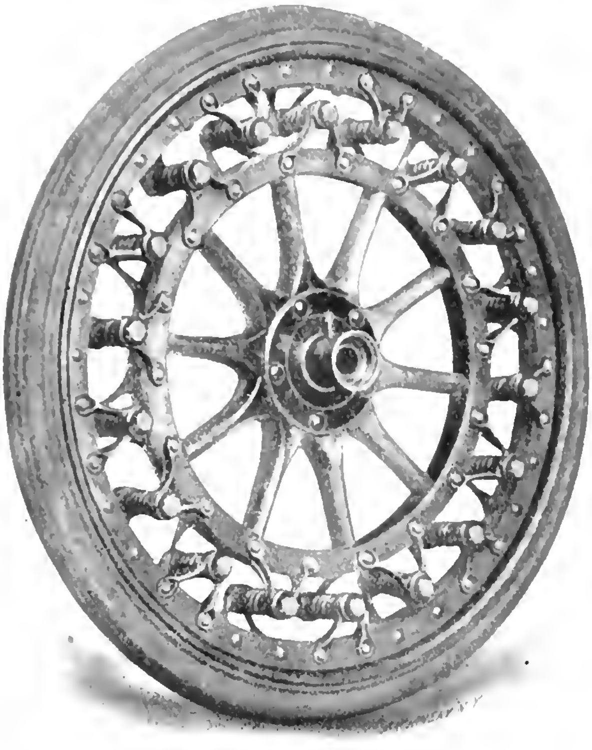
Fig. 1. The Seaton Spring Wheel for Automobiles, Trucks, etc.

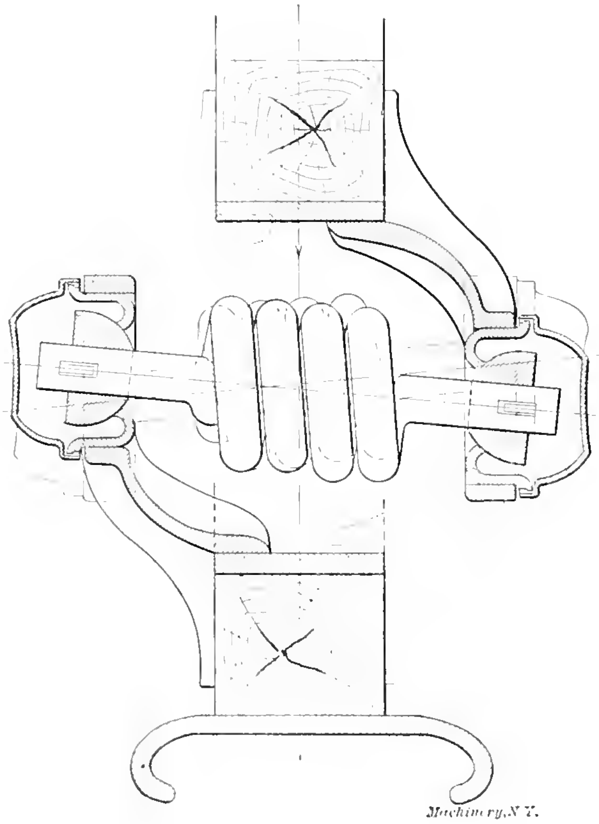

Fig. 2. Action of the Springs under Load

This wheel, which is known as the Seaton spring wheel, is constructed in two parts, an inner wheel or hub, and an outer part with a solid rubber tire, which corresponds to the felloe and tire of the ordinary wheel. These two parts are connected by springs set parallel to the axis of the hub, and with their ends held in brackets which extend radially from the two main parts of the wheel. As will be seen by referring to the engraving, Fig. 1, one end of each alternate spring is connected to the bracket of the inner rim, and the other to the bracket of the outer rim. These connections, however, are not rigid, as the ends of the springs are attached to their brackets by ball-and-socket bearings. A detail of one of these springs with the bracket and bearing in section, is shown in Fig. 3. The brackets *A* are turned to fit the steel-bound felloes to which they are bolted, and they are also bored to fit the case-hardened cups *B* which form the seats for the bearings. The hemispherical balls *C* are slotted for the cotter-pins *D*, which pass through slots in the spring at each end, thus holding it in place. There are three slots of slightly varying depths cut across the flat of each of the half balls, so that springs of different lengths may be assembled with practically the same tension. By this construction each spring is enabled to accommodate itself to varying shocks, and by reason of the movement allowed by the ball bearing it is, practically speaking, only subjected to a straight pull. The springs in the assembled wheel are under an initial tension or stretch, of about 1/16 or 3/32 of an inch, in order that each one will take its full share of the load or shock at every point of the revolution. This spring arrangement, as is evident by examining the illustrations, gives the wheel considerable lateral strength. The normal position of the springs is parallel to the axis of the wheel, but when the inner section is subjected to a load, it moves downward against the tension of each spring which is also displaced from its parallel-to-the-axis position, as indicated in Fig. 2. As this downward

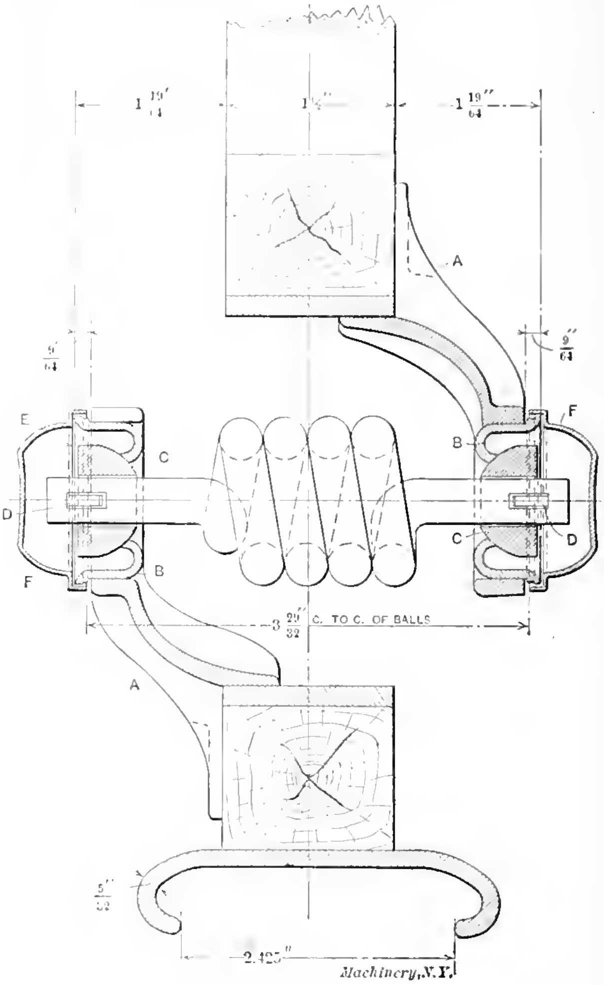

Fig. 3. Detail of the Bracket and Spring, showing the Ball and Socket Bearing

movement of the inner wheel takes places, the hemispherical parts of the spring bearing roll in their seats and, consequently, the springs, as before stated, are subjected to a stress which is parallel to their axes.

The bearings are lubricated with hard grease which is placed into the cavities *E* (Fig. 3). As is well known, grease is a lasting lubricant, and it also has the advantage in this case of protecting the bearing by its gradual outward flow, from dirt and other gritty substances which might otherwise enter from the inside. The lubricant itself is kept clean by the caps *F* which are held in place by a flattened part of the rim, which engages with a collar on the bearing cups *H*.

The one feature of the construction of this wheel which is basic in principle, and indicative of careful thought, is the arrangement of the springs, and the most valuable feature of the wheel from a mechanical point of view, lies in the fact that the load is evenly distributed over all the springs. This, of course, makes the use of a comparatively light spring possible, which adds to the resiliency of the wheel. It is said that the riding qualities of the Seaton wheel compare favorably with the rigid type equipped with a pneumatic tire.

Mr. Hubert H. Ward, Mr. William E. Metzger, formerly of the Everitt-Metzger-Flanders Co., of Detroit, and others have organized the American Spring Wheel Co., to manufacture the wheel in this country, while the International Spring Wheel Co. has been incorporated to handle the foreign patents. Mr. H. L. Olmstead, formerly assistant engineer of the Brown Hoisting & Conveying Co., of Cleveland, has been made mechanical engineer for the American firm.

* * *

FORMULAS FOR STRENGTH OF FLAT CIRCULAR PLATES*†

WM. F. FISCHER‡

When a flat circular plate becomes deformed under the action of a given load *W* applied normal to its surface, as shown in Fig. 1, the upper fibers *B* of the material are subjected to compressive stresses both radially and circumferentially, while the lower fibers *C* are subjected to tensile stresses both radially and circumferentially. This is caused by the fact that the plate, when bending, tends to assume a spherical shape. Stresses therefore, appear in the plate in a manner as indicated in the lower view in Fig. 1. The deformation of the plate as shown in an exaggerated scale in Fig. 2, tends to decrease the length or circumference of the upper fiber *B*, while it tends to increase the length of the lower fiber *C*. In the lower view in Fig. 1, the full lines with their arrows show the direction of the radial and circumferential compression stresses in the fibers on the upper side of the plate, and the dotted lines with their arrow heads show the tension in the fibers on the lower side of the plate.

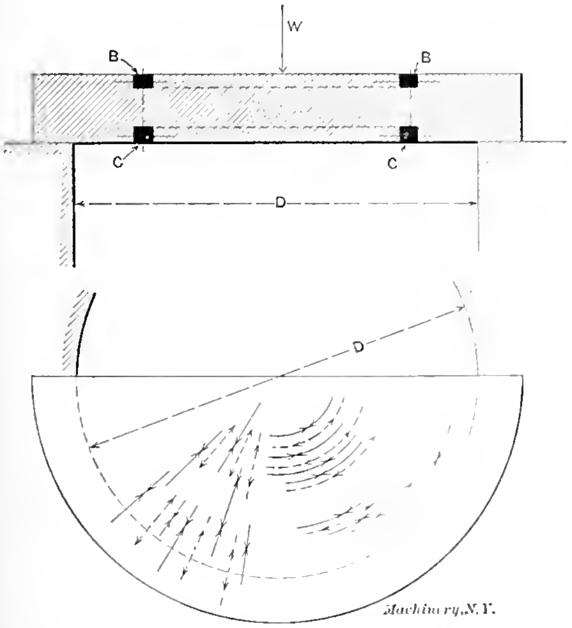

Fig. 1. Stresses in Flat Circular Plates Loaded at the Center

In the accompanying Supplement, several sets of formulas for circular plates are given, selected from different authorities. The formulas are presented as given by the various writers, and then the different quantities "safe load," "unit stress," "thickness of plate," etc., as deduced from the given formulas, are shown. The tables given should be considered as a part of a complete set of tables giving formulas of flat plates, four of which were published in the Supplement to the June, 1909, issue of MACHINERY. Table V refers to rectangular plates, and Tables VI, VII and VIII to circular plates.

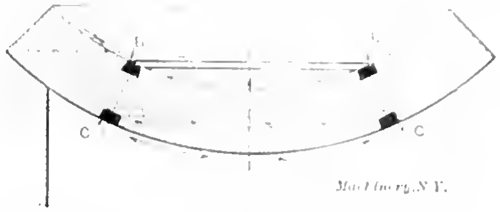

Fig. 2. Deformation of Loaded Flat Circular Plates shown in Exaggerated Scale

Exact formulas for finding the bending moments in flat circular plates and the resistance of plates to the stress created by pressures normal to their surface have not as far as the writer knows, been determined. The formulas given are founded on certain assumptions and must be considered merely as approximations. This, of course, is also indicated by the variations in the formulas given by the various writers on the subject. The formulas should be used with caution, and such formulas as give results on the safe side should be preferred. In deriving formulas of this character, all assumptions should be made so that the error is on the safe side.

* * *

ZEPPELIN'S LAST RECORD—THE DE BAUSSET VACUUM AIRSHIP

Count Zeppelin's new air-ship covered a distance of about 850 miles in 37 hours, starting from Friedrichshafen, Germany, May 30. Unfortunately the air-ship collided with a tree on the return trip from Bitterfeld. The impact smashed in the bow, but damages were repaired in a few hours and the return flight to Friedrichshafen was resumed. The success of Zeppelin's mammoth air-ship has caused some enthusiast to predict that a transatlantic trip will be made possible within a year, inasmuch as it is claimed that the possibility of such a trip is merely a question of fuel and supplies.

The success of this air-ship has also revived the De Bausset vacuum air-ship plan, which was promoted—and ridiculed—about twenty years ago. The plan of Dr. De Bausset was to build a huge steel cylinder over 700 feet long, internally stiffened so as to resist the external air pressure when the contained air was pumped out. It was the idea that a large vessel thus made of steel could be given sufficient buoyancy by pumping out the air to cause it to rise. The advantage of the plan, of course, is that there is no danger from explosion as in the case with gas. Another advantage is that the buoyancy of the balloon can be increased and decreased at will by simply pumping out the air or admitting it as the case may require. It is claimed that De Bausset had worked out his plan for a ship 744 feet long, having a diameter of 141 feet, the total displacement being about 11,000,000 cubic feet. The displaced air at sea level and at a temperature of about 65 degrees F. would weigh about 400 tons, which, of course, would be the measure of buoyancy, minus the weight of the cylinder, car, machinery, supplies, etc. It was calculated that the vacuum air-ship could be built so as to have a net lifting power of about 124 tons. The plan of interior construction by which the enormous pressure of the atmosphere could be resisted by a structure sufficiently light to answer balloon purposes has never been revealed. It is said that De Bausset had worked out the plan satisfactorily, but he never revealed it to others. The skin of the cylinder was to be made of rolled steel, ¼ inch thick. Beyond that nothing of the interior details is known, except that the air was to be exhausted by four powerful pumps, driven by electric motors, supplied by rolled batteries. C. A. McCready, of the New York Produce Exchange, is responsible for the effort to revive the project.

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* With Data Sheet Supplement.
† See also MACHINERY, June, 1909: Formulas for Strength of Flat Plates.
‡ Address: 220 W. 149th St., New York City.

THICK CYLINDERS*

P M GALLO[†]

The calculation of the thickness of cylinders for a given pressure has been so much discussed, and so many formulas have been deduced, some theoretical and others empirical, that there seems to be little to add. Yet this subject is so little understood that every experienced engineer relies on his own experience, and in most cases uses no formula at all, except a kind of proportional one, that is usually all right for limited pressures and sizes of cylinders, but which conforms neither with theory nor practice; but "it does the work," as the uninitiated say. Some formulas, although published in reputable engineering hand books, are absolutely worthless. Others, again, are good for high pressures but valueless for low pressures, and *vice versa*.

The writer has had considerable experience in this line of work, having designed the complete hydraulic, steam, and pneumatic power transmission system for the largest tube and pipe mill in the world, and has, therefore, given this subject considerable thought.

Commonly Used Formulas

In low pressure work the general practice is to make the thickness of the metal = diameter × unit pressure ÷ twice the allowable working stress of the material, and add to this a variable quantity to allow for unsound castings and possible unknown stresses, or

$$t = \frac{DP}{2S} + a \qquad (1)$$

Where t = thickness in inches,

D = diameter in inches,

P = pressure in pounds per square inch,

S = allowable tensile stress in pounds per square inch,

a = variable quantity.

The quantity a varies with the size of the cylinder and the pressure, and with the conditions under which the cylinder is operated.

For high pressures Lamme's formula is usually used and gives reliable results. This formula, transformed for practical application, is:

$$t = r\left[\sqrt{\frac{S+P}{S-P}} - 1\right] \qquad (2)$$

Where t = thickness in inches,

S = allowable tensile stress in pounds per square inch,

P = working pressure in pounds per square inch,

r = internal radius.

This formula is arrived at theoretically and expresses the exact relations between the tensile stress and the working pressure of an elastic material, with the exception that it does not take the lateral contraction of the material under stress into consideration; this can be omitted for practical purposes, since the variation of the quality of the material, unsound castings, and conditions of service, more than counterbalance the gain by considering the lateral contraction.

For those that care to note the difference between Lamme's formula and the one considering lateral contraction, the latter, for cast iron and steel, using the same notation as before, is given below.

$$\text{For cast iron } t = r\left[\sqrt{\frac{4S+P}{4S-4P}} - 1\right] \qquad (3)$$

$$\text{For steel } t = r\left[\sqrt{\frac{3S+P}{3S-4P}} - 1\right] \qquad (4)$$

Whereas Lamme's formula is the same for any material, the latter formula varies with the material, since the lateral contraction varies. This contraction is about 1/4 for cast iron and 1/3 for steel.

For pressures ordinarily used in hydraulic work formulas (3) and (4) give a thinner cylinder than (2); but for very high pressures, such as occur in guns and sometimes in intensifiers, formulas (3) and (4) give thicker cylinders than (2). Unless one is positive of a high-grade material and sound castings, cast iron should not be used on pressures over 2,000 pounds per square inch.

Formulas (2), (3) and (4) are deduced on the supposition that the inner laminae of a cylinder rupture first, and the moment rupture occurs, the stress on the material is increased, due to the diameter being increased by the starting rupture, and the rupture continues to the outer lamina, or, commonly speaking, the cylinder is "burst." Accordingly, the formulas give such a thickness that the pressure on the inner lamina does not exceed the allowable tensile stress, provided the assumed working pressure is not exceeded. The pressure on each succeeding lamina varies as the square of its radius. For the deduction of Lamme's formula, see Merriman's "Mechanics of Materials."

Since these formulas are deduced from the above assumptions, there must be some limited working pressure for each assumed allowable tensile stress, which, if exceeded, will produce a stress on the inner lamina exceeding this allowable tensile stress, even if the cylinder were made infinitely thick. We will now inspect Lamme's formula to find this limited working pressure. By making $P = S$, we have

$$t = r\left[\sqrt{\frac{S+S}{S-S}} - 1\right] \text{ or } t = \infty.$$

Therefore, S is, theoretically, the limit of working pressure; of course, practically it is much lower than this for economical reasons. The writer takes the thickness equal to the radius as a practical limit; if greater thickness is required a higher value for S is used, and consequently a lower factor of safety, or a better grade of material is employed.

In formula (4) make $P = \frac{3}{4}S$, then

$$t = r\left[\sqrt{\frac{3S+0.75S}{3S-3S}} - 1\right] \text{ or } t = \infty,$$

In this formula the limit of working pressure is $\frac{3}{4}S$, showing that the thickness increases much more rapidly as the pressure increases than it does in formula (2). In formula (3), again, $t = \infty$ for $P = S$.

Another formula frequently used is

$$\frac{t}{r} = \frac{P}{S}\left(1 + \frac{P}{S}\right) \qquad (5)$$

This is an empirical formula giving results agreeing very closely with those obtained by formula (2) for limited pressures; it does not give the true relation between S and P, and it is simply a modification of (1) with the quantity a replaced by the factor $\left(1 + \frac{P}{S}\right)$ which factor does not vary correctly with increased pressures and stresses. Make $P = S$ and we get

$$\frac{t}{r} = \frac{S}{S}\left(1 + \frac{S}{S}\right) = 2$$

or the thickness is equal to $2r$; even if we make $P = 2S$ we get a thickness apparently sufficient for the pressure; but to find what the actual tensile stress produced will be under such a pressure, we are compelled to resort to formula (2). The formula (5) is theoretically and practically wrong.

Conditions Governing the Thickness of Cylinders

Having investigated various formulas used for calculating the thickness of cylinders and given a fair average practice, we will now go into the conditions that govern the thickness of cylinders.

1. Two castings taken from the same cast vary widely as to chemical and physical qualities and soundness, depending on what part of the cast each is taken from, conditions of mold, etc. Castings from different casts vary still more.

2. There is a limited thickness below which casting is impossible; this varies with the kind and quality of metal and the skill of the men.

3. Castings handled by unskilled crane men receive very severe shocks and knocks, often producing stresses far in excess of the stress produced in service.

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* For additional information on thick cylinders, previously published in MACHINERY, see Design of Thick Cylinders, July, 1907, engineering edition, and the articles there referred to. See also MACHINERY'S Reference Series, No. 17, Strength of Cylinders.

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4. In hydraulic systems, the cylinders are subjected to shocks, the magnitude of which depends largely on the design of the system, the service for which the cylinder is used, and the construction and method of operation of the valves.

As far as the variation of the chemical and physical properties are concerned, that is taken care of by the factor of safety. The soundness of the casting is taken care of by allowing an additional amount of metal; this varies with the kind of material, being more for cast iron than for brass, for instance. The amount to be added increases in a certain ratio as the diameter increases, and decreases in a certain ratio as the pressure increases. The increasing pressure requires more body to the metal; therefore, the casting is sounder and less metal need be added. In fact, for pressures above a certain limit this addition of metal can be omitted altogether.

The amount of the addition depends on the quality of the metal and the allowable tensile stress, and should be proportioned accordingly by the designer. With a good quality of metal, the castings can be made thinner, and yet be sound. With a higher allowable tensile stress, the castings are thinner for a given pressure than with a lower, and consequently more metal must be added to make a sound and reliable casting.

The limit of thickness below which casting is impossible varies with the quality of metal used, and should be decided by the designer's experience and judgment.

From the conditions enumerated, the writer has deduced a formula, conforming with theory and practice, which can be used for any working pressure high or low and any allowable tensile stress. For the primary thickness for the pressure, formula (2) is used. Then add two quantities, one increasing as the diameter increases, and one decreasing as the diameter increases (but not in the same ratio as the first quantity), and both decreasing as the pressure per square inch increases. Following is the formula:

$$t = r\left[\sqrt{\frac{S+P}{S-P}} - 1\right] + \frac{S-P}{S}(0.452 - 0.0061\,D) + \left(\frac{S-P}{S+P}\right)^5 0.023\,D \qquad (6)$$

The notation is the same as previously given.

Now let us inspect this formula:

Make $P = S$ and we get

$t = \infty + 0 + 0$,

which is theoretically correct.

Now let us make $P = 0$ and we get

$$t = 0 + (0.452 - 0.0061\,D) + 0.023\,D,$$

which is the minimum thickness. For a two-inch cylinder this would be $t = 0.4398 + 0.046 = 0.4858$ inches, and for a thirty-inch cylinder, $t = 0.269 + 0.69 = 0.959$ inch, or for a sixty-inch cylinder, $t = 0.086 + 1.38 = 1.466$ inch. These thicknesses are within the limits of possibility of casting, and the formula is, therefore, correct from a practical standpoint.

Diagram for Calculating Thick Cylinders

From the diagram, Fig. 1, the thickness of cylinders can be taken directly for any working pressure up to 5,600 pounds per square inch, and for the commonly used fiber stresses.

The line AB is the base line on which the fiber stress curves are constructed. A 32-inch diameter cylinder was the maximum considered in plotting the curves, but the diagram can be made to read up to 40 inches diameter by extending the diagonals, reference from the fiber stress curves always being made to the base line AB. By letting the diagonals encroach on the fiber stress chart, the limit will be the full extent of the chart; the 5,600 line or the maximum diameter of cylinder would thus be 96 inches diameter. The formula is developed for a maximum diameter of cylinder of 74 inches, above which the second term of the right-hand member becomes negative.

The location of the fiber stress curves with respect to each other is proportional to the respective fiber stress values measured along the ordinates. For if $S = 7{,}000$ pounds per square inch is required, divide a number of intervening ordinates between the 6,000 and 8,000 pound curves in half and draw a smooth curve through the points thus located. If $S = 6{,}500$ pounds is required, the points are located one quarter of the length of the intervening ordinates above the 6,000 pound curve. Therefore, any number of curves can be plotted with little trouble.

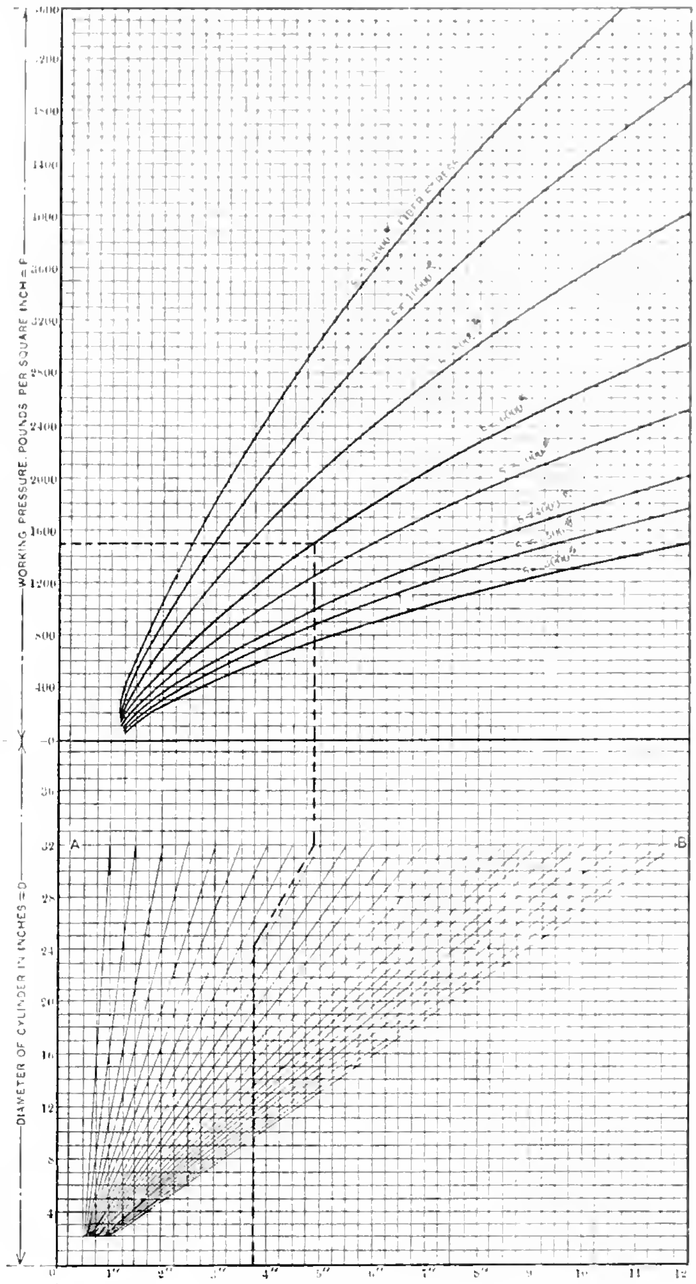

Fig. 1. Diagram for Calculating Thick Cylinders

Formula on which diagram is based:

$$t = r\left[\sqrt{\frac{S+P}{S-P}} - 1\right] + \frac{S-P}{S}(0.452 - 0.0061\,D) + \left(\frac{S-P}{S+P}\right)^5 0.023\,D$$

in which t = thickness of cylinder in inches,

S = allowable fiber stress in pounds per square inch,

P = working pressure in pounds per square inch,

r = internal radius of cylinder in inches,

D = internal diameter of cylinder in inches.

Example of use of diagram: Required, thickness of cylinder, D = 24 inches, P = 1,500 pounds, S = 6,000 pounds.

Follow horizontal line from P = 1,500 to 6,000-pound curve; then follow vertical line down to base-line AB; then diagonal line until opposite 24 inch diameter; then vertical line to bottom scale, where the thickness (= 3¾ inches) is read off.

For intermittent stresses, such as for cylinders for steam and hydraulic work, $S = 3{,}000$ pounds for cast iron, $S = 5{,}000$ pounds for ordinary brass, and $S = 10{,}000$ pounds for steel castings is ordinarily used by the writer.

For steady or gradually applied stresses, such as pipe line fittings, cast pipes, pneumatic cylinders, etc., the stresses should be: for cast iron, $S = 3{,}500$ to $4{,}000$ pounds, for brass, $S = 6{,}000$ to $7{,}000$ pounds, and for steel castings, $S = 12{,}000$ pounds per square inch.

If the cylinder is turned on the outside and bored, the thickness given in the chart is too high for working pressures up to 500 pounds, and the thickness can be decreased by the following amounts with safety. Let T be the thickness required and let t be the thickness taken from the diagram, then

$$T = t - \frac{500 - P}{500}(0.31 + 0.0146\,D),$$

in which D = diameter of cylinder. It will be seen that for 500 pounds $T = t$.

For pressures of 2,000 pounds and over, cast iron should not be used, especially if subjected, additionally, to bending and tensile stresses due to external forces, as the factor of safety becomes too low, and the thickness prohibitive; even when an extra good quality of cast iron is used, such as gun iron, 2,000 pounds is about the safe limit, because it is not possible, in most cases, to determine the maximum pressure due to shocks, etc. Even if the pressure due to shocks comes within a reasonable limit, the cast iron will not last long under repeated shocks. An idea of the life of materials under repeated blows or shocks can be found in Merriman's "Mechanics of Materials."

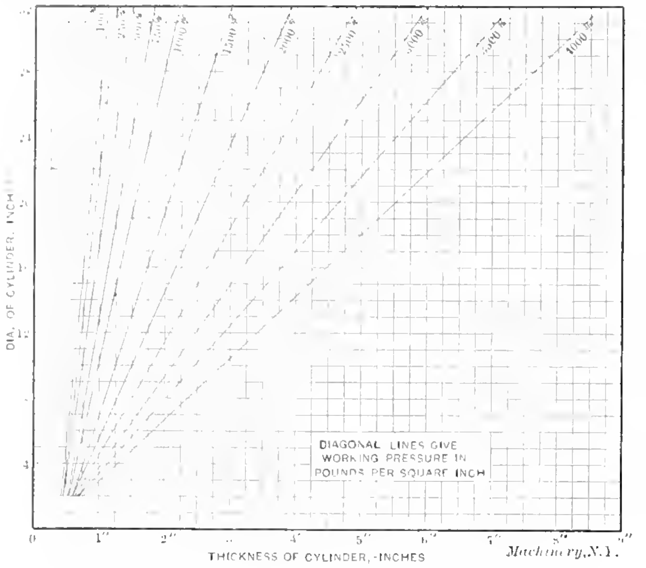

Fig. 2. Diagram for Cylinders with 10,000 Pounds per Square Inch Fiber Stress

In low pressure cylinders, the thickness of metal is much greater than the working pressure requires, but must be such to obtain a good sound casting, and the actual pressure that could be put on such a cylinder without exceeding the allowable tensile stress of the material can be found by the following formula:

$$p = S\,\frac{R^2 - r^2}{R^2 + r^2} \qquad (7)$$

Where R = the outer radius, the remainder of the notation being the same as before.

To find the tensile stress that a given pressure produces, simply transpose the above formula and solve for S; thus,

$$S = p\,\frac{R^2 + r^2}{R^2 - r^2} \qquad (8)$$

Having now developed a practical formula for cylinders for any pressure and tensile stress, and inspected various existing formulas, there remains little more to say except that many formulas, in general, are correct for the conditions and assumptions for which they were developed; but owing to the authors of these formulas and engineering handbooks failing to state these conditions and assumptions, combined with the inability of the majority of engineers and draftsmen to apply formulas correctly, often impossible results are obtained, and the formulas are always doomed as being unreliable and incorrect. Of course, the man that uses them is never at fault. It may therefore be well to state a few points as to the application of the writer's formula.

The thickness obtained is the true thickness of the cylinder rough or finished. If the plunger works by displacement, as it generally does in hydraulic work, or with non-compressible fluids, t is the rough thickness. If the cylinder is finished, t is the finished thickness. If the cylinder is to be rebored, t must be figured for the rebored cylinder, and the amount allowed for reboring must be added on the inside, even if a steel tube is to be forced into the rebored cylinder to obtain the original diameter. If the cylinder is subjected to shocks, this must be allowed for. In hydraulic work the shocks can usually be calculated approximately; not necessarily what the effect of the shocks actually will be, but the maximum effect under working conditions. In well designed piping systems the effect of shocks in a high pressure system is, contrary to general opinions, less than in a low pressure system for the same work.

Calculate the thickness for the static pressure, and investigate this thickness for tensile stress produced by the possible maximum shock under working conditions; if the stress comes within reasonable limits the cylinder is satisfactory. For cast iron the maximum tensile stress due to shock should not exceed 4,000 pounds when often repeated, or 4,500 pounds when rarely repeated. For brass 6,000 to 7,000 pounds, and for steel, 15,000 to 17,000 pounds are average values.

In case of hydraulic test pumps, especially as used for testing pipes, where the pipe is first filled with low pressure water before the test pressure is applied, no matter how suddenly the pressure is applied, the stress in the material cannot rise above that due to double the working pressure, since the water is not in motion, or inappreciably so. But in cylinders operating plungers, a maximum stress many times greater than the initial static pressure may result owing to the inertia of the moving water suddenly brought to rest. If the cylinder also acts as a support, the thickness need not be increased, even if the compressive stress is nearly equal to the allowable tensile stress, a case found in hydraulic accumulators, where the plunger remains stationary, and the cylinder carries the balancing weight and resists internal bursting pressure at the same time. Yet, mathematically, the square root of the sum of the squares of the compressive stress and the tensile stress due to the weight and working pressure should not exceed the allowable tensile stress of the material. If the cylinder supports a weight producing a tensile stress, additional metal must be provided to resist this stress, exclusive of that which resists internal bursting pressures. This additional metal may be in the form of ribs, provided the thickness of the ribs is equal to the thickness of the cylinder, so as to prevent stresses due to unequal cooling or contraction. If the cylinder is subjected to bending, an additional amount of metal must be provided, the moment of inertia of which, about an axis through the center of the cylinder, is sufficient to resist the bending stress.

In addition to the diagram, Fig. 1, a diagram for 10,000 pounds fiber stress only is given in Fig. 2, showing the plotting of the curves and how the thickness increases with the working pressure. It also shows plainly that the formula (6) deduced is a straight line equation, and gives the reader a better idea of the ratio of increase in thickness than the general diagram, Fig. 1.

The writer has applied formula (6) for nearly all conditions of service, and also compared numerous values computed therefrom with the thickness employed under similar conditions by reputable manufacturers, and found, in general, a very close agreement and in many cases an exact agreement. This certainly seems to prove the reliability of this formula.

* * *

According to the *Sheffield Daily Independent*, over $1,500,000 of foreign capital has been invested in Great Britain as a result of the new Patents Act. English workman are, for the most part, employed in these new industries, but some of the foreign manufacturers have brought over foremen from their own plants, and in some cases, English mechanics have been taken abroad to be initiated in the methods of manufacture of the foreign patented articles, which are now to be manufactured in Great Britain. Up to the present time, nine patents have been revoked by the Comptroller-General.

THE MANUFACTURE OF CRANK-SHAFTS

A great deal has been published from time to time in MACHINERY and other mechanical journals describing odd jobs of crank-shaft turning and devices especially rigged up for this work, but little has been said regarding the important operations on crank-shafts which precede the turning of the pins and journals, and practically nothing has been published giving a complete description of the methods followed in plants where crank-shafts are made on a manufacturing basis. For this reason the following article describing in detail the methods used by the A. P. Witteman Co., of 112-116 North Broad St., Philadelphia, Pa., manufacturer of high-grade crank-shafts, has been prepared in order to give a general idea of the methods followed in the manufacture of crank-shafts.

The reason why the making of crank-shafts has become an important item as a specialized manufacture during the last decade is explained by the great demand created by the growth of the automobile and motor boat industries. Many manufacturers of engines for automobiles and motor boats have found it advantageous to buy the crank-shafts for their machines completely finished from firms making a specialty of this line. In order to meet the growing demand, the present shop of the A. P. Witteman Co. at Thurlow, Chester, Pa., about 15 miles south of Philadelphia, was built and equipped in 1907, and the demand for the company's product appears already to make a new addition necessary, inasmuch as the machining department of the shop is now running day and night, employing two shifts of men, the total number employed being about sixty.

When deciding upon the manufacture on a commercial basis of any article sold in a competitive market, there are two methods to follow; one is to decide upon the use of the cheapest methods of production and enter into competition on the basis of low price; another is to disregard the question of cheapness of production if cheapness is not consistent with the obtaining of the best results in the final product, and to use only those methods which are most certain to insure a uniform and reliable product, irrespective of cost, thus selecting the field of competition on the basis of quality. When deciding to manufacture crank-shafts for the trade, the A. P. Witteman Co. chose to follow the latter course, because it was evident that the demand of the market was for a high-grade crank-shaft which could be made light in weight and yet be capable of standing high stresses. Another deciding factor of commercial importance was that while the competition would be keen in the low priced, cheaply made crank-shafts, the competition in a high quality product would be far less formidable, as the tendency of modern manufacture, unfortunately, is to sacrifice quality for cheapness of production. That the Witteman Company adopted the right course when deciding upon quality rather than low price is evidenced by the success the company has met with. Reference will be made in the following to various methods which will indicate the tendency outlined above of looking to quality first, irrespective of the fact that cheaper methods can be used to obtain what on the surface would appear to be the same results; and in this connection it is safe to say that in many other lines of manufacture, makers would find competition less keen if they devoted more time to the quality of their product rather than to reducing the price of production.


Fig. 1. View of the Heating Furnace, showing Pyrometer for gaging Heat, to the Right


Fig. 2. A Six-throw Nickel Steel Crank-shaft Forging ready for the Annealing Pit


Fig. 3. A Large Crank-shaft Forging under the Steam Hammer


Fig. 4. A Collection of Huge Tongs, Fullers and Breaking-down Tools

Material Used for Crank-shafts

For high-grade crank-shafts, alloy steels are used almost exclusively, vanadium, chrome-nickel and nickel steel being the three classes of steel used by the Witteman Co. For crank-shafts subjected to less severe stresses, a good quality of open-hearth steel is also used.

The vanadium steel used, after having been subjected to proper heat treatment as explained in detail in the following, will have a minimum tensile strength of 150,000 pounds per

square inch and an elastic limit of 127,000 pounds. This is the highest grade steel that can be used for crank-shafts and is also the most expensive, its price being about fifty per cent more than that of regular 3½ per cent nickel steel.

The chrome-nickel steel used has a minimum tensile strength of 140,000 pounds per square inch and an elastic limit of 110,000 pounds. These figures, of course, refer to the steel after having been subjected to the required heat treatment. The nickel-steel used contains 3½ per cent nickel, and has tensile strength of from 110,000 to 120,000 pounds per square inch, and an elastic limit of 80,000 pounds. While the nickel steel does not possess as high a tensile strength or elastic limit as the vanadium and chrome-nickel steels, it is preferable in cases where extreme strength is not the most important object, partly because it is cheaper, partly because it is easier to obtain nickel steel of uniform quality, and partly because it is not a material requiring such expensive heat treatment as the other alloy steels. Vanadium and chrome-nickel steel require the utmost care in the heat treatment and while being worked in the forge shop, if satisfactory results are to be obtained. With proper facilities, however, and when thorough care is being used, vanadium and chrome-nickel steels make a superior product possible, although of course, the price is necessarily considerably higher.

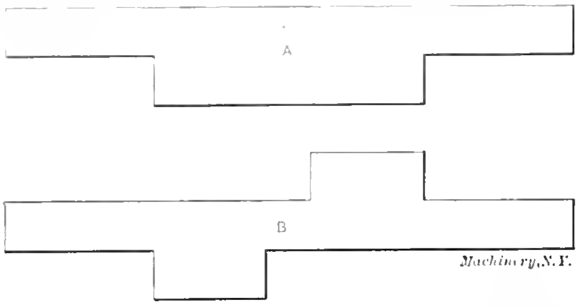

Fig. 5. Comparison of Two Methods of Forging a Two-throw Crank-shaft

The ordinary open-hearth steel which has proved itself best suited for crank-shafts contains from 0.35 to 0.40 per cent carbon, and possesses a tensile strength of from 80,000 to 90,000 pounds per square inch, and elastic limit of from 40,000 to 45,000 pounds.

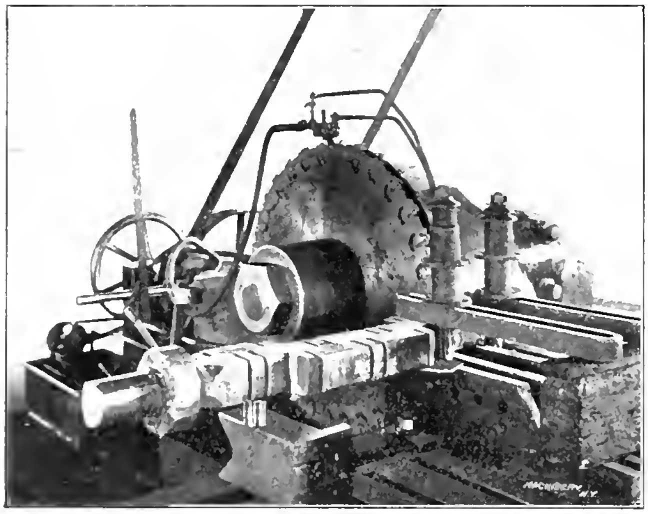

Fig. 6. Sawing out the Blocks between the Webs of the Crank-shafts

Forging Crank-shafts

All crank-shafts are forged from square billets the size of which vary from 4 to 14 inches square, according to the size of the crank-shafts to be made. While it is cheaper to make the crank-shafts from billets which have approximately the same thickness as the thickness of the webs of the crank-shaft, and a width determined by the throw of the finished crank, because of the saving in the expense of forging, it being merely necessary to draw out the ends for the journals, no reduction in the thickness of the billets being required, this method is not conducive to obtaining the best results. When a square billet is used, all parts receive approximately the same amount of hammering, and a solid forging free from flaws and with increased ability to resist stresses is obtained. Practically twice the amount of work in the forging, however, is required when following this method, because the work must go twice under the steam hammer, once for reducing the billet to the proper thickness, and a second time for drawing out the ends of the journals and forging the projections for the cranks.

The billets are heated in a furnace, a front view of which is shown in Fig. 1. The material is put into the furnace in the evening and left to soak over night, the heat being kept constant by means of a pyrometer attached to the furnace and shown to the right in the illustration. All alloy steels are heated to a temperature of 1,800 degrees F. It is very important that the steel be worked at this heat, as, if not hot enough, it is liable to crack; and if over-heated, chrome-nickel steel, in particular, crumbles under the hammer. The furnace is fired with soft coal, and a return arrangement for the combustion gases is provided, by means of which the gases are carried back into the furnace after having once passed over the grate, thus insuring perfect combustion, with the result that practically all of the heat of the gases is extracted before they pass up through the chimney. When working open-hearth steel it is not as necessary as in the case of alloy steels to keep the furnace at one constant temperature. The heat used for open-hearth steel can vary from 2,200 to 2,500 degrees F. without impairing the quality of the finished product.

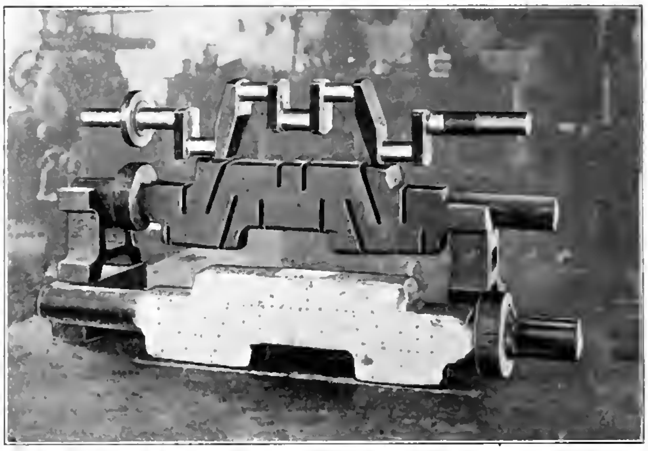
Fig. 7. Inclined Web Crank-shaft at Different Stages of Completion

When the square billets have been heated over night in the furnace, they are worked down under the steam hammer during the next day to the proper thickness, the reduction in thickness being about fifty per cent. After having been hammered down, the billet is again placed in the furnace so as to regain the proper temperature for working, and is then taken out and blocked out under the steam hammer to the proper shape and size for the crank-shaft. When blocked out under the steam hammer, two or three men handle the forging by large tongs supported by chains, while another man operates the hammer and still another handles the fullers and other tools required for blocking out the forging. In Fig. 2 is shown a crank-shaft forging ready for the final heat treatment, and in Fig. 3, a large forging under the steam hammer, the size of which is just to be calipered. This illustration shows plainly the method used for supporting the work, and the means for turning it on the anvil.

One of the greatest expenses for the equipment of the forge shop is met with in providing the great variety of tongs, fullers and breaking down tools required. A respectable looking collection of tongs and other tools, rather larger than those which the ordinary blacksmith is used to handling, is shown in Fig. 4. Crank-shafts have been forged, the finished weight of which has been 5,800 pounds, and the shop is equipped to take care of all work up to three tons. The crane equipment and the steam hammer, however, are of a size permitting work up to five tons to be handled, if necessary.

The capacity of the 4,000-pound steam hammer used is four tons of open-hearth steel per day, or two tons of alloy steel. The reason why the production per day of alloy steel crank-

shafts is so much less, is the greater care that must be exercised when working this steel, and consequently the work must be carried on at a slower rate.

No crank-shafts are drop forged in this shop, because a drop forged crank-shaft is not as reliable as one forged in the manner outlined above.

Another method employed which differs from the commonly accepted practice, is the manner in which all two- and four-throw crank-shafts are made. Instead of forging them as shown at *A* in Fig. 5, blocking them out and then twisting them on the journal bearing between the cranks, the forging is made as shown at *B*, in which case each crank can be blocked out directly from the forging, thereby avoiding any twisting after the forging has been once completed. Crank-shafts made in this manner are stronger, more reliable, and more certain not to contain any fractures in the metal, but they are more difficult to make. Six-throw cranks, of course, must be twisted, but by laying out the projections for the cranks on both sides of the forging the same as in the case of two- and four-throw cranks, it is possible to avoid twisting any crank more than to an angle of 60 degrees. In this way the material is displaced comparatively little as compared with the displacement when the crank is twisted through an angle of 180 degrees.

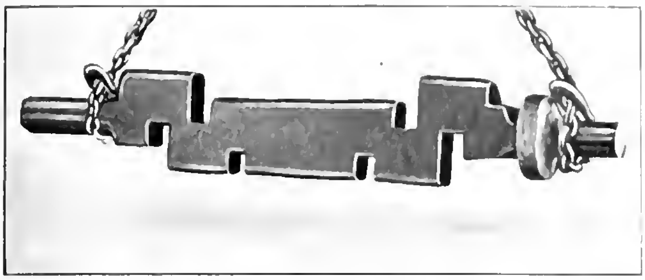
Fig. 8. Six-throw Chrome-nickel Crank-shaft, Sawed, Drilled and Blocked out, ready for Rough Turning previous to Twisting

Heat Treatment after Forging

When the forging operation is completed, nickel steel, then at a temperature of about 1,400 degrees F., goes direct from the steam hammer to the annealing pit, where it is covered with lime and permitted to remain for about twenty-four hours. This relieves the strains that would be set up by unequal cooling.

Chrome-nickel steel, after having been worked to shape at the hammer, and reduced to a temperature of about 1,500 degrees F., is immersed in cotton-seed oil, where it is permitted to cool thoroughly. It is then put back into the furnace, which is now kept at a temperature of 1,200 degrees F. for twenty minutes. This process draws the temper. The forging is then taken out of the furnace and packed in lime, in which it remains for twenty-four hours, the same as nickel steel.

Vanadium steel is quenched in oil immediately after coming from the steam hammer at a temperature of about 1,500 degrees F. The temper is then drawn at a temperature of 1,000 degrees F. in the furnace for about five minutes, and the forging is then permitted to cool in the open air.

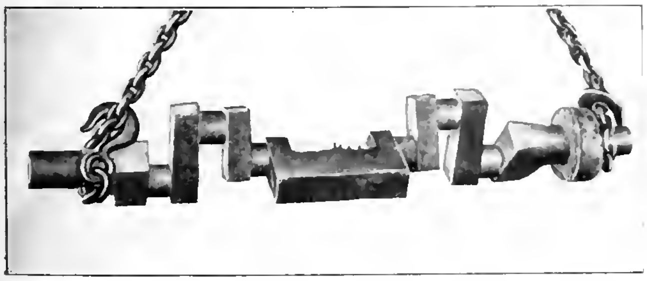
Fig. 9. Crank-shaft in Fig. 8 after having been Rough-turned on the Journals and Twisted

Machining Operations

The forgings are now ready for the machining operations. As the alloy steels are very difficult to machine, a low cutting speed is necessary, and it has been found that No. 5 Burgess high-speed steel works best for cutting this class of steel, when heat treated as previously described. The same steel is also used for the inserted blades in the saws used for cutting out the blocks for giving a rough form to the cranks.

When entering the machine shop the forgings first pass to the laying out table, where they are properly laid out and marked for the blocking out of the various cranks. They then pass to the saw where cuts are taken as shown in Fig. 6. The saw is double, so that both of the cuts required for each crank are made simultaneously, the distance between the saws, of course, being easily adjustable. For crank-shafts which have inclined webs, the saw cuts are also made inclined to the same angle as the web, so that no subsequent heating and bending of the webs will be required. No additional strains are thus set up in the web, and the material in the forging is not disturbed, which insures a more uniform and more reliable crank-shaft. A crank-shaft of this type is shown in Fig. 7, where the bottom view shows the forging as it comes from the forge shop, and after having been laid out and marked on its front surface. The middle view shows the same crank-shaft after the saw cuts have been made, but before the blocks between the saw cuts have been removed, while the crank-shaft on the top has been completely blocked out and rough turned on its pins and journals. This view shows in a general way the method for transforming the heavy rough forging into a slender crank-shaft.

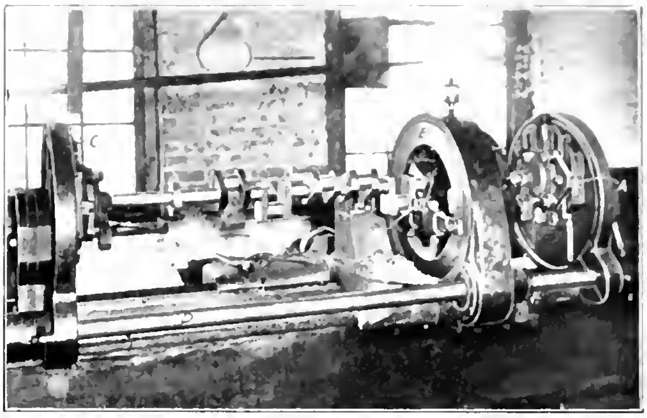
Fig. 10. Crank-pin Turning Machine

When the saw cuts have been made, the crank-shafts pass to the drill press where one or more holes, according to the size of the crank-shaft and the width between the webs, are drilled between the saw cuts made for each crank. Only a very thin rib of material is left between the drilled holes and the saw cuts, so that the part between the webs of the crank can easily be knocked out by a hammer or sledge. It has been found that flat twisted drills are far superior for this work to the ordinary twist drill; in fact, the ordinary high-speed twist drills would not stand up for the severe duty required of them when cutting alloy steels. When drilling vanadium or chrome-nickel steel, cotton-seed oil is used for lubricant, but for drilling nickel or open-hearth steel, as well as for the sawing operation, nothing but ordinary cutting compound is employed. In Fig. 8 a six-throw crank-shaft, sawed, drilled and blocked out between the webs, is shown.

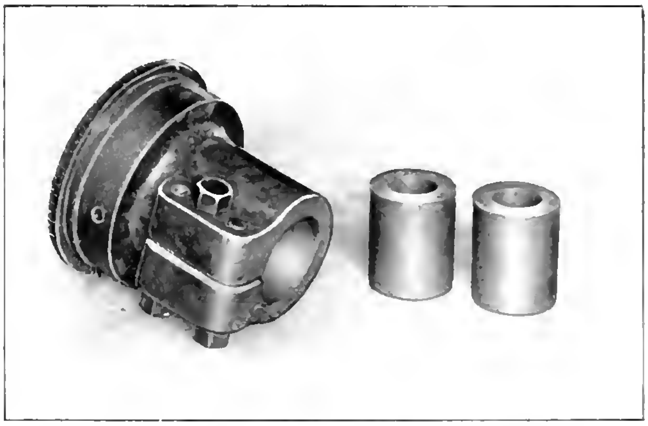
Fig. 11. Holder and Bushings for Finish Turning Crank-pins

When the cranks have been blocked out, all two- and four-throw cranks, which, as previously explained, are not twisted, go to the journal turning machines where the journals are rough turned to about 1/8 inch over standard size. Such cranks as must be twisted also go to the journal turning machines, where the journal pins between the cranks are rough turned to about 1/2 inch over size, after which the crank-shafts go back into the forge shop where they are heated and twisted to the required angles. When twisting, it is very important that the heat for alloy steels be as nearly 1,800 degrees F. as possible, as a lower heat will cause cracking, and a higher heat makes the material crumble under the tools. The twisting of the crank-shafts requires special skill on the part of the operators, as the pin in which the twisting must be done is often very short, which makes the operation a difficult one. In Fig. 9 is shown the same six-throw crank-shaft as is shown in Fig. 8, after the journals have been rough-turned and the crank-pins twisted to their respective angles. The short length of the journal pin between two adjacent cranks should be noted.

When returning to the machine shop, the crank-shafts pass again to the journal turning machines where the journals are rough-turned to 1/8 inch over size, the same as for the crank-shafts which are not twisted. These journal turning machines are ordinary lathes, the shafts being held on centers. They then pass to the crank-pin turning machines, one of which is shown in Fig. 10, where the pins are rough-turned to 1/8 inch over size. These machines deserve some additional explanation. The machine consists principally of a head-stock and tail-stock, on the spindles of which are mounted face-plates at *B* and *C*, and a driving head *E*. The face-plates are driven by spur gearing from a shaft *D* in the back of the machine, as shown in the engraving. From this shaft is also driven the driving head *E*, which is provided with clamping arrangements for holding and driving the crank-shafts by gripping the web, as shown at *F*. The object of this is to have the drive placed as near as possible to the crank-pin being turned, so as to avoid the twisting strains incidental to driving the crank-shaft from a point not in the immediate vicinity of the pin.

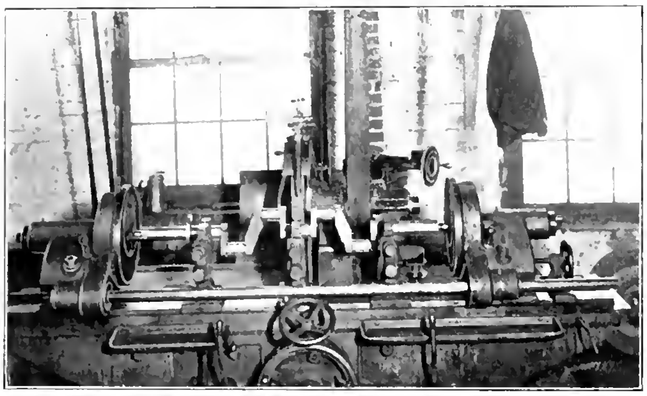
Fig. 12. Grinding the Crank-shaft Journals

The face-plates are fitted with ways and slides, the latter having centers on which the crank-shaft is held. The slides are adjustable, and at *A* graduations are provided so that the slides can be set at the required position for turning cranks of different throws; the machine has a capacity of turning crank-shafts up to 6 inches throw. When the pins are finish-turned the centers are removed together with the bracket in which they are mounted, and instead a bushing holder as shown in Fig. 11 is mounted on the face of the slide. Various sizes of bushings can be clamped in this holder, two of which are shown to the right in the illustration. The ends of the crank-shafts revolve in these bushings, thereby insuring that the crank-pins and journals will come in a fixed relation to each other, something that would not be possible to obtain if the crank-shaft was supported on centers when the pins were finish-turned.

When the crank-pins have been rough-turned, the surplus length of the forging which is from 2 to 3 inches longer than the finished crank-shaft, is cut off and the ends again centered. The journals are then turned on the ends for the bushings in Fig. 11, already mentioned, and the crank-pins are then finish-turned while the crank-shaft is held in these bushings. One-thirty-second inch on the diameter is allowed on the pins for grinding. The webs are finished in the same operation as the pins, in the crank-pin turning lathes. Afterwards the journals are finish-turned to 0.008 inch over the finished size. The crank-shafts are now ready for grinding.

A regular Landis grinder is employed with the regular crank-pin grinding attachment, and the pins and journals are ground to size, the limit of accuracy of all ordinary work being within 0.0005 inch over or below the standard size. The webs are then finished in a shaper and during this operation the crank-shaft rests on its pins and journals, thus insuring absolute balance and preventing more material being removed from one side than from the other. While milling the sides of the webs is by far quicker and cheaper, it is much more difficult to obtain uniform results in this manner. It has been concluded that to insure absolute truth, the shaper is preferable for this class of work.

The crank-shafts are now finished except in cases where they are required to be hollow, in order to make them lighter. In such cases holes are either drilled in the drill press or bored in the lathe through the crank-pins and shaft. Hollow shafts of this description are largely used for high-speed automobile and motor boat engines.

The careful development of the definite methods employed for the heat treatment and the general procedure of the work through the forge and machine shop is due to Mr. Henry P. Arnhold, superintendent of the shop. Mr. Arnhold was for six years with the Tindel-Morris Co. before he engaged with the A. P. Witteman Co., and at the former place he developed some original methods and machines for the manufacture of crank-shafts. E. O.

* * *

In the Bureau of Standards, Washington, D. C., are doubtless the most sensitive balances in existence. They are used only for comparison and are kept, as far as possible, in a room maintained at a constant temperature and free from all outside disturbing influences. The Bureau of Standards is located several miles from the center of Washington in a region comparatively removed from manufacturing industries and railroads. The scales or balances are enclosed in hermetically sealed cases and the weights are manipulated from outside by means of levers which are so ingeniously constructed that the weights may be transferred to the scale pans and then reversed so as to check results. So sensitive are these balances that it is necessary for the operator to stand some distance away, as the heat of his body will affect the balance and cause it to vary, particularly if he stands at one side so that one weight is affected by the heat more than the other. A curious action has been discovered in the manipulation of these delicate balances, which is that a minute quantity of air penetrates the pores of the balance weights, even though gold plated as is common practice. The inflow and outflow of this minute quantity of air at various seasons of the year is said to affect the specific gravity of the weights, and to be detectable by the balance. On account of the variation produced by even such small factors, it is strongly advised by the Bureau that all weights be made in one piece and not with a screwed handle as is a not uncommon practice. The screwed handle weight has a small cavity at the bottom of the hole into which the handle is screwed, and in this cavity and the interstices of the threads is imprisoned a small amount of air. The effect of this imprisoned air is said to be very disturbing to accurate work. The screwed handle also affords opportunity for fraudulent practice, and for this reason also is discouraged.

* * *

Statistics published in the *Archiv für Eisenbahnwesen* give the total mileage of the railways in the world as follows: Europe, 199,385 miles; Asia, 56,294 miles; Africa, 18,519 miles; North America, 268,058 miles; South America, 34,911 miles; Australasia 17,700 miles. Since 1897 the world's railway mileage has increased 140,000 miles or 23.5 per cent. The total amount of capital invested in railways approximates $49,000,000,000. This corresponds to an investment of $31.50 per each inhabitant of the earth.

MACHINE SHOP PRACTICE*

SHRINKING AND FORCING FITS

When heat is applied to a piece of metal, as is commonly known, a certain amount of expansion takes place which increases as the temperature is increased, and also varies somewhat with different kinds of metal, copper and brass expanding more for a given increase in temperature than iron and steel. When any part which has been expanded by the application of heat is cooled, it contracts and resumes its original size. This expansive property of metals has been taken advantage of by mechanics in assembling various machine details. A crank-pin, or other part, which is held in position by being tightly fitted into a hole, is first turned a few thousandths of an inch larger than the hole; the diameter of the latter is then increased by heating it, and after the pin is inserted the heated part is cooled, causing it to grip the pin with tremendous pressure. This is what is known as a shrink fit.

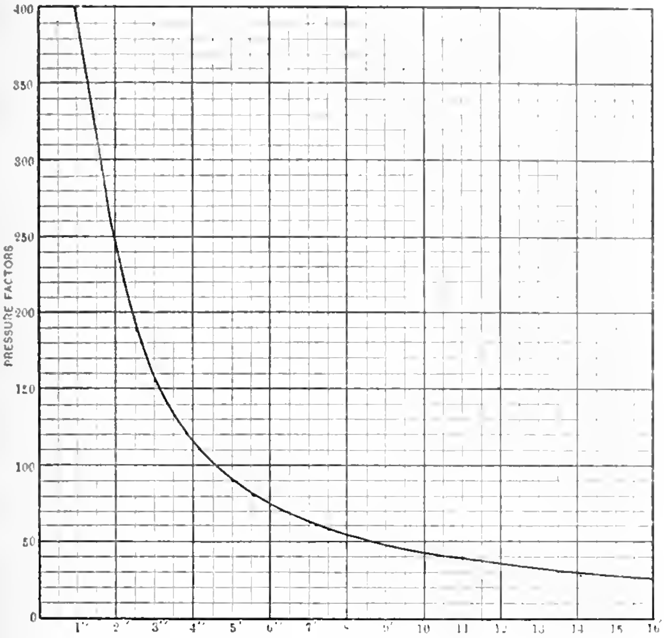

Fig. 1. Pressure Factor Curve used in determining the Allowance for Forcing Fits when a Certain Tonnage is required

A force fit is the term used when a pin, axle or other part, which is somewhat larger than the hole into which it is to be inserted, is pressed into place by a hydraulic press, or other means. The crank-pins and axles for locomotive driving wheels are usually inserted in this way, while the tires are always shrunk on their wheel centers. These tires are first bored a trifle smaller than the diameter of the wheel center, and then heated sufficiently to allow them to pass over the latter. Cooling water is then applied, which causes the tires to contract and grip the wheel center tightly. When old tires are to be replaced by new ones they are, of course, easily removed by again heating them. The shrinkage allowances for tires adopted by the American Railway Master Mechanics' Association are as follows:

Center diameter, inches...	38,	44,	50,	56,	62,	66.
Allowance, inches	0.040,	0.047,	0.053,	0.060,	0.066,	0.070.

Whether parts are assembled by being pressed into place or by the shrinking method, depends somewhat upon circumstances. To press a tire, for example, over a wheel center, would be rather an awkward and difficult job, owing to its size and shape. On the other hand, a pin is easily forced into place with a hydraulic press, but if such a tool were not available, the hole could be heated and expanded sufficiently to permit the insertion of the pin by sledging, or even by hand. The hydraulic press is more economical for most work, and in addition there is an advantage in its use in that the exact pressure or tonnage required to force the part in is indicated by a gage, while there is more or less uncertainty connected with a shrink fit. If the allowance when turning a pin for a shrink fit were too great, the part into which the pin was fitted might be broken when it was cooled owing to the excessive pressure, whereas by the use of a press this danger is largely eliminated as the approximate pressure required is known and the gage indicates just what the pressure is. Tests have demonstrated however that a shrink fit is superior to a force or press fit as the assembled parts are held more securely. Let us assume that holes of the same diameter are bored in the centers of two cast iron disks of the same size and that two pins are turned to exactly the same diameter and a given number of thousandths of an inch larger than the holes. Now, if one of these pins is pressed into place and the other is assembled by shrinking the difference in the pressures required to start the pins out will be considerable the pin which was shrunk in requiring much more pressure than the pin which was pressed into place. The force required to start these same pins by twisting or turning them in their holes would also be much greater for the shrink fit, therefore, when assembling such work as a large built-up crank shaft, or other parts which will be subjected to severe torsional stresses, it is preferable to shrink the parts together as described in the Shop Operation Sheet accompanying this number.

TABLE OF ALLOWANCES IN THOUSANDTHS OF AN INCH FOR FORCING AND SHRINKING FITS

Shrinking Fits				Forcing Fits					
					Allowance			Allowance	
Diameter	Allowance	Diameter	Allowance	Diameter	Minimum	Maximum	Diameter	Minimum	Maximum
2	0.0026	10	0.0112	2	0.003	0.005	10	0.010	0.013
3	0.0036	11	0.0122	3	0.005	0.006	11	0.011	0.013
4	0.0048	12	0.0134	4	0.006	0.008	12	0.011	0.014
5	0.0058	13	0.0144	5	0.007	0.009	13	0.012	0.014
6	0.0070	14	0.0156	6	0.008	0.010	14	0.012	0.016
7	0.0080	15	0.0166	7	0.009	0.010	15	0.014	0.016
8	0.0090	16	0.0176	8	0.009	0.011	16	0.014	0.017
9	0.0100	..	......	9	0.010	0.011		...	.....

The accompanying table gives the allowances for both forcing and shrinking fits in thousandths of an inch. After investigating considerable data collected in various shops it has been found that these allowances for different diameters represent a fair average value as taken from common practice. In some railroad shops, however, the allowances are greater than here given, while in other branches of manufacturing they are less.

The ultimate tonnage, or the pressure finally required to force a pin or other part into place, depends not only upon the allowance for the fit, but also upon the length of the bore or the area of the surface of the fit. For example, if a pressure of 20 tons is required to force a pin halfway into a crank disk, approximately 40 tons will be the ultimate pressure; therefore if a certain tonnage is required, the proper allowance may be determined by the formula

$$A = \frac{2P}{a\,(P\,F)}$$

Where A = the allowance in thousandths of an inch.
P = the ultimate pressure in tons.
a = the area of the fitting.
$P\,F$ = a factor which may be found by the use of curve, Fig. 1, which is reproduced from one of MACHINERY'S Data Sheets.

Let us assume that we are to fit a crank pin into the disk shown in Fig. 2, and that neither the allowance nor pressure are given on the drawing. The average ultimate pressure in tons, commonly used, ranges from 7 to 10 times the diameter in inches. Taking 8 as a factor we would then have $8 \times 4 = 32$ tons. The area of the fitting equals $4 \times 3.1416 \times 5\frac{1}{2} = 69$ square inches; and the pressure factor for a diameter of 4 inches is 115, as will be seen by referring to the curve in Fig. 1. Substituting these values in the formula we have:

$$A = \frac{2 \times 32}{69 \times 115} = .008 \text{ inch}$$

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* With Shop Operation Sheet Supplement.

This formula is intended for steel plugs pressed into cast iron hubs; but it should be remembered that a formula for forcing fits can, at best, only give figures which are approximate, because there are a number of factors which enter into the problem that cannot be taken into consideration. The kind and quality of the material into which a part is pressed, the smoothness of the pin and bore, as well as the taper and rotundity of either part, and the mass of metal surrounding the hole, all affect the pressure required in assembling. When a pin or other part is pressed into a hole a second time, the allowance for a given tonnage should be somewhat diminished, because the surface of the bore is more smooth and the metal more compact. Then there is the personal factor which is much in evidence in work of this kind. As machinists do not have the same sense of touch, and as some are more careful when taking measurements than others, the results in the way of tonnage for parts which are supposed to be duplicates, often vary considerably when the work is done by different men.

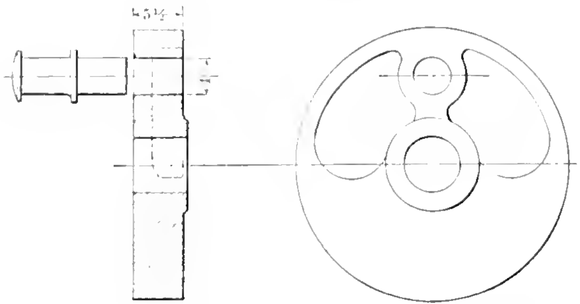

Fig. 2. An Example of the Work assembled by a Forcing Fit

By examining the formula given in the foregoing, it will be seen that the allowance for a given diameter and pressure will be greater as the area of the fitting is diminished, and *vice versa*. When parts are ready to be assembled, variations in the ultimate tonnage required can only be obtained by varying the allowance. The area of the fitting should, however, be great enough so that the allowance will not be excessive. If an effort is made to secure an ultimate pressure of say 8 or 9 tons per inch of diameter, by increasing the allowance to compensate for a small area, the resulting tensile stress upon the hub when the part is pressed into place, may be great enough to strain the material beyond its elastic limit. It is better, therefore, to secure the required ultimate pressure by changing the area of the fitting rather than the allowance, which should remain practically constant for a given diameter; of course, the length of the fitting as well its diameter are usually determined by the designer.

* * *

INVOLUTE GEARS, STANDARD

In a letter by Mr. P. V. Vernon, engineer of Alfred Herbert, Ltd., Coventry, England, published in the May 28, 1909, number of *Engineering*, he heartily advocates the cooperation of the committees appointed by the Institution of Mechanical Engineers and the American Society of Mechanical Engineers to formulate a standard of involute gears. As the matter now stands these committees will proceed independently, whereas in the opinion of Mr. Vernon they should take joint action. A great deal of experimenting is now going on in Great Britain in gear tooth forms, but as the experiments are not made under any central authority, it is doubtful that they will result in a standard that is likely to be universally adopted. The suggestion of cooperation on the part of the two committees is one worthy of serious attention. The subject is of great importance and it would be a pity to have two distinct standards adopted if it is possible to agree on a common standard.

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A correspondent to the *Engineering* (London) calls attention to the fact that there is still in use, near Fairbottom, England, a Boulton and Watt engine working at three pounds pressure. The requirements of "modern industrial conditions" evidently have not yet reached that part of the world.

MINIMIZING THE TIME OF DRILLING OPERATIONS—1

ALFRED SPANGENBERG*

Rapid drilling in a shop is very necessary. It is, of course, important from the standpoint of economy in drilling, but the main feature to be considered is the fact that when work is sent to the drills, generally it is then in steady progress of manufacture, and under ordinary conditions, some of the assemblers will be found waiting for the drilling operations to be finished. The object of this article is to analyze thoroughly the elements that enter into the problem of rapid drilling and point out some of the usual defects in methods and processes.

The Machine Tool

The starting point for minimizing drilling costs naturally will begin with a discussion of the machine tool. There are several types of drilling machines, each adapted to a certain class of work. Sensitive drill presses having from one to four spindles are convenient for light work. The spindles have vertical movements by means of hand levers, and are balanced by coiled springs. The table is counterbalanced by a weight and may be swung around as well as raised and lowered. These machines drill holes up to ½ inch diameter. Besides having the advantage of high speed, the drive, which is some form of friction drive, lessens the danger of breaking drills.

The box column, high-duty type of drill press having a table of the knee type, is the best form for comparatively small work that requires extreme accuracy and is drilled without the use of drill jigs. On account of the great rigidity of this type of drill, it is particularly well adapted for the manufacture of jigs and fixtures. For this work, however, better results will be obtained by substituting a compound table so that the work remains clamped to the table until all the drilling or boring operations are completed.

Gang drills which consist of several stationary overhanging arms bolted to a common base and having a common work table are economical where several operations have to be performed on one hole. One operator usually runs the gang.

Radial drills are most convenient for handling heavy work, where a number of holes have to be drilled at different points. This type of drilling machine has a wider range of usefulness than any other, but from the very nature of its design, it is imperative that the column and arm be made unusually stiff. The amount of work that can be turned out from a modern, high-duty radial drill, when driven by a variable speed motor of ample power and using the new flat-twisted drills, is astounding. A well-built, modern radial drill meets all general requirements for accurate drilling, tapping and reaming, but when extreme accuracy is required, and when the machine is used for boring, jigs are needed to guide the tools. Universal radial drills are very handy for large work having holes to be drilled on an angle; but for angular work that can be drilled by clamping it to the swivel shelf of a box table, or where angular work is only occasionally met with, the plain radial drill is to be preferred.

I recently witnessed an interesting job that was being performed with the aid of a universal radial. The drill spindle was swiveled to a horizontal position and used to drive and feed a boring-bar that was boring some holes in a heavy vertical spindle milling machine head and column. The work was bolted to a large angle plate secured to the floor. For boring the head, the bar was guided by means of the top bracket on the milling machine column. The head was then used as a jig to bore the column. The bar in each case was driven through a universal joint. A floor drill would, of course, have handled the job to better advantage, but none being available, the universal radial performed the job in a very satisfactory manner.

Radial drills are sometimes placed in gangs and driven from a single shaft, a very good arrangement for long, heavy work. A very efficient and inexpensive horizontal drill for drilling, tapping, reaming and boring, consists of a radial drill head mounted on a vertical column. This column should

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travel in suitable guides on a base having a surface for supporting the work.

Adjustable, multiple-spindle drills are designed for drilling, simultaneously, a number of holes in groups of square, circular or other geometrical forms. The spindle heads are provided with vertical adjustment on the arms to compensate for variation in length of drills or to enable drilling to be done at different levels, the amount of this adjustment varying according to the diameter of the spindles. In setting the spindles, the work jig is bolted to the table, the drills are inserted in the jig holes and the arms are adjusted to bring the spindles into proper alignment and are then clamped. These machines are often used without the aid of drill jigs by clamping the work against suitable stops on the table. There are three standard types of multiple spindle drilling machines: 1. The smaller sizes have the head fixed on the column and are provided with the knee type of table. The table is counterbalanced and its movements are controlled by adjustable hand- and foot-levers. This type is furnished with a No. 1 or No. 2 Morse taper hole in the spindles. 2. A heavier type consists of a work base having a column bolted to it. The head slides on this column and has a quick traverse by hand and power. A box table is furnished to hold small work. This is the type that takes a No. 3 Morse shank. 3. The largest size of multiple-spindle drills have a head sliding between two columns. The work table is mounted on wheels and is arranged to run on a track for bringing the work under the drills. This type is usually motor-driven and has No. 4 Morse taper holes. Any of these types may be furnished with a square, rectangular, or circular head. The spindles are all driven through universal couplings from a central gear. Power feed, automatic and positive stops are features common to all.

TABLE I. POWER DATA ON HIGH-SPEED STEEL FLAT TWISTED DRILLS TESTED ON POND RADIAL DRILL

Size of Drill, Inches	Peripheral Speed, Feet per Minute	Revolutions per Minute	Feed per Revolution	Number of Holes Drilled	Condition of Drill	Horse-power Consumed	Material Drilled
$1\frac{11}{32}$	150	426	0.016	9	Good	11.9	Cast iron plate, $2\frac{3}{4}$ inches thick
$1\frac{11}{32}$	185	528	0.016	30	Needed grinding	12.8	
$1\frac{11}{32}$	210	597	0.016	4	Burned off at point	17.9	
$1\frac{11}{32}$	85	241	0.016	2	Burned off at point	11.9	Machine steel, 4 inches thick
...	85	241	0.009	14	Needed grinding	7	

The value of multiple spindle drills for duplicate work manufactured in large quantities can hardly be overestimated. But for work made in lots of twelve pieces or less, it is often quite a problem to decide just what class of work this machine will handle more economically than the radial drill. This is because the time required to set the spindles of a multiple drill to a complicated layout, is an appreciable percentage of the total time required to complete the job. The layout often involves two or more settings of the work or the spindles, and this nullifying condition also enters into the problem. Provision should be made for tapping on these machines, as several holes can be tapped simultaneously.

General Requirements of Drilling Machines

Accurate tests have demonstrated that the average drilling machine should have fully double the driving power contemplated in its design. This is a point that must be considered carefully, and especially in the case of multiple-spindle drills. A proper increase in driving power means heavier motors, wider pulleys, stronger gearing and larger bearings. Immediately there follows the question of rigidity. Even at risk of reiteration, I want to emphasize the fact that ample driving power and rigidity are the vital features in a drilling machine. The fullest possibilities of economy attending the use of the new high-speed steel, flat-twisted drills cannot be realized unless these provisions are made. An idea of the amount of power required to drive these drills to their limit of endurance may be obtained from the data presented in Table I, which was obtained through tests recently made at the Pond Works of the Niles-Bement-Pond Co. It was desired to obtain power data for a $1\frac{3}{8}$-inch drill, but as several makes of 1 11/32-inch drills were available, these were used for the test, the object being to determine the amount of driving power required by selecting for the data the drill that would stand the maximum amount of speed and feed.

The very simplest form of driving mechanism is to be preferred. Undoubtedly the best type of drive is by a direct-connected 6 to 1 speed range motor through gears and splined shafts. I have never favored a speed box for the reason that they seldom stand for any length of time the severe usage imposed upon them. The feed range of a modern drilling machine meets all general requirements. In the writer's opinion a motor never should be mounted on top of the drill column. While this is the practice with some makers, the plan is open to the practical objection that the vibration caused by unbalanced mechanical and electrical elements in the motor, becomes a serious matter, especially in machines with a long overhanging arm. This trouble will be largely overcome, however, by bolting the machine to a solid concrete foundation. On account of the high speed at which modern drilling machines are run, it is important that they be provided with self-oiling bearings and ball-thrust bearings for the spindles. A reverse for the spindle in the form of positive clutches is handy for tapping. Machines that are frequently used for drilling steel should be provided with an oil pump and pan for taking care of the cutting compound. Drill presses that have the knee type of table which is fed by a rack and pinion should be provided with an adjustable counterweight. This is to compensate for varying weights of work that are placed on the table. When this provision is not made, the work table will fall like a drop hammer when the feed is released. In the type of multiple spindle drill with the sliding head, the drive for the rapid power traverse should be through a friction. When drilling deep holes it is, of course, necessary to frequently withdraw the drills from the holes for the purpose of removing chips and with the positive-driven traverse and automatic stop, much time is lost by having to run the head by hand past this stop. Better results would be obtained by using the friction drive and dispensing with the automatic stop. The head could then be run by power to any position, either in starting to drill or running to the bottom of the holes, without danger of breaking the drills or throwing the power traverse belt off. There would also be the added advantage of not having to run the feed by hand. Some of the smaller sizes of multiple spindle drills are not furnished with T slots in the table to clamp the work by or for use in fastening stops, on the supposition that work will not have a tendency to turn when several drills are operating simultaneously. While a majority of the work handled by these machines does not need clamping, it often happens that several operations have to be performed on a single hole, or the axes of two holes in a piece may lie at right angles, or several pieces having one hole in each may be placed side by side and drilled

TABLE II. SPEEDS AND FEEDS FOR HIGH-SPEED STEEL FLAT TWISTED DRILLS

Material—Cast-iron			Material—Steel		
Size of Drill	Speed, Revs. per min.	Feed per Revolution	Size of Drill	Speed, Revs. per Min.	Feed per Revolution
$\frac{1}{2}$	1150	0.010	$\frac{1}{2}$	535	0.006
$\frac{5}{8}$	920	0.010	$\frac{5}{8}$	425	0.006
$\frac{3}{4}$	760	0.012	$\frac{3}{4}$	355	0.006
$\frac{7}{8}$	655	0.012	$\frac{7}{8}$	305	0.006
1	570	0.012	1	265	0.006
$1\frac{1}{8}$	510	0.016	$1\frac{1}{8}$	235	0.006
$1\frac{1}{4}$	460	0.016	$1\frac{1}{4}$	215	0.006
$1\frac{3}{8}$	415	0.016	$1\frac{3}{8}$	195	0.008
$1\frac{1}{2}$	380	0.016	$1\frac{1}{2}$	180	0.008
$1\frac{5}{8}$	350	0.020	$1\frac{5}{8}$	165	0.010
$1\frac{3}{4}$	325	0.020	$1\frac{3}{4}$	150	0.010
$1\frac{7}{8}$	305	0.020	$1\frac{7}{8}$	140	0.012
2	285	0.020	2	135	0.012

simultaneously and in each case it would be necessary to use appropriate stops for holding the work.

High-speed Drills

The new high-speed steel, flat-twisted drills have been the most potent factor in reducing drilling costs. It is astonishing to note, however, that the tremendous enthusiasm attending their use is often confined to the primary installation; after that the drills are run far below the proper point of speed and feed and the ultimate increase in efficiency instead of being fully 300 per cent or more over that obtained with the older carbon drills, is nearer 50 per cent. Soon the important matter is lost sight of and the only real knowledge the firm possesses on the subject is that "We are buying and using regularly such-and-such a make of high-speed steel drills." In view of the lack of accurate information relative to the proper amount of speed and feed for the new high-speed steel flat twisted drills, Table II will prove interesting. The results shown may not, in all points, prove to be the limit of speed and feed, but are far in excess of those usually secured, so that they can be safely used as a basis upon which to work.

Many manufacturers of high-speed drills lay great stress on the length of time their drills will run without regrinding. This, however, is of very little importance, as the question is not how long a drill will run without regrinding, but how much should a drill be forced so as to produce the most work with a minimum expense for grinding. The crowding of the drilling machine is the important consideration. The question of how long a drill may run without regrinding sinks into the background when the grinding is done by automatic grinders. It is important to state in this connection that a large supply of drills already ground should be kept in the tool supply room, so that under no circumstances will the drill hands be compelled to wait for their drills. This important point is often overlooked. When drilling steel, the use of cooling agents, such as soft soap is highly desirable. These should be used very freely.

TABLE III COMPARISON OF STANDARDS FOR TAPER SHANKS ON DRILLS

Drill Makers' Standard for Taper Shanks		Pond Standard for Taper Shanks	
Size of Drill	Taper on Shank	Size of Drill	Taper on Shank
1/4 to 19/32	No. 1 Morse taper	3/16 to 31/64	No. 1 Morse taper
5/8 to 29/32	No 2 Morse taper	1/2 to 45/64	No. 2 Morse taper
15/16 to 1 1/4	No. 3 Morse taper	23/32 to 63/64	No. 3 Morse taper
1 9/32 to 2	No. 4 Morse taper	1 to 1 13/16	No. 4 Morse taper
......	....	1 7/8 up	No. 5 Morse taper

Miscellaneous Tools

The new sockets for driving drills and other tools with broken or twisted tangs have saved these tools from the scrap heap. Before these sockets were introduced, many firms avoided the trouble by ordering their tools with taper shanks larger than standard. In fact, this is just what the new sockets do—provide the tools with the next larger size of shank. Table III shows the standard adopted by the Pond Machine Tool Co. and also the drill maker's standard for taper drill shanks.

Whenever possible, tapping should be done in a machine on account of the time saved. Some form of safety tapping device will prevent the danger of breaking the taps. For tapping several holes simultaneously in a multiple spindle drill, when the holes are close together, these safety tapping fixtures cannot be used on account of their large diameter. In this case, ordinary tap-holders having a square hole to fit hand taps are used. The tap holder should be provided with a spring pin to keep the tap from dropping out. A plug tap is generally used for machine tapping in cast iron. For steel, the hole is drilled 1/64 larger than standard and two taps are used.

Rose reamers are very extensively used for reaming holes in jig work. These reamers have no cutting edges on the lands, and so permit the reamer to be guided in a cast-iron bushing. Inasmuch as the size is not adjustable it is essential that the wear of a rose reamer be reduced to the lowest limit, in order to ream a large number of holes of a uniform size. The standard form for rose reamers, as made by a number of manufacturers, is illustrated herewith. A study of the engraving will reveal the fact that it would be a decided improvement to cut all the flutes the entire length of the body. When made in the form shown there is no escape for the chips cut by the edge of the short flutes, especially when reaming to the bottom of a blind hole. The result is that the lands are soon cut and make a rough hole. Experiments and experience prove that a rose reamer having all the flutes cut the entire length and provided with a sufficient number to make the lands about 1/4 inch wide will outwear the other form 3 to 1.

Fig. 1. Standard Rose Shell Reamer—Life is Prolonged and Smooth Holes Result by cutting all Flutes entire Length of Body, enabling the Chips to Escape

All boring cutters and counterbore cutters should be made of high-speed steel.

The question of jigs naturally will come under the subject of tools. The great value of jigs as a factor in reducing drilling costs is so well recognized, however, and the subject has been so thoroughly threshed out in a series of articles recently published in MACHINERY, that no further comment is necessary.

* * *

DOES EDUCATION PAY?

W. L. CHENEY*

Does education pay? In the higher sense, yes; but from a financial standpoint it does not always pay its possessor.

The kind of education under consideration is an acquired mental equipment that enables its possessor to think more clearly and correctly than he naturally would. This may be acquired by thinking, and hence it is possible for a man to be wholly self-educated. The quicker and usual way is to study what previous thinkers have put on record, *i. e.*, "the books"; but when books are used blindly, and accepted as rules of thought or conduct, instead of as assistants to thought, they become a hindrance rather than a help.

All progress is the result of education; therefore education is good—so good and grand and fine that it should not be prostituted to commercialism. I therefore protest against certain advertising that is much in evidence, and which would be more appropriate to "Somefeller's Bitters" than to education.

Men are not paid for what they *know* but for what they *do*. If an education enables its possessor to do more or better things, it will, *other things being equal*, increase his money *earning* capacity in direct proportion (and it might decrease his money-*making* capacity—but that is another story).

However, other things are *not* equal, and two other factors must enter into the calculation. First, the number of men who have the same education; and, second, the demand for services that the educated men can render.

In consequence of these other factors, sometimes the man who comes out of the "other" door, or is on the "other" side of the desk, gets more money for his services. One door and one side of the desk cannot exist without the other, and both are therefore equally necessary and, in consequence, equally honorable, and should not be pictured otherwise.

The sort of advertising in question contains not only the possibility of raising false hopes, but also of promoting wrong and snobbish ideas and adding to class feeling, of which some people think there is already too much.

* * *

The Third Avenue Railroad Co. of New York has ordered experimental cars of two kinds to be placed in service with a view of supplanting the horse cars now in use on branch lines. One of the experimental cars will be a gasoline electric having a gasoline engine driving the dynamo which operates the car through the motors direct or by charging a storage battery. The other car will be of the pure storage battery type.

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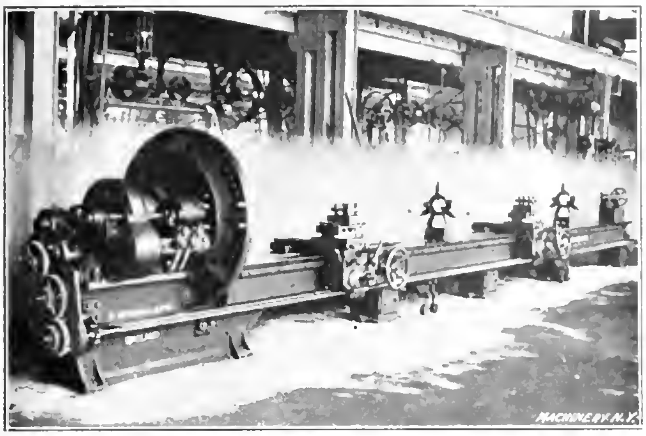
* Address: Meriden, Conn.

LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

A KINK IN PHOTOGRAPHY

Some time ago I had to take a photograph of the lathe shown herewith. This lathe has a 28-inch swing and a 36-foot bed, and in one particular it is rather out of the ordinary. Normally, there are two complete lathes on the one bed, the headstocks being at the extreme ends and the tailstocks in the middle. One operator is at the back of the machine and one at the front, as usual. The rear lathe has a lead-screw and feed-shaft slightly less than half the length of the bed, while in front, as will be seen from the photograph, the lead screw and feed-shaft extend along the whole length. The novelty of the arrangement is that the carriage belonging to the rear lathe can be turned around to the front so that both carriages may be at work on the same job, one headstock and one tailstock being, of course, removed. Normally, however, the machine is worked as two independent lathes and as such was photographed by me and also by a professional photographer whom we generally employed when we wanted an extra good job.



The White Background for this Large Lathe was obtained by moving a Small Sheet from One End to the Other during Exposure

Anyone who has tried to block out a negative of a machine which has the shop for a background, knows that it is a difficult matter to tell which is the machine and which is the shop. It is always advisable to have a white sheet for a background so that the outline of the machine is easily discernible; in fact, the writer has taken scores of machines where no blocking out was necessary at all. The white sheet should be gently swayed during exposure in order to remove all creases, and dirty marks which would show if the sheet were still. This method is a good one to adopt if a large enough sheet is available; it is hardly practicable, however, to have a sheet big enough for a 36-foot lathe. The only thing then that can be done is to rig up a background that will enable the blocking out of the negative to be done more easily.

When the first photograph of the lathe was taken, a large sheet was suspended from the crane. This was made of a lot of white paper fixed up on cords very much like the family washing, and, in addition, a smaller sheet was held up by three men. It took about an hour to get the background fixed, so after once dismantling it (this was necessary in order to run the machine) I didn't like the idea of putting it all up again to take the other view; consequently I thought I would only use the small sheet, but instead of keeping it in one position, have the men who were to hold it walk from end to end of the machine during the exposure. This was done, and, as will be seen from the reproduction (which has not been retouched in any way) the idea was a success. It leaves the outlines of the machine well defined, and no time was required in putting up a background.

For all practical purposes, it is unnecessary to block this negative out, as the girder work, counter-shafts, etc., rather improve the appearance of the picture, besides giving some idea of the size of the machine. If, however, a pure white background is essential, the negative must be blocked out this can be much more easily done when a background is used.

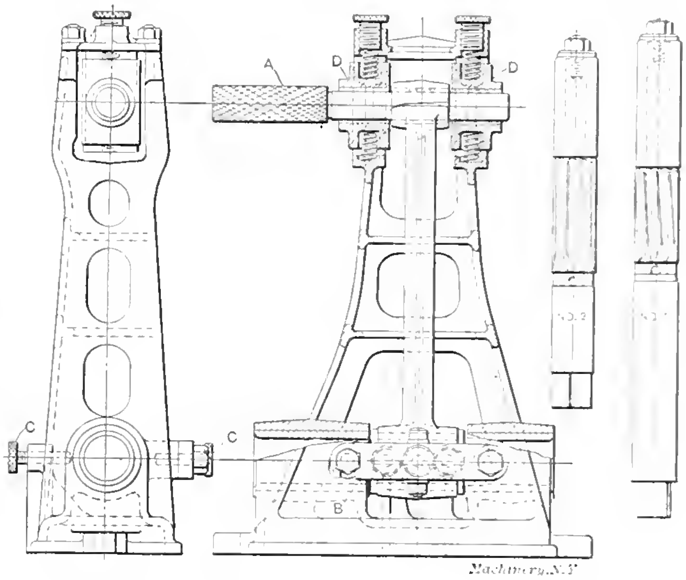
ALBERT CLEGG

Keighley, England.

FIXTURE FOR REAMING CONNECTING-ROD BEARINGS

The jig and tools shown herewith were designed for the purpose of eliminating, as far as possible, what I once heard a manufacturer call "a slow, money-eating process"—that of scraping. We began finishing the bearings of a lot of gasoline engine connecting-rods by first reaming with a standard hand reamer and then scraping them to a good bearing and running fit. This proved to be a slow method, for the connecting-rod bearings were so short that there was difficulty in starting the reamer straight, and it was also liable to chatter, which necessitated a great deal of scraping and bending to make the wrist and crank-pin bearings parallel. The jig referred to was first designed with the wrist-pin end solid, but this proved unsatisfactory as some of the rods had not been machined as accurately as a solid jig would require. To overcome this difficulty the jig was re-designed, and movable brass boxes *D* and springs were used. After this the jig worked satisfactorily and gave a variation of about six-thousandths of an inch, this being the limit allowed by the maker.

The connecting-rod was placed in the jig and held by the pin *A* and the pilot of the line reamer number 1. Then gate *B* was closed and the set-screws *C* locked against the rod to relieve any side strains or tendency the springs might have to pull when reaming. After this the reamer was run through the box reaming it to 0.002 inch below size. After this operation the rod was removed and reamed by the standard size reamer number 2. This method was found to be a satisfactory one, giving a true bearing which could be fitted with but little scraping (most of which had to be done upon the fillets) besides making the wrist and crank-pin bearings practically parallel.



Fixture designed to ream Bearings Smooth and Parallel and thus Eliminate Scraping

In fitting connecting-rod bearings I have found that babbitt bearings will wear longer by being fitted as closely as a good running fit will permit. On the other hand, I find that when using bronze it has proved better to make them a thousandth larger than the journal. If fitted closely they are inclined to seize, after which they pound quickly. For the process of scraping we found that a three-cornered file ground to the proper edge was one of the most satisfactory scrapers that could be made. It is a comparatively easy matter to hold the bearing in the hand and scrape it, whereas with a half-

round scraper, such as is customarily used, it is necessary to use a vise to hold the box and both hands to manipulate the scraper.

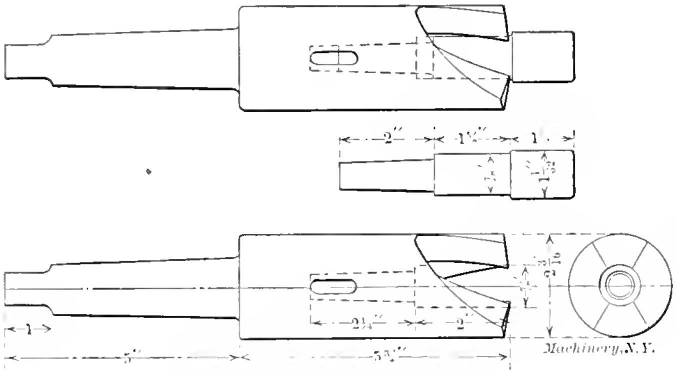
A box wrench should be used, when possible, for tightening the connecting-rod nuts. While this may seem a small matter, one has only to stand for a few minutes and watch a man with a clumsy monkey-wrench to see that the workman with a box wrench can not only do a much quicker and better job in tightening the nut, but does not bruise it during the operation—a consideration which amounts to quite a good deal on a finished product.

Salem, Mass. JOHN F. WINCHESTER.

FLUE-HOLE CUTTER OR COUNTERBORE

A special tool for the drill press, used in cutting the flue holes in the flue sheets of boilers is shown in the engraving. This tool is of tool steel and is made the size of the flue hole. The center hole is bored and tapered to fit a Morse No. 2 taper, and the center piece or guide shown, which is also of tool steel, is then turned and fitted. The jaws are next milled, and then both the tool and the center guide are hardened and ground to the exact size, clearance being given to the cutting edges.

The flue sheets to be drilled are first laid off, centered, and one-inch holes punched. They are then taken to a radial drill press and the holes are reamed out with a one and one-sixteenth inch drill, which takes only a short time and leaves a clean round hole for the center guide to work in. The tool illustrated herewith is then put in the drill press and used as a drill, the center guide being placed in the holes already made. The center guide pin is made removable so that the edges of the cutter can be ground easily, and also extends over the inner edge of the cutters, which makes the tool work very evenly. This cutter has been used in the D. & I. R. shops at Two Harbors, Minn., and its work is satisfactory.



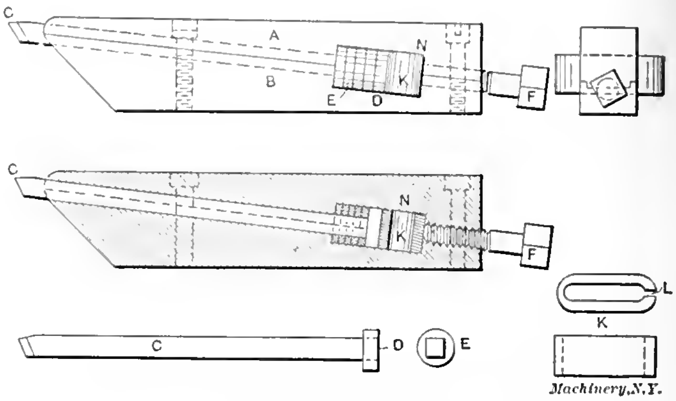
Flue-sheet Cutter or Counterbore

Two Harbors, Minn. AUSTIN G. JOHNSON.

PRECISION THREAD TOOL

Every toolmaker and machinist knows the difficulties often encountered in cutting screw threads of even ordinary accuracy, owing to the tendency of the thread tool to leave chatter marks, especially on large work where the steel is very soft. The goose-neck thread tool of old has gladdened more than one weary heart, only to sadden it again when the work reached the inspector, for I believe that while this tool will make a smooth and very beautiful appearing thread to the casual observer, it is impossible to make an accurate thread with it, or anything like a thread that a nut can be fitted to so that it will not speedily become loose if used a few times. This is caused by the springing of the tool into and out of the metal being cut, as well as sidewise, distorting the thread angles, and causing variations in the depth of the thread so that when a nut is fitted to this thread the high spots soon wear away. With all of its imperfections, however, the goose-neck tool is extensively used, as it will do fine looking work much quicker than the ordinary straight, rigid tool. The toolmaker, however, is often confronted with work which must not only look well, but must be done quickly and accurately, and then he is filled with a longing for a better tool with which to do the work.

I think it is safe to say that steel cannot be made, or at least has not yet been made, so that it is of exactly the same consistency all the way through from end to end. There are places near together where the metal is either softer or harder than the average, the difference being very slight, yet existent. Then there is the imperfect lathe, made as perfect as man is capable of making it, yet to the toolmaker there are observable plenty of signs of wabbling and winking, on the best makes of lathes—small it is true, but nevertheless there —that combine with the more or less imperfect steel to make the toolmakers hair grow white while he is still young.



Precision Thread Tool designed to allow the Cutter to spring away from the Hard Spots

In the effort to better conditions in my own practice, some time ago I designed and made the thread tool shown in the sketches herewith. I do not claim that it is so perfect that it will overcome *all* the troubles of those who make an effort to cut ideal threads, but I do claim that an approximately perfect thread can be made more expeditiously with it than with any tool of its class I know of, and the thread will be as smooth and pleasing to the eye as the very best work done with a goose-neck tool. The accompanying illustration shows the construction of the tool. The cutter-blade *C* is made of a piece of self-hardening steel, which is ground on the surface grinder as nearly square as possible, and then lapped to exactness. On its rear end is a collar *D* which is made of machine steel and shrunk on. The other end is carefully ground to the angle of the thread to be cut. To hold this cutter in the tool-post of the lathe, two pieces, *A* and *B*, of machine steel are milled, grooves being cut in both the top and bottom pieces as represented by the dotted lines, so that the cutter-blade will be held between them. They are also made to interlock as shown in the end view. These cutter grooves should be made so that the blade will fit perfectly, and yet allow it to move rather freely longitudinally. Four screws hold *A* and *B* together, two on each side of the blade, and at opposite ends. A rectangular slot *N* is cut through the tool transversely, one-half of this slot being in the part *A*, while the lower half is in the part *B*. All of the work should be accurately done, as it will pay in a tool of this class to make it as perfect as possible in order to get corresponding results. A hole is drilled and tapped in a line axially, with the cutter groove, for the set-screw *F*. In the slot *N*, there are five washers *E* which are strung on the cutter-bar before it is finally inserted in the holder. The purpose of these washers is to allow the cutter-bar to be advanced as it is ground off, from time to time. A rectangular spring *K* having a slot *L* in one end is placed in the slot *N* behind the head *D* of the cutter. A core made of whitewood and slightly smaller than the interior of the spring is inserted within it. The assembly now being complete it will be seen that the cutter-bar *C* is free to slide back in the groove in the holder so far as the spring *K* will allow it, the pressure of the spring against the cutter-bar being adjusted by the set-screw *F*.

As before mentioned, the old goose-neck tool is free to spring into as well as away from the work, and it is also free to spring sidewise. It will also spring while taking the finishing cut as well as when roughing, which is fatal to accurate results. From the extensive experience I have had with the tool herewith shown, it appears that to cut a

smooth thread, it is only necessary to allow the point to spring *away* from the harder spots in the steel and to prevent the cutting point from digging into the softer part after it has passed the hard. I usually take the roughing cut on small work with the set-screw *F*, slackened so that the slot *L* in the spring *K* is well opened, and when I am ready to finish, I turn the set-screw up until the whitewood core is gripped by the spring. For roughing large work the ordinary goose-neck tool may be used, but care must be taken not to take off too much, as work done with this tool is deceptive, and where accuracy is required it may dig in so deep that when an attempt is made to finish with this new tool it will be found that in places it will not touch the thread made by the goose-neck roughing tool. When properly made there is no chance for side movement of the cutter-bar *C*, in the holder *A-B*, and the resulting thread angles are as perfect as they are ground on the cutter and as the various imperfections of the lathe will allow.

Newark, N. J. G. J. MURDOCK.

JIG FOR DRILLING SLOTS

There are many details in machine construction that require an oblong slot. This work can be readily done with an ordinary slot milling machine when the width of the slot is great enough to permit the use of a stiff cutter; but a slot or other milling machine is not always available, in which case the jig described in the following will be found an excellent substitute. In fact, for doing such work as cutting spring cotter slots in the valves shown in Fig. 1, milling cutters are too weak to withstand more than a slight cutting pressure sideways, as the slots are only about 1/16 or 3/32 inch in width. A drill of this size, however, will cut very rapidly with a direct vertical pressure. In Fig. 2 a jig for drilling these slots is shown with the valve stem in position. The stem is held in place by the set-screw *C*. The two holes *A*, which are 3/16 inch apart, are first drilled in the stem, after which the jig is turned over and the hole *B*, which is central with the holes *A* is drilled, which produces a slot as shown at *A* in Fig. 1. As will be seen, there is very little metal to remove in order to obtain a smooth slot. This is accomplished with the drift shown in Fig. 3, the end of which is turned to a sliding fit for a 3/32 inch hole. This end acts as a guide or pilot to the cutting teeth. The number of teeth in this broach should be sufficient to allow a very slight amount of metal to be removed by each tooth. The drawing is shown on an enlarged scale in order that the construction may be better understood. The teeth on the sides of the broach are inclined in opposite directions in order to counterbalance the thrust endwise. Of course, if the teeth on both sides were inclined in the same direction the broach when driven through the slot would tend to bind against one end of the latter. As will be seen in Fig. 2, the valve stem is located in the jig by the adjustable screw *D*. Only part of the full area of the end of this screw comes into contact with the end of the stem to be drilled. This provides an opening through which any dirt or chips which may be in the hole when the stem is inserted, may pass out. This opening also allows a punch to be inserted for the purpose of driving the valve back when the holes have been drilled.

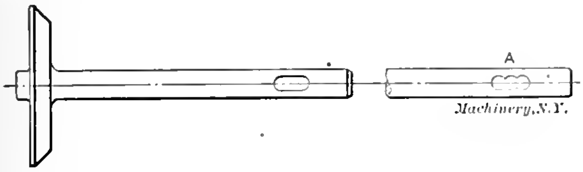


Fig. 1. Oblong Slot drilled in the Jig shown in Fig. 2

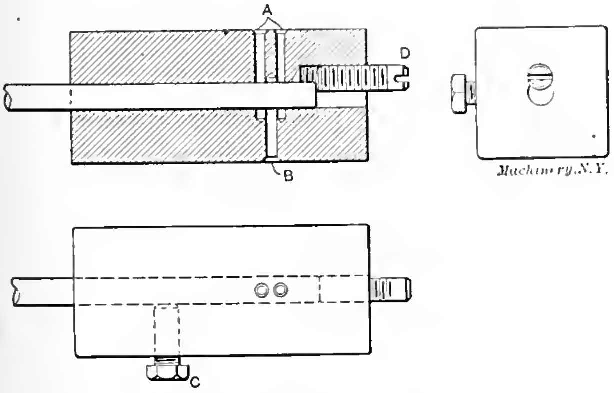


Fig. 2. Jig in which the Central Hole of an Oblong Slot is drilled from the Opposite Side

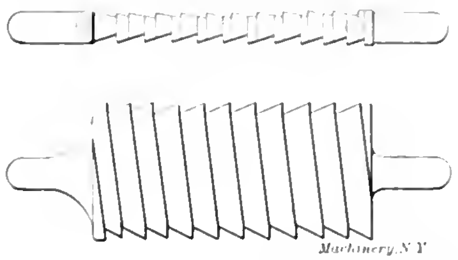
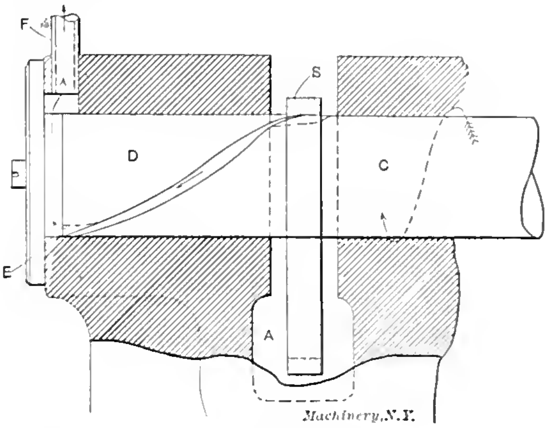


Fig. 3. Enlarged View of the Broach for Finishing the Slots

If a blind hole were used it would be quite difficult to remove the chips, with the result that the holes in the stem would be drilled in the wrong position. By referring to the sectional view of the jig it will be seen that the holes for guiding the drill are extended a little way into the opposite half; this is done in order that the drill may pass clear through the stem. CONTRIBUTOR.

FORCED LUBRICATION

An ingenious and simple method of continuous and forced lubrication, which has given complete satisfaction for the purpose intended, is shown by the line drawing. In many respects it is similar to the usual ring oiling bearing, but an important difference consists in utilizing a spiral groove for forcing oil to another bearing which could not be reached by a ring oiler, and for which a liberal supply of oil was necessary. Referring to the drawing, *A* is an oil reservoir; *B* a loose ring on the shaft *C*; *D* a spiral groove cut in the shaft; *E* a plate covering the end of the bearing; and *F* a pipe through which the oil is forced to the other bearing (not shown). The shaft revolves at a high speed, and the ring *B* carries oil from the reservoir to the shaft. Some of this oil is deposited in the groove *D*, and, owing to its inertia and the angle of the groove, the oil is forced along the groove into the chamber at the end of the shaft, and up the pipe *F* as shown by the arrows. When trying this in its initial stages, it was an easy matter to force the oil 3 feet above the shaft. OILER.

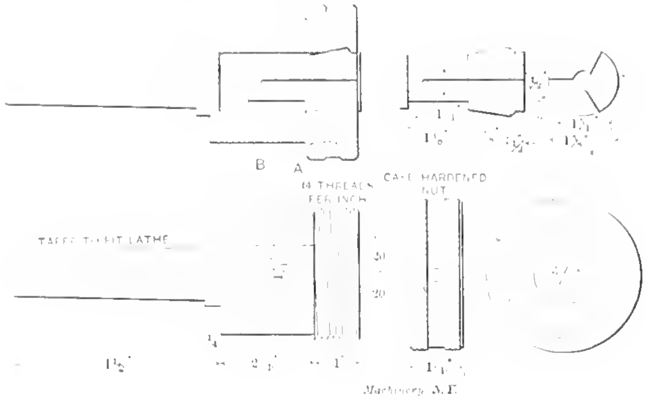


Ring Oiling Bearing arranged to force the Oil to another Bearing

IMPROVED LATHE CHUCK

Many of the standard bench lathe chucks on the market present the disadvantage of having a very short gripping surface; it is also difficult, at times, to release the work from the draw-in chuck without tapping on the hand-wheel. When the rear end of the collet has a larger hole than the front, the work is also constantly tossing about. The accompanying drawing shows the construction of a lathe chuck which is designed to remedy these troubles. This chuck was especially built to hold drill rods from 3/16 to 5/8 inch in diameter. The

body is made of tool steel. The taper shank should first be fitted to the lathe in which the chuck is to be used, so that the latter may be inserted in the spindle and finished. The nut A is made of machine steel and case-hardened. It may be turned with a spanner wrench, holes being provided as shown. Collets of the required size are made of tool steel and hardened. The rear end of the collets have the same size holes as the front, so as to prevent the work from being tossed about. A spring is inserted in the body of the chuck, which is held in position by a flanged collar *B*, which, in turn, is retained by dowel pins. When the collet is in position, it is forced against the collar and spring by nut *A*. When this nut is released the spring forces the collet out and thus releases the work, which can be removed without trouble. These collets should be tempered so that the center is as soft as possible to prevent their being easily broken. As will be seen by referring to the illustration, this chuck can be made in almost any shop without the use of special tools.



Chuck with Spring-actuated Collet

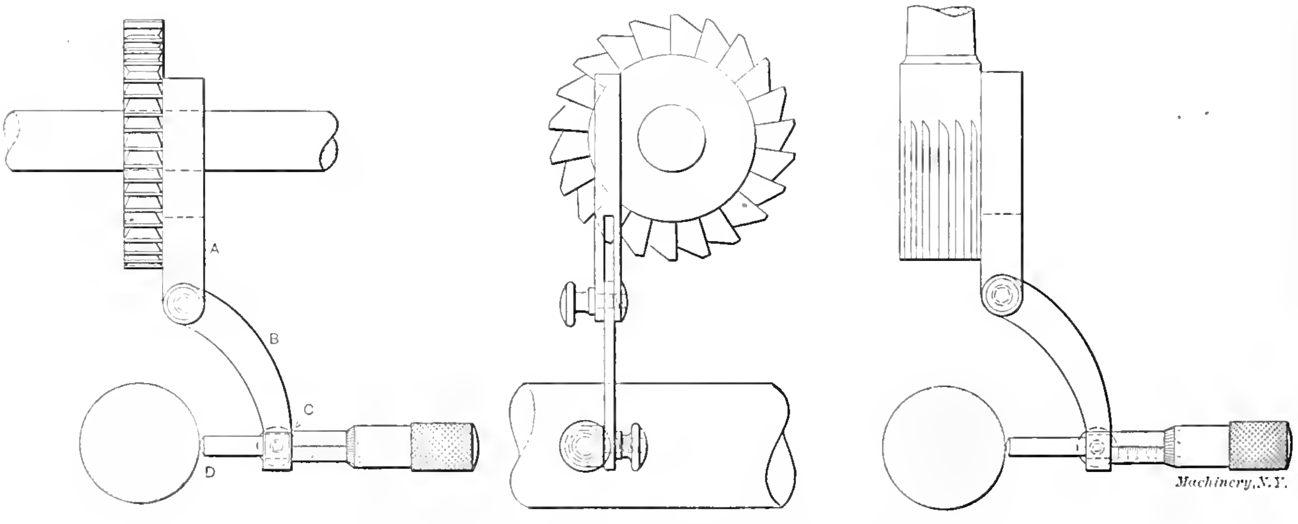
Washington, D. C. H. D. Chapman.

A GAGE FOR CENTERING WORK WITH MILLING CUTTERS

The accompanying drawing shows a handy tool for milling machine work, such as milling keyways and gears. One method of setting the work central with the cutter is to place a square on the table of the machine with the blade in contact with the work, and caliper between the upper end of the blade and the cutter first on one side and then on the other. The cutter is, of course, central when the caliper reads the same on both sides. The method of dial reading is also used.

I made this micrometer attachment for such work. Place the base *A* against the cutter as shown in the engraving. Move the arm *B*, which swivels at pivot *C*, so that the point *D* of the micrometer screw nearly touches the work; then adjust the micrometer until the point touches the work and take the reading. Use the tool on the other side of the cutter in the same way and adjust the work until the micrometer shows the same reading on each side. This tool is also handy for leveling work on grinders or planers, where accuracy is desired. H. D. Chapman.

Washington, D. C.

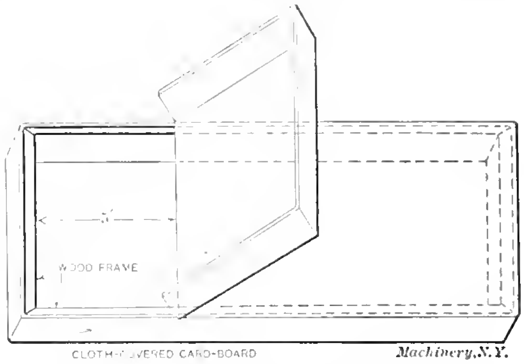


Micrometer Gage for Setting Work Central with Milling Cutters

SIZE OF WORKING DRAWINGS

In commenting on Mr. Breath's article advocating the use of several small sheets for detailing one part, Mr. Washburn in the May number of Machinery makes some very strong points against such practice.

We started some time ago to reduce our large sheets containing numerous details to individual sheets of small size. Three sizes were adopted: 14 x 18 inches; 9 x 14 inches; and 7 x 9 inches; and the size which gives the best results as to clearness of outline is used. Occasionally it has been necessary to put three views on separate sheets, in which case we paste the blue-prints together on one sheet for shop use. The views, however, were all detailed (in pencil) on one sheet and projected as usual, only becoming separate when traced. Repetition of dimensions is avoided by a note which reads: "For other dimensions see sheet number — and number —." This note is placed on each view with the proper numbers added. In this way we have met the objections mentioned by Mr. Washburn.



Portfolio in which the Drawings are Filed

We do not designate the size of the sheet by any symbol, but have assigned certain blocks of numbers—enough to last some years—to each size, which allows each size to be filed numerically, as the numbers are assigned serially and placed on corners of the tracing. In place of the envelope, which is liable to tear if frequently used, we used a portfolio which is illustrated in the engraving. These boxes each hold one hundred sheets and they are made in three sizes to fit the drawings.

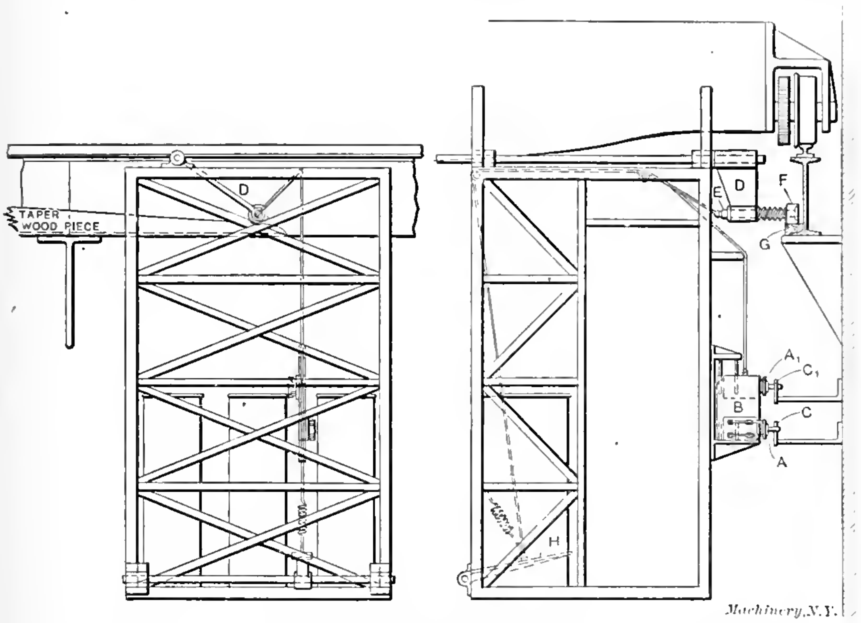
The box has a framework of metal or wood which prevents it from being crushed or broken, and it is covered with cloth-covered card-board. Any first-class box factory will make these portfolios at a reasonable figure, and they will last for years. Ralph W. Davis.

Rochester, N. Y.

SAFETY DEVICE FOR ELECTRIC CRANES

I ran across a safety device the other day for automatically stopping the bridge travel of the electric cranes, which seemed meritorious to me. At least, it possesses the virtue of originality. It was not the product of a mechanical engineer, nor did it have its conception in the brain of an electrical wizard. It is just a plain, simple, practical affair without the "frills and furbelows" of electric brakes, circuit breakers, etc. However, from what I know of the device, I am not sure but that I would trust to its operation in preference to any other with which I am familiar. It consists, primarily, of two positive, quick-breaking switches (one operating in either direction to cut out the power from the bridge travel); and an automatic device for applying the friction brake, to overcome the momentum of the crane and to bring it to a stop at any desired point.

Referring to the accompanying illustration, *A* and A_1 represent the cut-out switches which are fastened to a wooden piece *B*, about 8 inches wide by 12 inches long, located at the back of the operator's cage. Trips *C* and C_1 are arranged at the proper points along the wall to trip their respective switches as the crane passes them. An arm or lever *D* is attached to the extended end of the friction brake shaft. The outer end of this lever carries a stud *E* upon which is mounted a roller *F*. A tapered piece of hard wood *G* is secured to the I-beam at each end of the travel of the crane. The length and degree of taper of these pieces are regulated by local conditions. When the crane reaches the danger points, at which places the trips are located, *C* or C_1, as the case may be, knocks out its respective switch, and the roller *F* begins to ascend the incline of the piece *G*, in consequence of which the friction brake is gradually applied, and the crane is brought to a gentle stop.



A Safety Device for Automatically Stopping Electric Cranes by Breaking the Power Current and Applying the Brake

If it is necessary to pass the danger points, the operator presses the foot-lever *H*, which, through the medium of a small wire cable, raises the piece *B* carrying the switches, and allows the latter to pass over the trips. The same operation of the foot-lever withdraws the stud *E* through the arm *D*, and the roller *F* passes in front of the tapered piece *G*, instead of running up the incline. This leaves the crane in normal condition, free to be operated in either direction as though no safety device existed. While in the danger zones it is not necessary for the operator to keep the foot-lever depressed, as it may be released as soon as the trips *C* and C_1 are passed, for then the roller *F* cannot resume its normal position, but will slide along the face of the tapered piece *G* until the crane has been reversed and passes out of the danger zone. In leaving the danger zone, the spring on the stud *E* forces the roller *F* back into its normal position. The trips *C* and C_1 are hinged to move in one direction only, thus allowing the crane to pass out of the danger zones without interfering with the switches.

A telltale light is hung in the cage and lights a few feet in advance of where the trips operate so that the operator knows when to depress the foot-lever if he desires to enter the danger zones.

The distance in which a crane can be stopped and the consequent length of the danger zones, are, of course dependent upon such conditions as the size and weight of the crane, the traveling speed, and the efficiency of the friction brake; but to give an idea of what these may be, the crane upon which this device is in operation is one of 20,000 pounds capacity, with a span of about 45 feet, and running at full speed from one end of the building to the other is brought to a stop in from six to eight feet after the power is cut off.

Cincinnati, O. J. F. MIRRIELEES.

TOOL-ROOM CHECK SYSTEM

In the March issue of MACHINERY Mr. George D. Hadun has something to say in regard to tool-room check systems. In my wandering about I have found that most of the shops have the check system which Mr. Hadun abandoned; that is, the system in which each man has a number of checks in his own keeping and when a tool is wanted a check is given for it and placed where the tool is kept. The shop in which I am employed has the same system and we also find that it is very unsatisfactory. Very often the men are charged with tools they haven't seen, and, then again, others get possession of tools somehow without a check and refuse to turn them in—then, of course, there is trouble.

Mr. Charles Dodd, tool-room foreman of a well-known shop employing about 250 mechanics in one department, informs me that he has an addition to this system which has proved helpful. A number of checks stamped from one to thirty-one and of a different shape than the other checks, are kept in separate boxes in a drawer and used for each date of the month; they are used for the finer tools only, such as standard plugs, etc. When a man gets a standard plug, for instance, his check is placed on the pin where the tool is kept, and a check with the date of the month is also placed on the same pin, thus showing what day the tool was taken. At the end of the month if the tool is still out the man having it is looked up and if he still wishes to use the tool, he must first return it to the tool-room; another check is then put on the pin showing that the tool was taken again on the first of the month. By this method the tool-room foreman knows where the tools are on any date of the month, and how long they have been out. No trouble has been experienced with this part of the system thus far.

Mr. Dodd has in mind a system that is a little different from the ordinary, which I think is worthy of a trial. Each man has a number of checks in his own keeping, as before. A check of different shape, with the name and size of tool stamped on, is placed on a pin near each tool on the shelf or in the drawer. When a man calls for a tool, he gives his check, and, in return, receives in addition to the tool, the check with the name and size of tool on it; it is really an exchange of checks. This system would tend to prevent the men or boys who give out the tools, from placing the wrong check on the peg of some missing tool and holding the wrong man responsible for it, because the man who has the tool also has the check to show for it; furthermore the men sometimes forget what tools they have out on check, either by lending or misplacing them, and in such a case the check with the name and size of tool on, would be a reminder. [The system advocated in the foregoing, in which there is an exchange of checks, is in use and is, as far as we know, satisfactory.—Editor.]

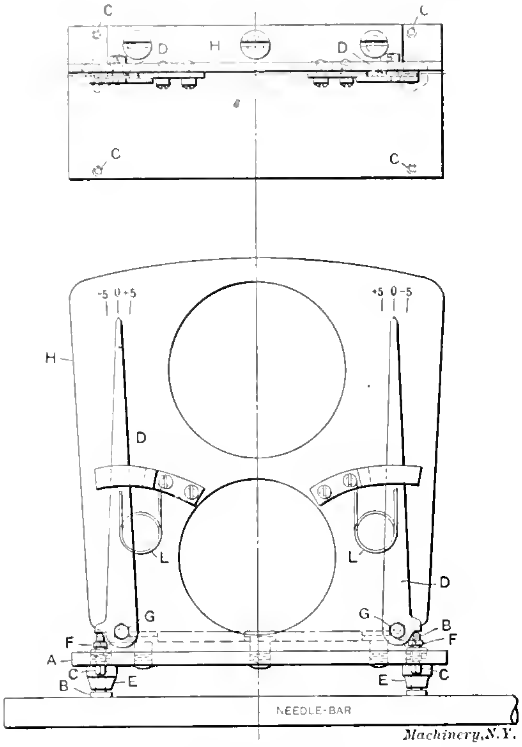
A neat way of arranging small emery wheels that are let

out on check is to have the pin on which they are kept in the drawer turned smaller at the top end to fit the hole in the check; when the wheel is taken off the peg the check is slipped on the end of the pin so that when the wheel is returned it cannot be put in place unless the check is first taken off.
A. J. De Lille.

Elgin, Ill.

A SPECIAL INDICATOR

In one type of shoe sewing machine there is a needle-bar which has besides its endwise motion a swinging motion sidewise through a small arc. For each stitch the bar makes a full advance, a slight return to loop the thread, a full advance and a full return; during this time it also makes one lateral motion. Aside from time, the chief requisite is exact alignment, or that the bar shall be at all times parallel with the base, which lies in a horizontal plane. The inspectors found in some machines that this bar did not swing parallel with the frame, and a special indicator was needed which would show at once such error.



Indicator for Testing the Parallelism of a Sewing Machine Needle-bar with the Frame

After sketches had been made of two or three designs, the indicator illustrated herewith was made. The steel base *A* rests on four feet *C*, which were hardened and then ground and lapped into the same plane. When the indicator is in use, these feet rest upon the frame of the machine. The hardened tool steel plungers *B*, which come into contact with the needle-bar, are flat on one end and spherical on the other, as shown. These plungers fit loosely into the bearings *E*, and are held from dropping out by the nuts *F* which are adjusted to allow sufficient rise and fall. The bearings *E* are of such a length as to give a slight clearance when the plungers are raised as high as they will be when the indicator is in use. Fulcrumed on the studs *G* are the pointers *D*, which have small hardened projecting arms which are in contact with the upper ends of the plungers *B*. The frame *H*, which is of sheet steel, is bent at a right angle along the bottom and screwed onto the base. Right and left coiled springs *L* act in opposition to the plungers and return the pointers to their extreme outward positions. A description of how these springs were made right and left without winding twice may be of interest. A short section of spring was first wound, and then cut into two pieces. The end of one of these sections was bent through it axially and grasped with pliers, while the other end was also held with pliers; the spring was then easily reversed by simply pulling the end through quickly. When the pointers were to be adjusted, the instrument was set on parallels, a height gage inserted under each of the plungers, successively, and the rounded ends of these stoned off until at the same setting each pointer stood at the zero mark. The figures + 5 0 — 5 indicate thousandths of an inch. When completed this tool proved very satisfactory.
H. V. Purman.

Winchester, Mass.

RECORDING BOARD TO KEEP TRACK OF THE BELT LACER

A recording board for keeping track of the belt lacer is shown in the illustrations. We have a man who does nothing but attend to belts, and formerly there was a lot of time wasted in trying to find this man, so a board was provided which indicates the department in which the belt lacer is at work, and also tells him the number of the department in which he is wanted. This board has thirty holes at the top, as shown in Fig. 1, each having a number corresponding to a department. Below these holes there are additional holes containing six black pegs and fifteen red ones. When the belt lacer is wanted, one of the red pegs (which have numbers painted on them from 1 to 15) is put in the hole at the top, which has the correct department number. Then when the belt lacer looks at the board he knows in which department he is wanted; but before leaving he takes out the red peg and puts in a black one. By having the pegs numbered the lacer knows where to go first; the men also know just what department he is in by observing the number of the hole in which the black peg is inserted, so that he may be called in case of emergency. The board is kept in a central location, and it is a case of "First come, first served"; whereas by the old way the first man lucky enough to find the belt lacer would get his belt laced first.
F. Terry.

West Toronto, Canada.

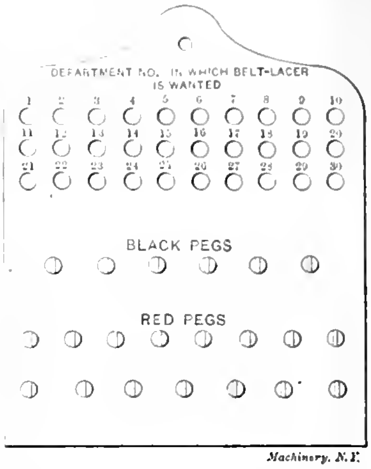


Fig. 1. Board which gives the number of the Department in which the Belt-lacer is at Work, and also Indicatee where he is wanted

Fig. 2. View of the Recording Board, which hangs in a Central Location

BENDING DIE FOR ARMATURE BAR CLIPS

The article in the January issue of Machinery entitled "Bending Die" was very interesting to me, and I thought possibly my way of doing the same work might be of interest to others. Some years ago I was called upon to design tools for blanking and forming armature bar clips. The pieces are first blanked as shown at *A*, Fig. 1, in a tandem punch and die, which is so simple that it need not be described. The first operaton of U-bending, as shown at *B*, Fig. 1, is done

by the forming or bending die illustrated in Fig. 2. This tool has replaced 37 formers of the old style. A space former *A* was made to suit the width of the space in the clips. The parts *B* are adjustable jaws which are moved by the screw *C*. These jaws are held in place by springs fastened to hooks *D*. These springs are used for the purpose of keeping the jaws in position after adjustment, and to cause them to release the work after bending has taken place. The block *E* is given an inward movement by two cams or punches with angular ends set in the punch-head which, in turn, is attached to the

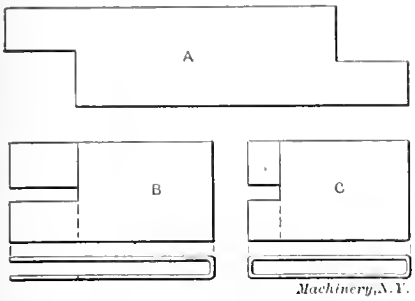


Fig. 1. The Blanked Clip and its Shape after the Two Bending Operations

press ram. As this ram moves downward, these cams come against the angular surfaces *H* and give the block *E* a forward movement toward *A* so that any stock placed between the parts *B* and *A* will be formed in a U-shape. Block *E* is returned to its original position by springs which are fastened to the pins *G* and the eye-bolts *I*.

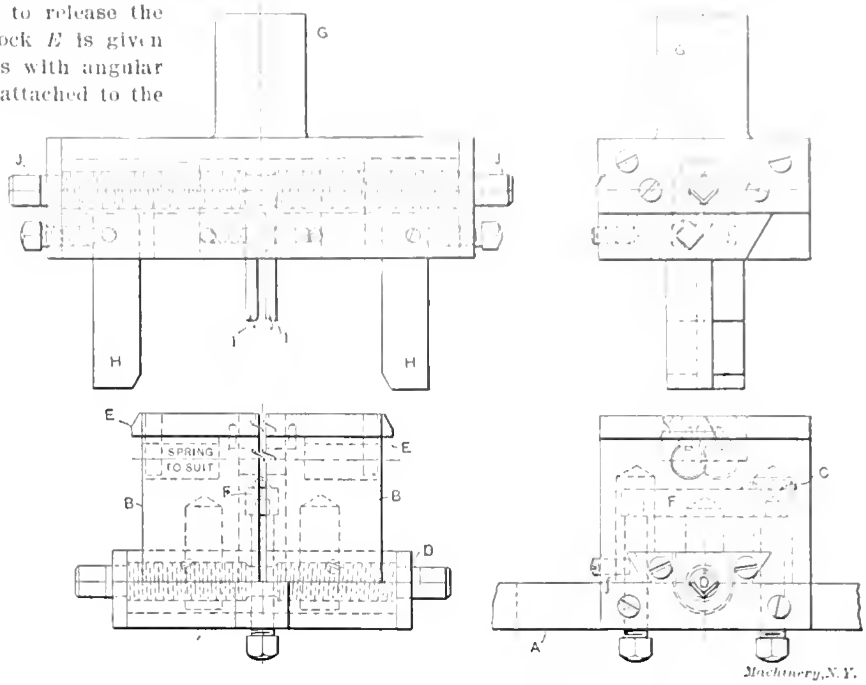


Fig. 3. Punch and Die for Finishing the Clip as shown at C in Fig 1

The clip is now ready for the second and last bending operation, which is done in the tool shown in Fig. 3. This tool, as is the one shown in Fig. 2, is adjustable for anything within its range and forms 37 different clips; but 57 could be

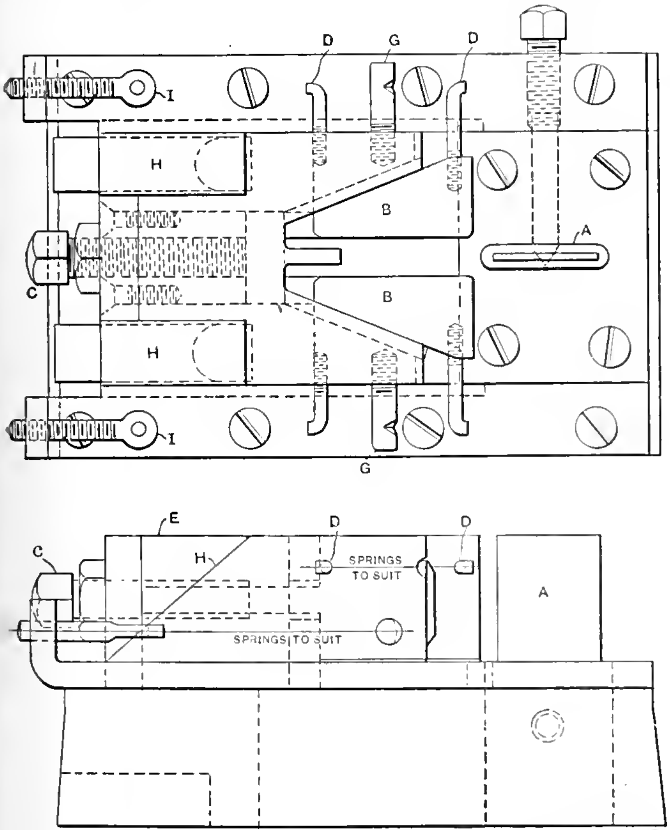


Fig. 2. Die for Forming the Clip as shown at B, Fig. 1

formed with it just as well. The tool is made entirely of steel and consists primarily of a base *A*, two blocks *B* which are adjusted by right- and left-hand screw *D*, two horizontal forming tools *E*, and a support *F* which is adjustable for clips of different heights. This adjustment was required in order to bring the space former (Fig. 4) upon which the clip is mounted during the bending operation at the right distance from the forming tools *E*. On this support *F* there is a small screw *C* which locates the former, thus bringing the work central. The punch *G* has two cams *H* and two formers *I*. These cams and formers are adjustable by the right- and left-hand screw *J*. To perform the last operation on the U-shaped piece, it is put on the space former (Fig. 4) which is then placed on top of the support *F* with the notched corner shown resting against the small screw *C*.

The formers *I* are then adjusted to the outside width of the clip. As the formers *H* are fastened to the same block they are, of course, adjusted at the same time. As the press ram descends, the cams *H* strike the formers *E* and cause them to move toward the center of the die. This movement bends the prongs of the clip to a horizontal position; as the ram continues its downward stroke the vertical formers *I*

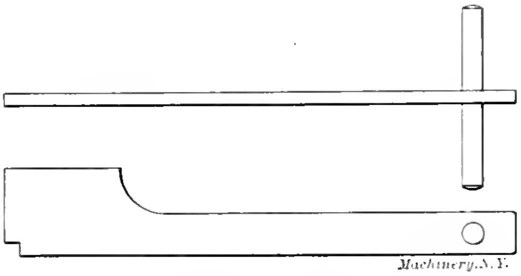


Fig. 4. Former upon which the Clip is Mounted during the Last Bending Operation

bend these prongs down and set them. This finishes the second and last operation forming the piece as shown at *C* in Fig. 1. These tools have been in daily use since they were first made.

J. A. G. GOULET.

Peterboro, Ont., Canada.

* * *

A kink which comes from Carr Brothers, of Syracuse, relates to the cutting off of thin tubing of copper, brass, etc., with the power hack-saw. This is usually a matter of some difficulty, owing to the tendency of the saw to dig into the thin walls of the soft metal. To overcome this tendency, an old saw blade is used for this work. The blade is first run over the face of the emery wheel, so as to grind the teeth almost down to the roots, leaving only very small notches. The saw thus treated is used in the regular way. It cuts very slowly when it first begins, but works at good speed and without digging in during the remainder of the operation.

HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

FIGURING GEARING FOR WORM-WHEEL HOBBING MACHINE

J. B.—The engraving, Fig. 1, shows the gearing on a hobbing machine. Please explain to me how to figure and prove the change gears to cut a worm gear of, say, 50 teeth. A 48-tooth gear is sometimes used in place of the 96-tooth gear at *A*, when cutting a large number of teeth. Please explain how to allow for this.

A.—The way in which the machine is geared will depend on the assortment of change gears with which it is provided. If there is a sufficient variety of these, simple gearing may be employed, using an idler on the swinging arm to connect the gear on shaft *D* with gear *A*.

First find the revolutions of the hob for each revolution of the worm-wheel. This is found by dividing the number of teeth in the wheel by the number of threads in the hob, or worm, with which it is to run. For instance, if there are fifty teeth in the wheel and the worm is single threaded, the number of revolutions of the work to one of the hob will be $50 \div 1 = 50$. This may be called the *ratio* of the wheel. If the worm is double threaded, the ratio will be $50 \div 2 = 25$, and so on. With the gear connections you have shown for simple gearing, when *A* has 96 teeth, the gear on shaft *D* must have a number of teeth equal to 4 times the ratio; that is to say, if we have a worm-wheel with 50 teeth, driven by a double threaded worm, the ratio is 25, and the number of teeth in the gear at $D = 4 \times 25 = 100$. If a 48-tooth gear is used at *A* in place of the 96-tooth gear, the gear on *D* is found by multiplying the ratio by 2. If, for instance, the number of teeth in the wheel to be cut is 135, to mesh with a triple threaded worm, the ratio will be $135 \div 3 = 45$ and the number of teeth for gear *D* will be $2 \times 45 = 90$, when *A* has 48 teeth.

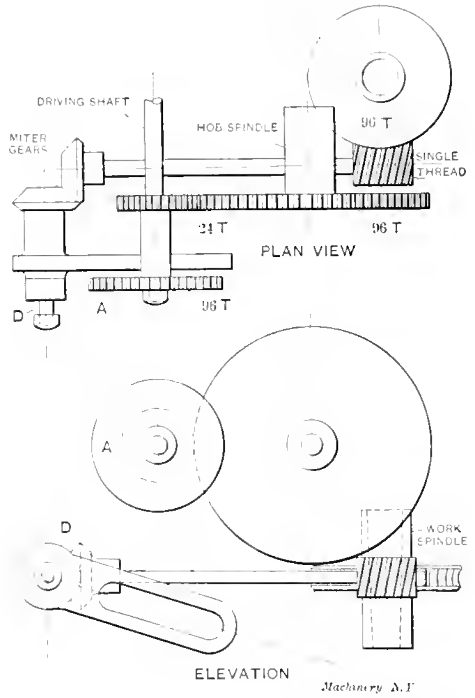


Fig. 1. Arrangement of Gearing in Hobbing Machine

A wider range of ratios can be provided for with a given number of change gears if *A* and *D* are connected by compound gearing, as shown in Fig. 2, where *A* and *C* are the driving gears and *B* and *D* the driven gears. The rule for finding the number of teeth for *B*, *C* and *D* when *A* has 96 teeth then becomes

$$\frac{\text{number of teeth in } B \times \text{number of teeth in } D}{\text{number of teeth in } C} = 4 \times \text{ratio.}$$

When *A* equals 48, this becomes

$$\frac{\text{number of teeth in } B \times \text{number of teeth in } D}{\text{number of teeth in } C} = 2 \times \text{ratio.}$$

Suppose, for instance, that we have a set of change gears going by 6's, that is to say, the numbers run 18, 24, 30, 36, 42, etc., from 18 to 120. Suppose the ratio of the worm gear to be cut is 50, and the number of teeth in gear *A* is 96; then we have:

$$\frac{\text{number of teeth in gear } B \times \text{number of teeth in gear } D}{\text{number of teeth in gear } C} = 4 \times 50 = 200.$$

By selecting the 60-tooth gear for *B*, a 120-tooth gear for *D*, and a 36-tooth gear for *C*, we have

$$\frac{60 \times 120}{36} = 4 \times 50.$$

Proving the calculations of the gearing for this machine is practically the same, whether simple or compound gearing is used. Consider that the whole mechanism is driven from the hob spindle; then the product of all the driven gears, divided by the product of all the driving gears, equals the number of teeth in the worm-wheel divided by the number of threads in the worm or hob. An idler gear between a driving and driven gear is not considered at all, as it has no effect on the motion other than to reverse it. Proving the first example by this method, we have

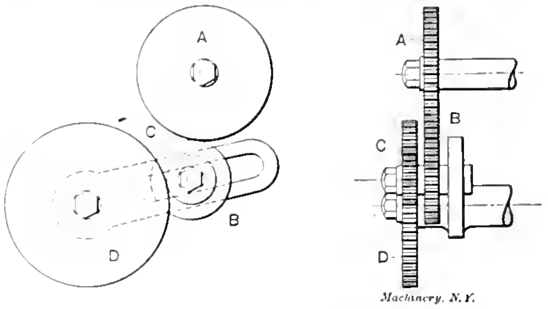


Fig. 2. Compound Gearing for Machine in Fig. 1

$$\frac{96}{1} \times \frac{1}{1} \times \frac{100}{96} \times \frac{24}{96} = \frac{50}{2} = 25.$$

The number of teeth in these driving and driven gears are given in their order from the work, through the mechanism, to the hob. The fraction $\frac{1}{1}$ represents the miter gears, which are of even ratio, but the number of whose teeth are not given. For the last example the proof is similar. Here we have

$$\frac{96}{1} \times \frac{1}{1} \times \frac{120}{36} \times \frac{60}{96} \times \frac{24}{96} = \frac{50}{1} = 50.$$

You can get further help in the matter of calculating gear ratios by studying Chapters IV and V of Shop Arithmetic for the Machinist, No. 18 of MACHINERY's Reference Series

* * *

The purchasing agent of a large electric railway company until lately bought metal for car journal bearings of a certain concern, paying twenty cents a pound. The metal gave satisfaction, but the price was considered too high. A sample was sent to a chemist for analysis and upon receipt of the report, the purchasing agent sent out for bids on a metal of the composition shown by the analysis. A reliable concern at once offered the same metal at six cents per pound. As the amount of metal used in the year is large the saving is considerable. This is an example of the materials that can be bought on specifications to advantage. The purchasing agent, armed with the knowledge of the desired materials' constituents, sends out the specifications and asks for bids. Those who bid, do so with a knowledge of the characteristics of the required materials, and that the material supplied will be rejected if it does not come up to the specifications. The plan has been followed for many years by the Pennsylvania Railroad Company with great satisfaction.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

BLISS COMPOUND PNEUMATIC FORGING HAMMER

As may be surmised from an examination of the accompanying engravings, the pneumatic forging hammer shown herewith, built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., closely resembles the construction of the ordinary steam hammer used for the same work. At first thought it seems improbable that the interposition of an air compressor between the boiler and the hammer would result in any actual saving in time, expense and labor. A study of the design and use of the tool, however, as given in the following paragraphs, will show that there is warrant for expecting a saving from this construction.

Fig. 1. An 800-pound Forging Hammer with Compound Cylinder, operated Pneumatically

Compound Air Distribution and Valve Mechanism

A most important improvement made possible by the use of air is the compounding of the cylinder so that the air is used expansively. Compounding has been tried many times with steam hammers, but has hitherto proved impracticable, on account of the tremendous condensation met with. By the time the hammer was ready to use the steam over again on the expansion stroke, there would be nothing left but water. With air, where there is no possibility of condensation, a high economy may be obtained by using the direct pressure for lifting the ram, and a second or expansion stroke for accelerating its downward movement. The arrangement of the cylinders and the valve mechanism for effecting this will be understood from a study of Figs. 2 and 3.

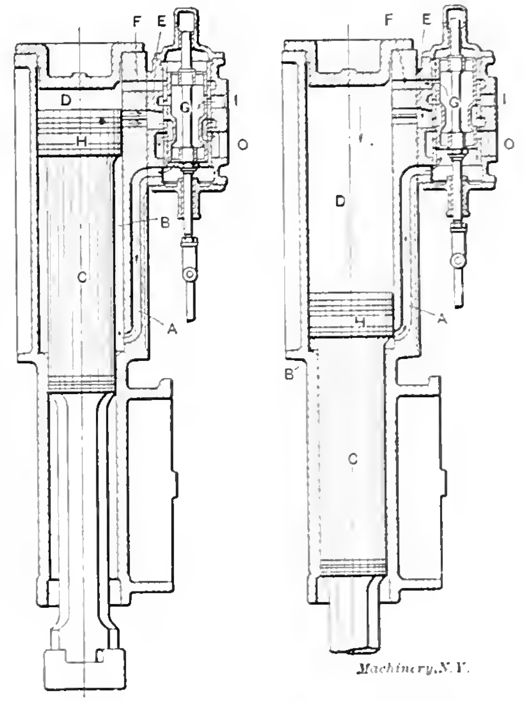
In Fig. 2 the hammer is shown raised to the upper limit of its stroke. The inlet is at *I*. From here the air follows the arrows through the port into the center of the valve *G*, and thence down through the lower port *A* into annular space *B*, and around the small diameter *C* of the piston, where it acts on the under side of head *H* to raise the ram. In raising the ram, the air in space *D* above the piston has been exhausted through ports *E*, following the arrows shown to exhaust *O*. Port *F* is closed by valve *G* in this position so that the upward movement of the piston and ram is limited by the cushion in space *D*.

On the down stroke the valve *G* is raised to the position shown in Fig. 3. Here the inlet *O* has been cut off the interior of valve *G* being connected with port *F* instead, which thus puts space *D* in communication with annular space *B* below head *H* of the piston. (Owing to the fact that the air in *D* in Fig. 2 is under compression, the evil effect of the clearance at this point is not so important as would otherwise be the case.) Port *E* is closed so there is no escape to the atmosphere, and the air at initial pressure in *B*, *A* and *G* is thus allowed to expand in the cylinder *D*, accelerating the downward movement of the ram and increasing the force of the blow without requiring any perceptible increase in air consumption. On lowering the valve again, to the position shown in Fig. 2, the space *D* is again connected with exhaust *O*, and space *B* with inlet *I*, raising the piston again to the position shown in the illustration.

Provision for Using Direct Pressure on Ram

By examining the side of the hammer frame in Fig. 1, it will be seen that the downward movement of the valve lever (and the consequent raising of the valve) is limited by a pin. This pin may be removed, increasing the valve travel. This increased valve travel allows space *D* to be directly connected with the compressed air supply on the downward stroke, space *B* meanwhile exhausting into the atmosphere. This provision permits the striking of a much heavier blow than is indicated by the normal rating of the hammer, thus increasing its capacity for exceptional work. This increase of capacity is naturally obtained at the expense of economical working, so it is not recommended for regular practice. It has the advantage, however, of giving the tool an exceptionally high "over-load" capacity.

The action of the valve when raised to the direct pressure position will be readily understood from Fig. 4, where it will be seen that the air at *B* escapes into *D* as before, but that in addition the inlet supply at *I* is connected by means of the annular passage around valve *G* with ports *E*, leading to space *D* above the piston.



Figs. 2 and 3. Position of Valves and Flow of Air in Compound Cylinder, with Ram held up and down, respectively

Fig. 5, which has reference letters corresponding to Figs. 2, 3 and 4, shows the arrangement of the valve mechanism for the largest size of double frame hammers, such as shown in Fig. 6. The reference letters correspond in all the engravings, and the principles of operation are the same for both cases.

Incidental Advantages of the Use of Air

Besides the advantage of using the air expansively as just described, there are a number of other advantages attaching to the use of air in place of steam. Long steam lines and a high rate of condensation are almost inevitable with the steam hammer. It is common practice to leave the drip valves open for the line, the cylinder and the exhaust, this being necessary to take care of the amount of water produced. The escape of steam through these openings amounts to more than a small percentage of the amount of steam usually employed. In this hammer no drips are necessary, as the air is relieved of its water in the receiver. Furthermore, long lines are unnecessary, as the compressor may be placed in the closest and most convenient position with relation to the boilers, irrespective of the position of the hammer and the furnace. It is also feasible to use a compressor of high commercial efficiency, using the steam in a far more efficient manner than in the crude mechanism of the ordinary steam hammer. The saving from these sources is considerable.

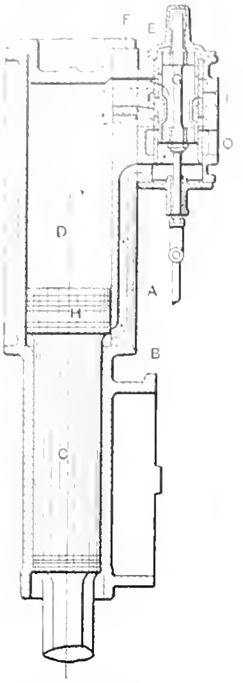


Fig. 4 Using Full Air Pressure on Down Stroke

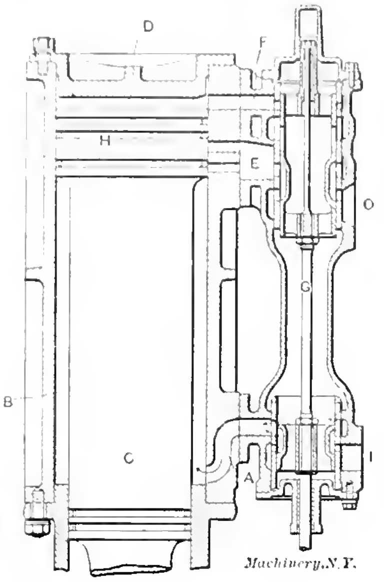


Fig. 5. Valve Arrangement used on the Large Sizes

The heavy condensation in the cylinders when using steam results in a constant flow of water through the stuffing boxes, down the piston, and onto the die faces. This makes it necessary to exercise great caution in striking the first blow on a piece of work, as striking the red hot forging loosens the scale. This makes a heavy blow dangerous, as the flying scale and metal are liable to injure the workman. For this reason the first blow given by the hammer man to a new spot on a forging is habitually light, so as to either compress the scale or knock it off. This blow is wasted so far as effectiveness in shaping the work is concerned, though it uses about as much steam as a heavier stroke. The absence of drip in the pneumatic hammer overcomes these difficulties, and the corresponding freedom from loose scale permits keeping the die faces clean, thus giving them much greater durability. The fact that there is but one line of piping, that for the air pressure, simplifies the matter of installation and maintenance. The exhaust takes place directly into the atmosphere, thus assisting in cooling and ventilating the building instead of heating and vitiating the atmosphere as in the case of a steam hammer.

Details of Mechanical Construction

While the hammer is made in the single frame design, shown for the 800-pound hammer in Fig. 1, for the larger sizes the double frame type shown in Fig. 6 is used. As will be seen in Figs. 2 to 5, these tools are of simple construction, with very few wearing surfaces. The small part of the cylinder forms a guide for the ram, which with the jaws for the die, are forged from a solid steel ingot. The shape of the section of the ram is nearly uniform throughout, while the cylindrical portion is almost entirely contained in the guiding cylinder when the blow is struck. Ordinary piston rings are employed in the guiding cylinder as well as on the main piston head, making the use of stuffing boxes unnecessary. The freedom from friction thus obtained is an important factor in increasing the efficiency of the machine.

The use of air in place of steam simplifies the mechanism in a number of ways. The absence of condensation, just mentioned, makes it possible to strike the first heavy blow without working the hammer. For this reason the automatic striking attachment usually found has been dispensed with. The valve is thus controlled by one hand-lever and the hammer is more simply operated. Proper manipulation of the single handle will give any weight of blow, light, heavy, exceeding heavy or holding down, as required. When the handle is raised, the ram rises and remains in its highest position.

The piston and dies are kept from rotating by wooden jaws, which bear against the flattened sides of the ram between the die head and the smaller diameter of the piston. These are kept automatically lubricated and have no other function than that of keeping the piston from twisting, so the service on them is not severe. A detail of interest will be noted in Figs. 2, 3 and 4, where it will be seen that the bearing surface by which the cylinder casting is bolted to the frame is provided with a tongue, engaging a corresponding groove in the frame. This takes the thrust and jar, relieving the bolts from shearing strain. The latter may, in fact, be quite loose without harm to the mechanism.

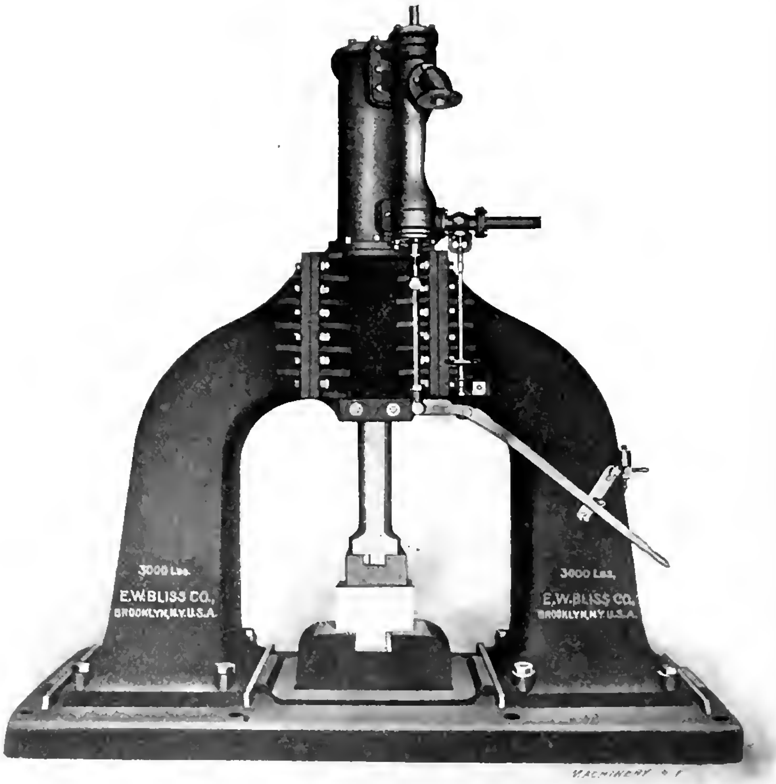


Fig. 6. Heavy Double-frame Pneumatic Forging Hammer

Sizes and Capacities

This pneumatic forging hammer is made in ten sizes, ranging from 150 pounds to 6,000 pounds. These figures give the

nominal size of the hammer, reckoned on the basis of the actual falling weight in pounds. The maximum blows per minute range from 120 for the smallest size to 30 for the largest size. These hammers are designed to use air at the usual shop practice of 80 pounds per square inch. Their consumption of free air in cubic feet per blow at this pressure ranges from 0.158 to 11.2 cubic feet per blow. The capacity of compressor recommended ranges correspondingly from 30 to 450 cubic feet of free air per minute.

An interesting application of the two smaller sized hammers (150 and 250 pounds) has been found, which is made possible by their operation with compressed air. This relates to the hammer for forging and dressing tools, such as are used in mines, quarries, etc. Such establishments are usually already provided with the necessary air pressure, so that the matter of providing a hammer is very simple as compared with installing one of the old style. These light hammers are mounted on trucks and may be moved from place to place whenever their service may be required.

Summary of Advantages

In brief, the advantages claimed for the use of air in this forging hammer are as follows: Greater economy through the use of the compound principle; increased capacity from the provision of direct action for taking heavy blows; no condensation and consequent economy in the use of steam—both in that escaping in the drip and that used when working out the hammer to free the cylinder of condensation; no long steam lines; location of compressor close to boiler and possibility of using a light economical form of engine and compressing mechanism, in place of the inefficient mechanism of the steam hammer; simplicity of construction and operation.

This tool is of English origin. The makers have had one of the smallest sizes, such as shown in Fig. 1, in use in their shops for many months, and their favorable experience with it has led to their purchase of the American rights for these tools. The 3,000 pound hammer shown in Fig. 6 was supplied to the Lackawanna Railroad Co., for general railway forging. In this work it has given complete satisfaction.

DAVIS CLUTCH

The clutch illustrated in the accompanying engravings is made by the Davis Clutch Co., 1232 East 3rd St., Cleveland, Ohio. It is the result of a desire of the makers to obtain a simple, durable and efficient construction embodying all the requirements necessary for meeting the exacting conditions under which such mechanisms are used.

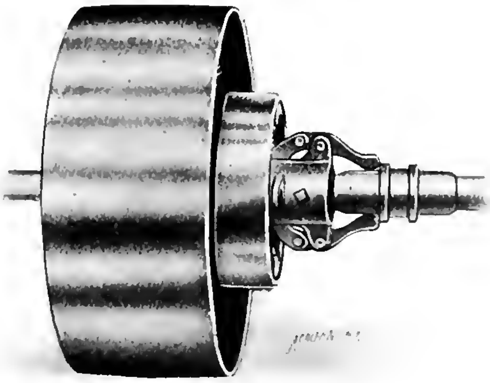
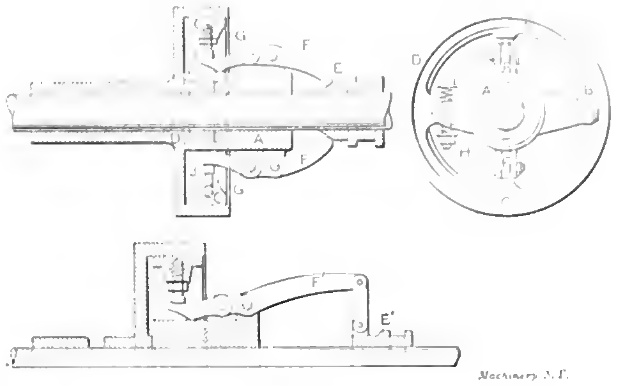


Fig. 1. The Davis Friction Clutch

The construction of this clutch is plainly shown in Figs. 2 and 3. The body piece *A* is keyed to the shaft. On this are hinged at *B* two friction rings *C*, which extend all the way around the hub and are pressed by the levers shown against the inner flange of the friction rings or hub *D*. On this latter member is mounted the pulley or gear which it is desired to connect with or disconnect from the shaft.

A compound lever system is used. The thimble *E* in Fig. 2 spreads apart the outer end of levers *F*, and thus tips up the toe of lever *G*, which is fulcrumed on the hub of the body piece against adjusting screw *J* in the friction rings. As shown, these rings terminate at one end in two lips provided with through-bolt *H* and springs, which assures plenty of clearance when the levers are dropped and the clutch is thrown out. A variation in the lever mechanism for larger clutches is shown in the lower view of Fig. 2. Here levers F' are connected with sliding sleeve E' by means of links as shown, the rest of the mechanism being practically identical with that just described.



Machinery, N.Y.

Fig. 2. Construction of the Davis Clutch

The provision for adjustment is very simple, and practically unlimited in range. The adjustment of the clutch is effected by throwing it into engagement, and then tightening down set-screws *J* with the same force on each side, to the degree desired, locking them at that point with the jamb nuts. Equal bearing of the fingers and levers on both sides of the thimble *E* holds the latter rigidly in place, and prevents spring of the shaft. The clutch is carefully balanced, so that there is no vibration, with consequent danger of jarring the thimble out of position.

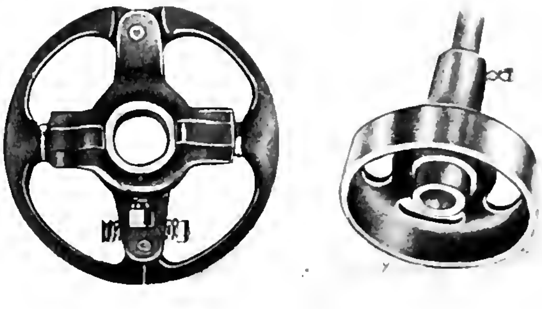


Fig. 3. The Clutch Disassembled

The matter of lubrication has been carefully attended to. Sleeve *D*, it will be seen, is of great length, being extended forward into a counterbore recessed into body piece *A*. From an oil chamber in the center of the sleeve (not shown) oil is distributed over the bearing through carefully located channels. It is recommended that the friction surfaces be lubricated with cup grease or vaseline; this improves their durability and action.

This clutch is very compact, and is easily adapted to special uses in machinery of all sorts. The length of the hub and diameter on *D* may be varied to suit the machine where it is to be used, and special forms may be given to this member to meet unusual requirements.

A test of a series of these clutches was recently made by an impartial investigator, Professor R. H. Fernald, of the Case School of Applied Science, Cleveland, Ohio. The purpose of this test was to enable the manufacturers to make conservative guarantees of the capacity of their productions when installed in the shops of their customers. They were made under the following conditions:

(1) The clutch must run perfectly free when no load is applied. (2) The load carried during each test must be entirely removed before releasing the clutch, and upon releasing, the clutch must run free, and the shaft must come speedily to rest. (3) With the clutch set as indicated in (1) and (2) the following ratings must be determined: (a) The load which the clutch, when suddenly thrown into action, will readily pick up and carry for a period of 15 minutes. (b)

The maximum load which the clutch will carry when the load is gradually applied. This maximum load is also to be carried for 15 minutes.

The five clutches submitted for test were tried out on the above basis. The principal dimensions and the results secured are presented below.

TABLE I.

Clutch Number	Diameter of Friction Surface, Inches	Outside Diameter of Clutch, Inches	Width of Friction Surface, Inches
6	$5\frac{5}{8}$	$6\frac{1}{8}$	$1\frac{5}{16}$
8	$7\frac{5}{8}$	$8\frac{1}{4}$	$1\frac{3}{4}$
10	$9\frac{7}{16}$	$10\frac{1}{16}$	$2\frac{1}{4}$
14	$13\frac{1}{4}$	$14\frac{1}{4}$	$2\frac{3}{4}$
18	$16\frac{3}{4}$	18	4

Under the conditions specified above, the following results were secured:

TABLE II.

Clutch No	6	8	10	14	18
Max. "pick-up" load, pounds.	21.5	50.5	70.5	254.0	354.0
Revolutions per minute for maximum "pick-up" load	91.4	111.7	122.8	119.3	133.8
Horse-power transmitted for maximum "pick up" load at r. p. m. indicated	1.96	5.64	8.66	30.3	47.3
Maximum load carried	35.5	58.0	81.5	254.0	354.0
Revolutions per minute for maximum load carried	86.5	111.0	129.8	119.3	133.8
Horse-power transmitted for maximum load carried, at r. p. m. indicated	3.07	6.40	10.57	30.3	47.3

Rating the clutches on the basis of 100 revolutions per minute, the horse-power transmitted was as follows:

TABLE III.

Clutch No	6	8	10	14	18
Horse-power transmitted for maximum "pick-up" load	2.15	5.05	7.05	25.4	35.4
Horse-power transmitted for maximum load carried	3.55	5.80	8.15	25.4	35.4

These clutches are made in sizes to deliver from 3 to 60 horse-power, at 100 revolutions per minute. Besides the difference in the lever mechanism shown in Fig. 2, the clutches are furnished in two styles, depending on whether they are to be used for counter-shaft or main line use. In the former case two levers are used, each friction ring having a single bearing point on the lever, as here illustrated. For line shaft use, four sets of levers are used, each ring having two bearings.

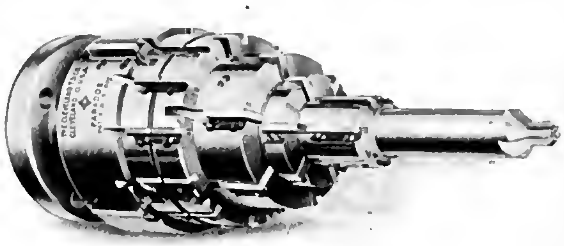
The tests given above are worthy of record as giving authentic results for commercial clutches under laboratory conditions.

CLEVELAND MULTIPLE REAMING AND FACING TOOL

The accompanying engraving shows a remarkable inserted tooth multiple reamer, recently built by the Cleveland Twist Drill Co., of Cleveland, O. It was built for a well-known cream separator company, and was designed for rough reaming and facing eight diameters, completely finishing all the holes in the casting on which it is to be used.

The body is made of a cylindrical casting carrying the outer blades, into which is fitted a second and smaller body of machine steel, turned and slotted to receive the next three sets. This body in turn holds the counter-sink, which is made of hardened tool steel. The tool is 21 inches long, and $6\frac{1}{2}$ inches in diameter, weighing nearly 100 pounds. The counter-sink, five reamers and the formed facing tool for facing and rounding the top ring, require in all 34 inserted blades. Twelve of these are of the double combination cutting type, making, with the four counter-sink lips, a total of 50 cutting edges. The tool, in use, is bolted on the boring head of a large horizontal boring machine.

The prime advantage of this construction is that the cost of the whole tool is considerably less than that of the set of individual ones necessary to perform the various operations. Another obvious advantage results from performing a number of operations at one time, thus saving labor and time. The high speed steel blades used reduce the necessary regrinding to a very small amount. The adjustable blade feature in this, as in other similar designs, is an important feature in the economy of the device. A solid, built-up reamer of the same character would scarcely pay in service for the large initial expense, since when one of the reamers is worn below size, the usefulness of the tool is destroyed. These blades, on the other hand, can be adjusted whenever required, and may be replaced with new blades at small cost when worn out.

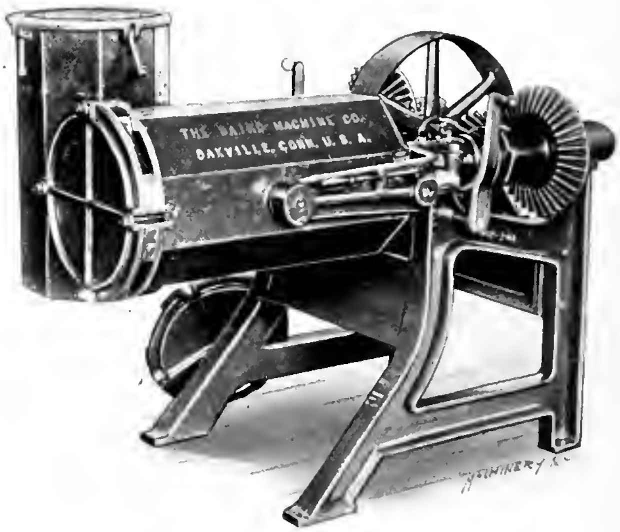


A Multiple Reaming and Facing Tool with Thirty-four Inserted Blades and Fifty Cutting Edges

BAIRD DOUBLE HORIZONTAL TILTED TUMBLING BARRELS

The tumbling barrel shown herewith is designed especially for rolling small metal articles with steel balls. This operation may be employed for burnishing such work before plating, or polishing it afterwards. It has been largely used on such articles as electrical fittings, typewriter, adding machine, and similar parts, chains, collar buttons and other jewelry, fancy hardware, etc.

The machine is double, as may be seen. The barrels are of cast iron, lined with maple. This lining is very durable, and when worn out, may be easily replaced, thus preserving the iron barrel indefinitely. The barrels are carried on forks on the ends of the spindles, being pivoted near their centers. A slight push on the locking pin allows the barrel to be swung from the horizontal operating position to the upright position for inspection, or to be dropped to the reverse position for dumping. The cover bolts may be quickly loosened and thrown back, permitting the cover to be removed. The operation of emptying out the work is thus one of moments only.



Tumbling Barrels of Convenient Construction, especially adapted to Polishing Work with Steel Balls

The advantages of this construction are obvious. There are no loose parts, the cover bolts being hinged to the barrel itself, and the nuts have only to be loosened and not taken off, so there are no parts to be lost. Each barrel is independently driven by a clutch engaging the driving gearing, so

that one of them can be emptying and refilling while the other is in motion. The barrels are water-tight, each being provided with a rubber gasket.

This machine is made in but one size, having a barrel 10½ inches inside diameter by 24 inches long, geared 2 to 1, with a driving pulley intended to run at about 60 revolutions per minute. This machine has a net weight of 1,300 pounds. Two other sizes will be made to order, or any other requirements on the part of the customer will be specially looked out for.

RIBLET TRANSVERSE CURRENT WATER HEATER

The apparatus shown herewith is called by its builder (the Riblet Heater Co., of Erie, Pa.) the "transverse current water heater." It may be used as an ordinary feed water heater, using the exhaust of a steam engine, but it has been especially adapted to the heating of water for shop, laundry, hotel or other purposes from the exhaust of the gas engine. It is believed to be the first commercially successful device for this latter purpose that has been placed on the market. As is well known, only a comparatively small percentage of the heat of the gas used in generating power in the gas engine, is changed into work. The balance is wasted through the exhaust and the water jacket. The exhaust has a temperature of from 600 to 1,000 degrees, and this heater is designed to save all of this heat that can possibly be saved. It has been found that with an engine using 15 cubic feet of gas per hour, nearly two-thirds of the total heat is thus made available. It has been calculated and found from experience that, allowing for loss from radiation, etc., one of these heaters will raise the temperature of nearly 70 gallons of water from 40 to 200 degrees per hour, for each horse-power developed by the engine.

Fig. 1. Water Heater adapted for Use with Gas Engine Exhaust, as well as with Steam

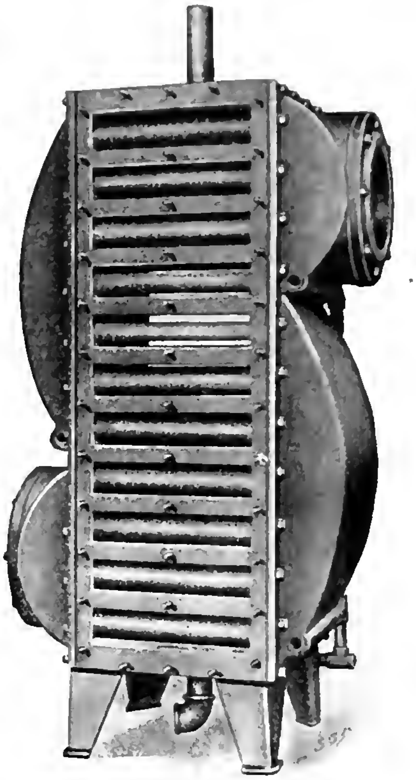


Fig. 2. Casings removed, showing Reverse Courses of Water and Exhaust

In construction the heater, as may be seen in Figs. 1 and 2, consists of a series of flat rectangular passages, of sufficient number to give the required heating surface. These are so arranged in connection with the inlet and outlet openings at the end that the exhaust enters the heater at the bottom, passing through a sufficient number of these passages or ports to avoid back pressure, and then turns backward again, passing through from side to side of the heater from three to five times before reaching the exhaust outlet which is located at the top.

The water enters the heater at the top, passes over the first port, back over the second, over the third, back over the fourth, etc., from top to bottom. This back and forth movement is controlled by the circulation plates. The water thus goes through but one passage at a time, traveling downward across, and in the opposite direction to, the exhaust. In this way, the hottest water, just as it leaves the heater at the bottom, passes through the section heated by the hottest exhaust. When more convenient for installation this order can be reversed without interfering in any way with the circulation. The entire heating surface is thus made effective, and as the water is constantly agitated, the maximum amount of heat is absorbed.

As a feed water heater operated by exhaust steam, this device has the advantage of being made entirely of cast iron, which does not readily corrode, and is not readily affected by electrolysis or acids. As the result of this precaution the life of the heater is, of course, greatly prolonged. There are no tubes to collect scale, no internal joints to leak, and the water does not come in contact with the exhaust.

This heater has been thoroughly tested out for some months in connection with both steam and gas engines, the results in both classes of service being satisfactory to the makers and users.

"NU-CLINCH" BELT AND ROPE DRIVE SURFACERS

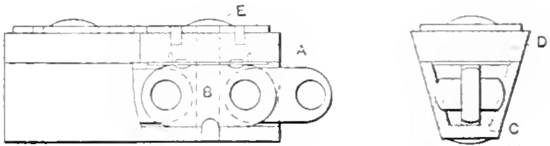
The Improved Surface Co., North Tonawanda N. Y., has placed on the market a line of belt and rope dressings which are designated respectively as the "Nu-clinch cleaner," "Nu-clinch filler," "Nu-clinch preserver" and "Flexite surfacer." The first two are intended for general belt use, the preserver is used on old worn-out belts, while the flexite surfacer is intended as a dressing for rope drives.

These compounds are composed of lubricating liquids of great penetration, which enter into the pores of belt or rope, reducing their internal friction, at the same time that they prevent them from slipping on the pulley or sheave. The material spreads throughout the belt and does not gum up, keeping the surface open and unglazed.

These products are given a careful chemical inspection before leaving the factory, together with the mechanical tests necessary to insure that they will produce the results for which they are sold. Each lot is thus tested. Samples will be sent free on request. They are put up for sale in 14- and 35-pound packages and barrel lots.

PEERLESS V-BELT

We describe and illustrate herewith a belt made by the Peerless V-Belt Co., 215-219 So. Clinton St., Chicago, Ill., which possesses many advantages over both the chain and the leather belt. It is designed to give a maximum of capacity and durability in the same product. Its construction will be understood from Fig. 1, where it will be seen to be composed of a central core of blocks *A* and side links *B* forming a steel chain, surrounded by a raw-hide and friction paper casing *C* and *D*. The cross-section of the belt is of V shape, to fit the grooves in the pulleys over which it runs.



Machinery,N.Y.

Fig. 1. Construction of the V-Belt

The lower or raw-hide casing *C* is a continuous strip, covering the bottom and the two sides of the chain. This material gives a friction surface of great efficiency, the coefficient of friction of raw-hide on cast iron being very high. The upper part of the casing is of friction paper, there being one section to each link of the chain. It is pivoted at an angle so as to continue the friction surface up the sides. Each section is fastened to the link by a rivet *E* passing through it.

The pulleys used are provided with grooved faces, cut to an included angle of 28 degrees, which has been found the most suitable for this work. At this angle the friction is very efficient, and still the chain does not become wedged into the grooves so that power is lost in pulling it out after it has gone round the pulley. To preserve the wedge-like tightening of the chain in the groove, the bottom of the later must be deep enough so that the belt will not touch it under any conditions, thus destroying the wedging effect and reducing the friction. It is not necessary in installing this belt chain to purchase new grooved pulleys in place of the old straight faced ones. Special V-groove rims will be furnished by the makers, so constructed that they may be placed on any ordinary flat faced pulley.

It was stated that capacity and durability were two prime points of the excellence aimed at in the construction of this belt. As to capacity, it is stated that raw-hide has a higher coefficient of friction than leather. The weight of the belt, where the center distance is reasonably large, causes the chain to wedge firmly into the groove, giving it a high transmitting capacity. The raw-hide itself is not subject to tension, only to the compression and transmitting strain. Under these conditions it is very lasting and may be subject to continued dampness without being impaired by it. Durability is also obtained by the careful fitting and hardening of the chain. The sides of the link and the forged connecting blocks are pack hardened to as high a degree as practicable. The rivet passing between the side links keeps these far enough apart to allow the free action of the block when the chain is bent around the pulley.

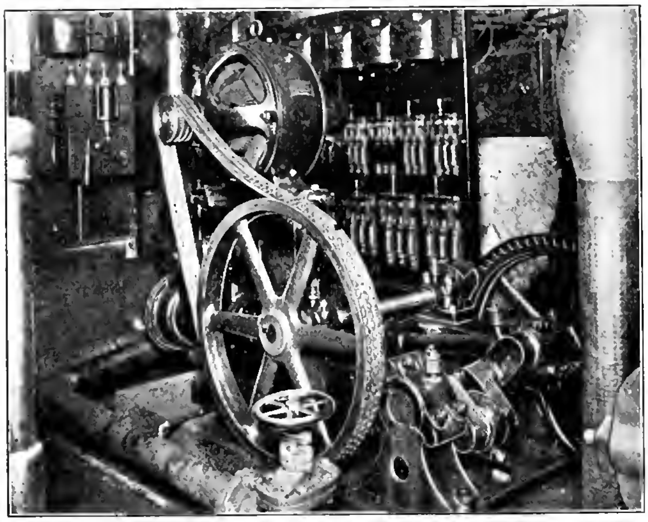


Fig. 2. The Peerless V-Belt, with Steel Chain Core and Raw Hide Friction Surfaces

The high efficiency obtained by the wedging action in the grooves of the pulley should give, from theoretical considerations, fully four times the capacity of a flat leather belt for the same width. This has been verified in practice. The following comparisons are based on the safe assumption that a flat belt 1 inch wide requires about 800 feet per minute of contact for each horse-power transmitted. The V-belt is made in two sizes, one ⅞ inch across the top and the other 1¼ inch. The ⅞-inch size will transmit 1 H. P. for every 200 feet per minute of contact. The larger belt requires only about 130 feet per minute per horse-power. This holds true even for short center distances, scarcely longer than those used for chains. For extremely short center distances, slightly larger velocities are required per horse-power.

The advantage of this belt over the ordinary flat belt lies in its strength and carrying capacity. As compared with the chain drive it has the advantage of being perfectly noiseless. It can also be used at much higher speeds. On small pulleys it may be used easily up to 3,000 feet per minute, while on pulleys of ample size it may travel at speeds as high as 5,000 feet per minute. When once put on, it requires very little attention. An occasional lubrication of the chain three or four times per year is all that is necessary. Any ordinary mineral lubricant is used, a drop or two being poured between each block as it passes over the sheave. The raw-hide absorbs a good deal of this and as it is in constant contact with the joints of the chain, it serves as a reservoir, supplying the lubricant for a long time.

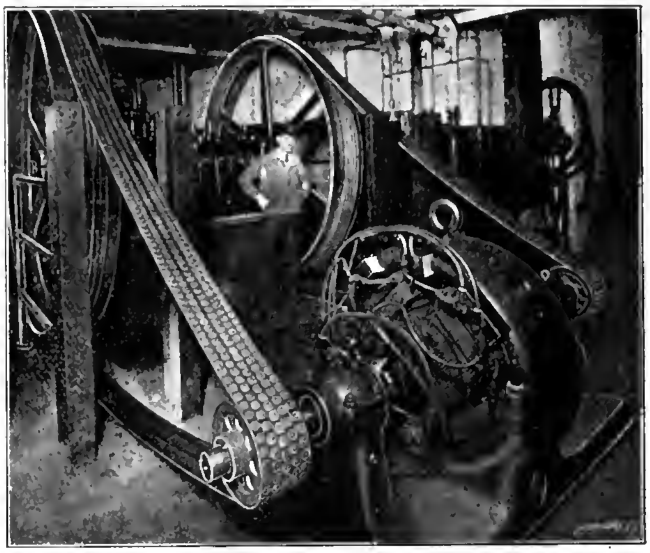


Fig. 3. Driving a Pump for High-pressure Electric Service

Two interesting applications of this belt are shown in the accompanying half-tone engravings. In Fig. 2 a 15 H. P. motor is direct connected to a duplex pump at a center distance of 36 inches. The pump was formerly used with a gear drive, which caused annoyance to the tenants from noise and vibration. The V-belt installation has worked noiselessly and furnished ample power. Fig. 3 shows a 50 H. P. motor driving an elevator pump, working at 900 pounds pressure. The ratio of pulley diameters is about 1 to 10. Formerly two 12-inch flat belts were used, pressed down by idlers weighted to 230 pounds each. An auxiliary pump was required to keep up the pressure during rush hours. With the V-belt and without idlers, slippage has been eliminated and the one pump does the work. A saving of 6 per cent on the power used has been effected.

IMPROVEMENTS IN THE TILTED TURRET SCREW MACHINE

In the department of New Machinery and Tools of the August, 1907, issue of MACHINERY, we described the original design of the tilted turret lathe built by the Wood Turret Machine Co., of Terre Haute, Ind. The construction which

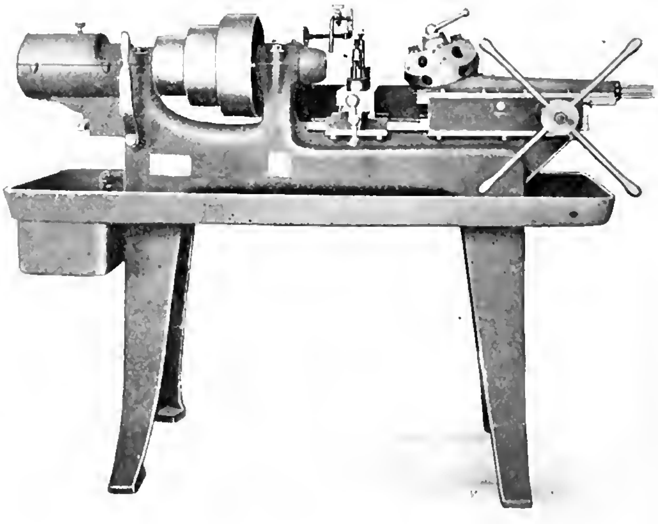


Fig. 1. New Design of the Tilted Turret Lathe

gives this machine its name, as described at that time and as plainly shown in the accompanying view in Fig. 1, is the setting of the axis of the turret at a considerable angle from the vertical position. While this had previously been done on the heaviest class of such machinery, its application to a small turret lathe was new, and it was applied in such a way as to offer distinct advantages not previously obtained.

In the first place, the tilting of the turret obviously allows the use of tools of large diameter. It allows such tools to swing over the rear of the turret slide, while still permitting a low and rigid design of the turret. The angle to which the turret is tilted is 15 degrees, so that tools are swung up at an angle of 30 degrees from the horizontal in the rear position. An exclusive feature of this turret is the continuation of each hole through the stationary turret stud and out through the further side of the turret, below the tool hole on that side. It is thus possible to pass bars of stock of great length through the hollow tools, without requiring excessive overhang. The tilting of the turret also brings the pressure of the thrust directly on the slide, which is brought up almost on a line with the center of the spindle. This relieves the center post from strain, and increases the rigidity and cutting power of the tool.

Fig. 2. Automatic Roller Feed Mechanism removed from the Machine, showing Compact Construction

The New Roller Feed Mechanism

The design of this machine shown in Fig. 1 has among its other improvements a continuous automatic bar feed in place of the old-style wire feed previously used. The compact and simple construction of this mechanism, shown in Figs. 2, 3 and 4, has made its use possible on this comparatively small machine. Fig. 2 shows the mechanism removed from the spindle. Fig. 3 shows a cross-section of the device in place on the machine, while Fig. 4 shows it disassembled, with the working parts in full view. When the lever A, see Fig. 3, is pushed to the left, wedge B is forced between two brake arms C. These arms are pivoted at D so that their upper ends are caused to close around scroll E and grip it firmly, stopping its revolution. As the spindle and casing of the mechanism continue to revolve, gears F and F', meshing with scroll E, set in motion gears G and G' and rollers H and H' which roll the stock in or out according to the direction in which the spindle is revolving.

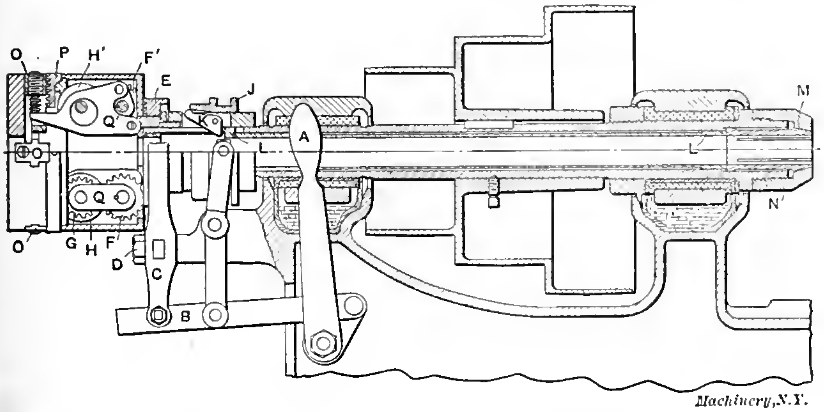


Fig. 3. Details of Chuck and Roller Feed Mechanism

As shown in Figs. 3 and 4, provision is made for adjusting the rolls to the diameter of the stock simultaneously with the adjustment of the supporting jaws at the rear end of the spindle. These latter, shown at O, are simultaneously adjusted in or out by means of a scroll P. Two of the jaws O are provided with slots and spring pressure devices for operating the pivoted jaws Q and Q' in which rollers H and H' are mounted. There is thus but one adjustment for changing the supporting jaws and rolls to suit different diameters of work. Suitable provision is also made for taking square hexagon, and other shaped stock through this mechanism as well as round stock.

Lever A, besides operating the roller feed, opens and closes the split chuck at the front of the spindle, opening it before the feed is thrown into action when the lever is moved to the left, and closing it after the stopping of the feed when the lever is thrown to the right. The mechanism for doing this will be understood from Fig. 3. In throwing lever A to the right, clutch collar J acts on chuck fingers K, which in turn force tube L against collet M. The latter seats in the tapered nose of hood N, thus holding the collet down on stock. The control of the chuck and of the feeding by the same lever gives rapidity of action and at the same time eliminates the destructive wear which would occur when trying to roll stock into the machine while the collet is gripped down upon it.

Fig. 3 shows the self-oiling arrangement used on the spindle bearings in this machine. Each bearing, as shown, has a groove in it through which is laid a wick with its ends dipping into the reservoir below. The thrust bearing, as shown, is at the front end of the spindle.

Construction of the Turret, Turret Slide and Saddle

Fig. 5 shows a detail view of the turret slide mechanism, illustrating the tilted turret construction very plainly. As explained, this permits the use of large box tools and die heads, while the double set of holes and the stationary stud allow the passage of long work clear through the turret, even with all the faces occupied. The turret being hexagonal in form, permits tools to be bolted to the face, thus giving a more rigid support to the tool, and leaving the turret hole free for the passage of large work.

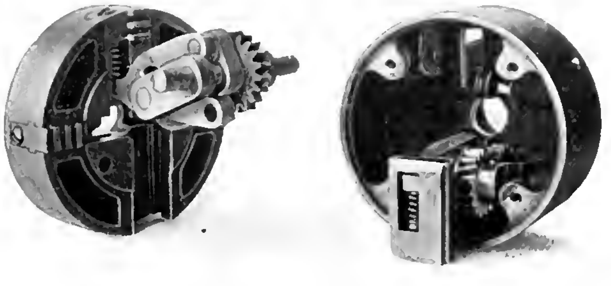


Fig. 4. Feed Mechanism Dismantled, showing Construction

The bearings of the cross-slide rest and of the turret slide and the saddle, are furnished with taper gibs passing the whole length on each side. This gives a crosswise adjustment to the turret. The saddle is held to the bed at the outer edges by flat gibs throughout its entire length. It is held down onto a supplementary taper base which is interposed between it and the top of the bed. By adjusting this taper base the center lines of the turret holes can be adjusted to the exact height of the center of the spindle.

The turret slide is shown removed from the saddle in Fig. 7. This, in conjunction with Fig. 6, gives a good idea of the arrangement of the indexing and stop mechanisms. At A is a latch pin which may be pulled out to cause the indexing finger B to clear the star wheel C. This simple provision sets the machine instantaneously for non-indexing work, as required by one-operation jobs made in large quantities. D is the locking pin which passes through the slide into the turret. The locking pin lever E is acted on by the eccentric cam F on the backward motion of the slide on the saddle. This pulls the bolt clear of its hole in the turret so that there is no dragging on the bottom bearing. The pin is held clear until the turret is revolved to the next hole, when it automatically drops into place and locks the turret.

In Fig. 5 is shown the turret and slide with the accompanying mechanism. Near the turret is seen the center bolt by means of which it is tightened down on the slide. The hole

through this bolt for the passage of the work is plainly seen. It will be noticed that this bolt is provided with a double taper bearing, seated in the turret. This may be adjusted to give the turret free movement at all times and still hold it firmly. With the backward movement of the slide the indexing finger *B* engages star *C* on the inner side. This through a geared connection shown more plainly in Fig. 7 swings the turret for one-sixth of a turn. The ratchet is fast to crown gear *C*, which engages a bevel gear screwed and doweled to the base of the turret.

As stated, a stop is provided for each hole in the turret, these stops being shifted automatically as the turret revolves.

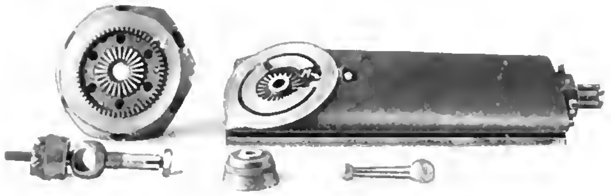


Fig. 5 Turret Slide removed from Turret, showing Construction of Stud Revolving Mechanism, etc.

They are contained in a drum as shown in Fig. 7, mounted on a long shaft connected by bevel gear *M*, see Fig. 5, through an intermediate, with bevel gear teeth *L* cut in the base of the turret. The automatic stops are adjustable for each tool without disturbing the others.

A self-oiling counter-shaft is furnished with each machine. The two friction pulleys in the counter-shaft are of single piece construction. Oil reservoirs are cored completely around the bearings, and the space is filled with cotton and oil. The hanger shaft bearings are supplied by oil boxes below them. Each of them is oiled in a way similar to that shown for the spindle bearings in Fig. 3.

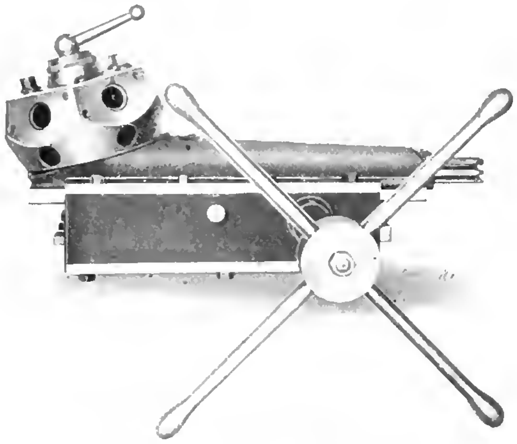


Fig 6. The Turret, Turret Slide, and Saddle

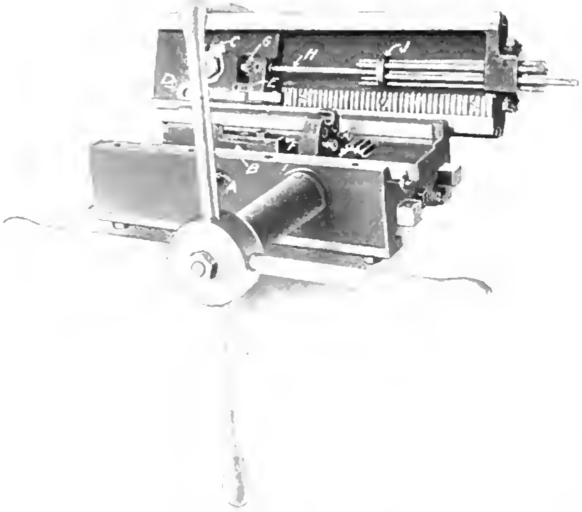
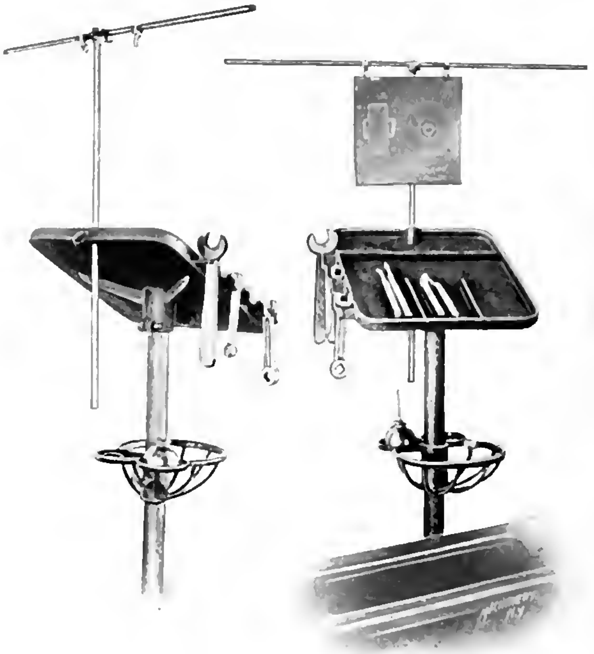


Fig 7 Slide removed from Saddle, showing Indexing Mechanism and Adjustable Stops

These machines may be seen in operation by a visit to one of the demonstration shops of Hill, Clarke & Co., Inc., of Boston and Chicago, or their branch offices at New York, Philadelphia, and Cleveland.

WELLS TOOL TRAY AND STAND FOR LATHES

The accompanying illustration shows a lathe tool stand or holder, made by F. E. Wells & Son Co., Greenfield, Mass.



A Convenient Tool Holder and Stand for the Lathe Operator

This device, which can be fastened to any lathe, is provided with places for oil cans, a basket for waste, a tray for lathe tools, chucks, centers, etc., and a rack for wrenches. There is also fastened to the back of the tray, as shown, an adjustable device for holding blue prints up to 26 by 30 inches. The whole tray is adjustable for height and can be swiveled to any angle, as can also the waste basket and oil can holder.

The attaching of this device is exceedingly simple. There are no holes to drill or tap, as a clamp is provided which is tightened to the lower side of the bed with a monkey-wrench, this being the only tool required for attaching the device. The provision of a suitable place for holding lathe tools, wrenches, oil cans and waste within easy reach of the operator, should result in permitting better concentration on the work in hand, and less loss of time and energy. The blue-print holder has been found especially useful in the way of keeping the work continually in front of the operator. It saves the print, as well, from getting torn or soiled from contact with boxes and castings on the work-bench. The illustration shows the tray and stand as seen from the front and back.

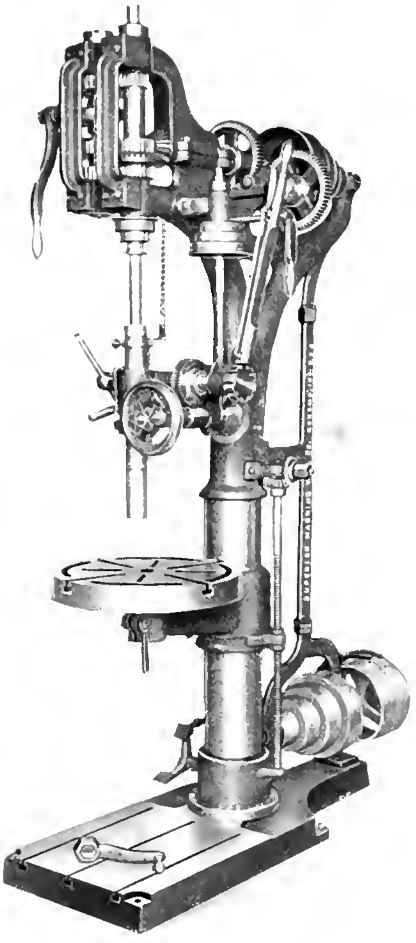


Fig. 1. Superior Machine Co.'s Drill Press with Tapping Attachment

THE SUPERIOR MACHINE TOOL CO.'S TAPPING ATTACHMENT FOR DRILL PRESS

The drill press made by the Superior Machine Tool Co., of Kokomo, Ind., was illustrated in the department of New Machinery and Tools of the April, 1907, issue of MACHINERY. This machine was substantially the same as the one here shown, except for the power feed, back gears and tapping attachment, which have since been added. The latter is of unusual interest as it differs radically from the usual construction.

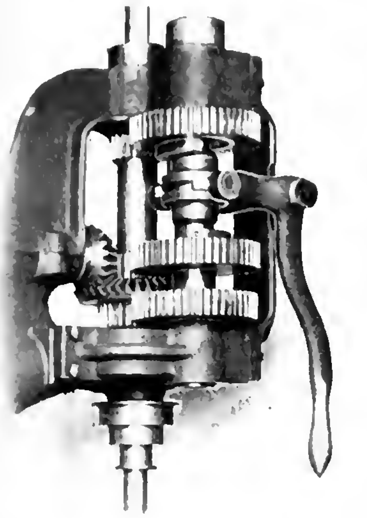


Fig. 2. Tapping Attachment for the Drill Press, designed to prevent Cramping the Spindle

One of the difficulties met with in applying a tapping attachment to the drill press is that of driving a spindle satisfactorily through the short key usually provided on the reversing clutch. This difficulty is met with in the usual construction, in which the clutch mechanism is mounted directly on the spindle. When the load of the tapping operation comes on to the spindle, the strain binds the key so strongly into the keyway of the clutch that if the load is great, it is difficult for the spindle to follow the tap.

With this attachment this difficulty has been overcome. The key and keyway have been greatly lengthened, passing through the full length of the long sleeve shown above the bevel gear. The friction clutches are mounted on a shaft parallel with the spindle. The upper driving shaft is connected by the usual bevel gearing with an idler gear, concentric to the spindle. This meshes with the driving gear on the supplementary clutch shaft (best seen in Fig. 2). On this clutch shaft are loosely mounted two gears, one meshing directly with a mate on the pinion sleeve, the other meshing through an idler. Either of these gears may be connected with the reversing shaft by friction clutches operated by the lever shown. This furnishes means for reversing the spindle for the tapping operation. The key in the sleeve on the spindle extends its full length. On the 23-inch drill this length is 14 inches.

As may be seen, the attachment may be added with practically no alteration in the regular design of drill press.

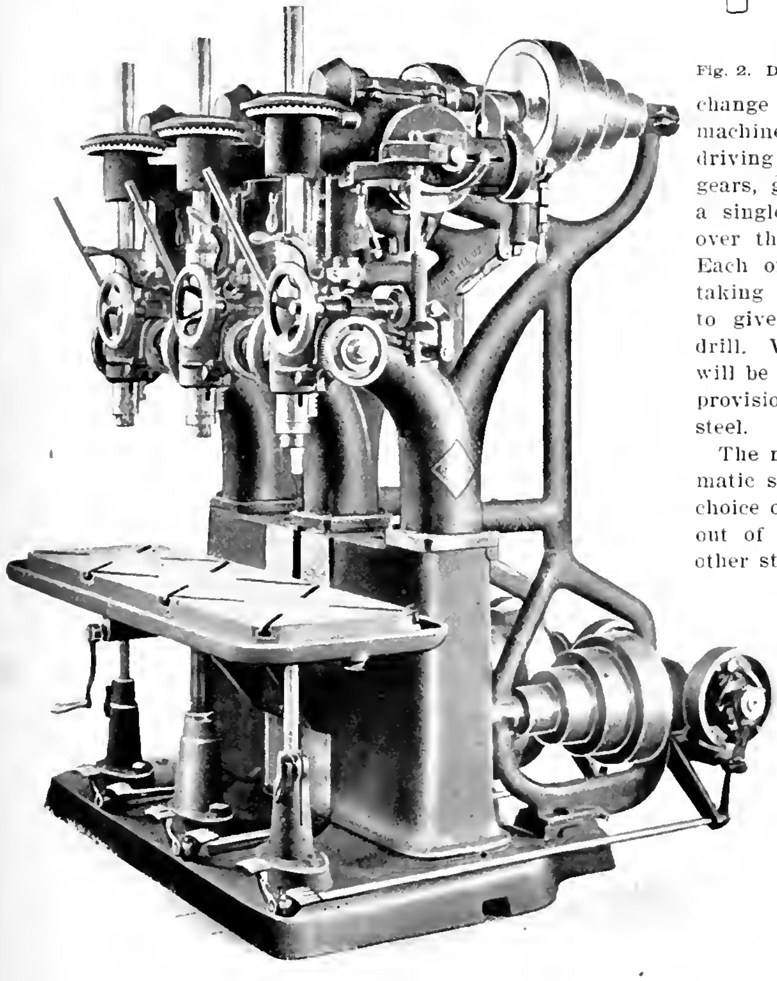


Fig. 1. Gang Drill with Improved Counter-shaft Drive and Feed Mechanism

BARNES $22\frac{1}{2}$-INCH DRILL

The accompanying illustrations show a gang drill built by W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. This drill is intended for heavy manufacturing service, being equipped with back-gearing, power feed, automatic stop and positive change feed gearing. The counter-shaft at the rear of the machine is driven by a single belt. It is connected with the driving cones of each machine by a friction clutch and bevel gears, giving separate control for each spindle. The use of a single belt drive effects a considerable saving in belting over the usual method of having individual counter-shafts. Each of the main shaft bearings may be adjusted without taking the counter-shaft apart. This drive is proportioned to give the same capacity as the makers' regular 34-inch drill. When desired, however, special three-step cone pulleys will be provided, which will carry a $4\frac{3}{4}$-inch belt. With this provision the machine will drive a $2\frac{1}{2}$-inch drill in solid steel.

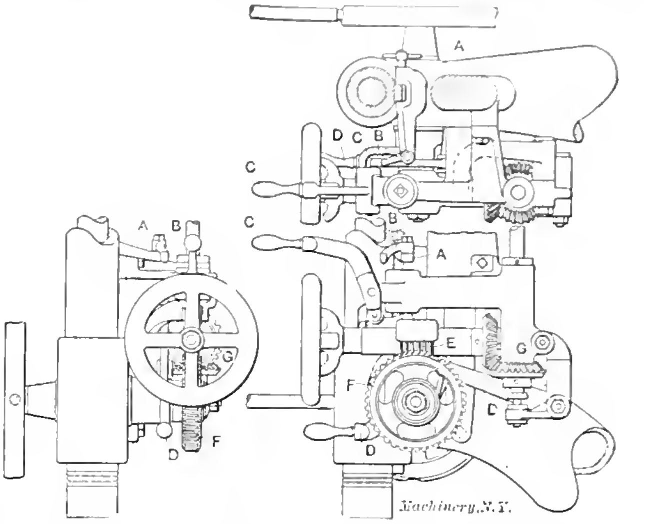


Fig. 2. Detail of Feed Mechanism, showing Double Automatic Stop Motion

The makers call particular attention to the feed and automatic stop mechanism shown in Fig. 2. The operator has a choice of two automatic stops. One of these throws the work out of mesh with the gear on the pinion shaft, while the other stops the main feed by throwing out the miter gear connection with the vertical feed shaft. The automatic stop dog is shown at *A*, clamped to the feed rack on the sleeve. It is provided with a tappet *B*, which may be swung so as to engage either lever *C* or lever *D*. In the top view in Fig. 2 it is in the latter position, its position for engagement with *C* being indicated by dotted lines. Lever *C* controls the engagement of worm *E* with wheel *F*, while *D* operates the throw-out mechanism on bevel gears *G*. The throwing out of the work gearing leaves the spindle free for action by the use of the hand or lever feed at the left side of the spindle. This will be appreciated in such work as requires facing or similar operations at the end of a drilling or boring job. The second throwout is the one more commonly used, but it does not leave the spindle free for motion, as worm *E* and gear *F* are still engaged after the feed is tripped.

The provision for back-gearing and the positive geared feeds will be readily seen in Fig. 1. The whole construction gives

evidence of possessing the power and rigidity required for the heavy manufacturing work the machine is intended to handle.

SELLERS CAR-WHEEL LATHE

A test to demonstrate the extraordinary power and speed of a new car wheel lathe was made in the works of William Sellers & Co., Inc., Philadelphia, May 15, before a large company of railway officials, mechanical engineers and others interested in improved railway machine tool design. Four pairs of steel tired wheels were turned, three pairs being nominally 36-inch coach wheels, and one pair 33-inch engine wheels. The accompanying log of the performance is a record that impressively shows the great advance made possible in tire turning by the new high-speed steels, when a machine is provided capable of utilizing them to the limit of capacity and an operator is available who can handle the machine with skill and energy.

Fig. 1. Sellers Car-wheel Lathe with Tool Turrets

The average official time for turning each pair of 36-inch wheels including the time required for placing the wheels in the lathe and removing them to the floor, or "from floor to floor," was 19.11 minutes. The time in the table is expressed in minutes and decimals, 19.47 minutes being 19 minutes and 28 seconds, and so on. The replacing of a burned tool required 27 seconds, which deducted from the total time leaves 72 minutes 1 second required for four pairs of wheels, floor to floor. This time does not include that required for changing the lathe for the last pair of wheels, which was just six minutes. On ordinary practice the operator would not change from outside to inside journal wheels pair by pair but would group the wheels so as to turn all of a kind or size in a lot. The steel used for roughing and finishing tools was "Novo Superior." The operator was Mr. William Anthony of the P. & R. Ry., Reading, Pa., shops.

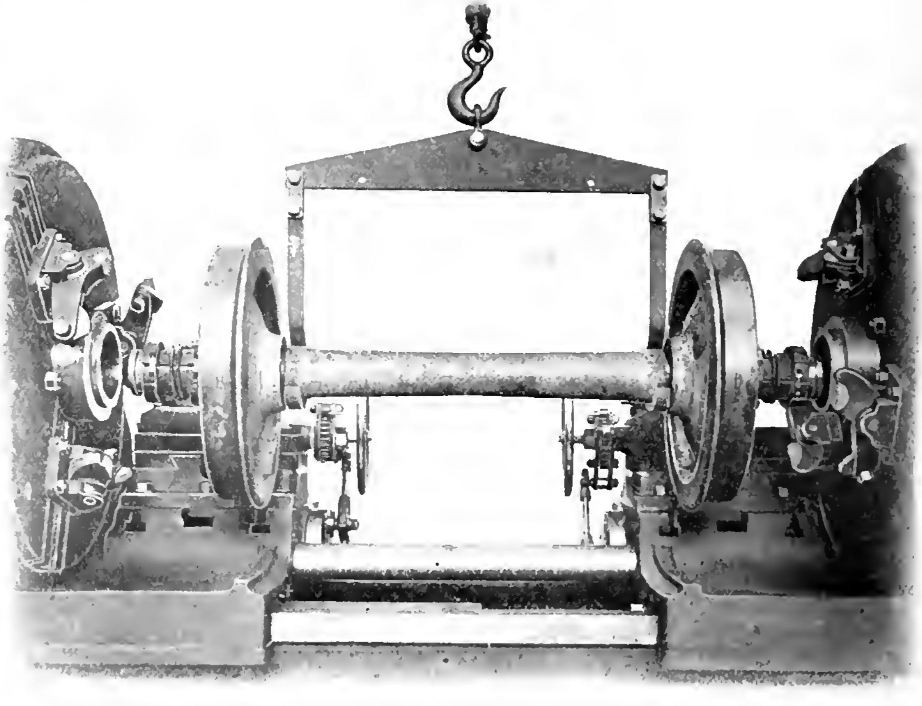


Fig 2. Turned Wheels being lifted out of Lathe. Note Faceplate Drivers, Bushings on Journals and Tracks cast on Headstock Extension to match Shop Track

Characteristics of Lathe

The lathe which is shown on the operator's side in Fig. 1 is designed to turn all kinds of steel-tired car wheels from 28 to 42 inches diameter, whether of plate or spoke center type. The machine as a whole and the bed especially are of massive construction as will be inferred from the weight which is 72,000 pounds. The headstocks have extensions on which the tool rests are mounted. The left-hand head-stock is fixed on the bed and the right-hand head-stock is traversed by power, an independent motor being provided for this purpose. The connection of the motor to the gearing is through a clutch that is adjusted to slip in case a solid obstruction is met by the head-stock in its traverse. The traversing motor is capable of exerting a pressure of 55,000 pounds through the head-stock against the wheels, and this power is utilized to sink the driving dogs into the tires when setting the wheels in place.

In its characteristics the machine is quite similar to the tool turret driving wheel lathe, illustrated and described in the June, 1908, number of MACHINERY. On this car wheel lathe, however, the tool turrets are square, having provision for four tools, and the indexing and locking mechanism are

simplified. The face-plate driver also differs, it being necessary to provide means by which the wheel can be driven by gripping the outer edges of the tires only. Another essential difference is the means for centering and supporting the axles of coach wheels and other car wheels having outside journals. Three-part taper bushings held assembled by two turns of a weak coiled spring are used, these bushings being slipped over the journals before rolling the wheels into place. The bushings enter the taper mouthed spindles in the head-stock and thus center the wheels by the journals. A coiled spring in the movable head-stock forces its spindle forward and "weighs the load," keeping a constant pressure on the bushings and journals, and holding them firmly against the pressure of any cut that the machine is capable of taking. For engine truck wheels having the journals between the wheels, pointed centers and bushings are provided to fit the taper holes in the spindles. The center points support the axle centers in the usual manner of common shaft turning.

TEST OF SELLERS CAR-WHEEL LATHE

	Wheels 1	Wheels 2	Wheels 3	Tank Wheels 4
Diameter of wheel, rough, inches	$35\frac{1}{8}$	$34\frac{15}{16}$	$35\frac{1}{4}$	33
Floor to chuck, minutes....	1.05	1.66	1.18	1.2
Rough turn	17.8	16.02	18.17	13.55
Rough flange.............				
Finish flange and tread...				
Finish chamfer, minutes.				
Machine to floor, minutes ..	0.62	0.77	0.65	0.4
Total time, minutes.......	19.47	18.45	19.40	15.15
Average cutting speed in feet per minute..........	15–16	16	14	19

The lathe equipped as shown in Fig. 1 has an overhead trolley track composed of two channel section beams rigidly secured to the upright springing from the fixed head-stock. The opposite ends are supported on friction wheels fixed to the upright springing from the movable head-stock, this arrangement being necessary on account of the traverse of the movable head-stock. The trolley carries an air cylinder and tackle for lifting and lowering the wheels; no crosswise movement of the trolley is provided or needed. Short tracks are cast on the feet of the tool carriages as shown in Fig. 2, which match the shop rails, thus providing support on which the wheels are easily rolled under the trolley, and out again when turned. During turning of the wheels the trolley tackle is not disengaged from the axle, but is simply lowered so as not to be in contact with the axle.

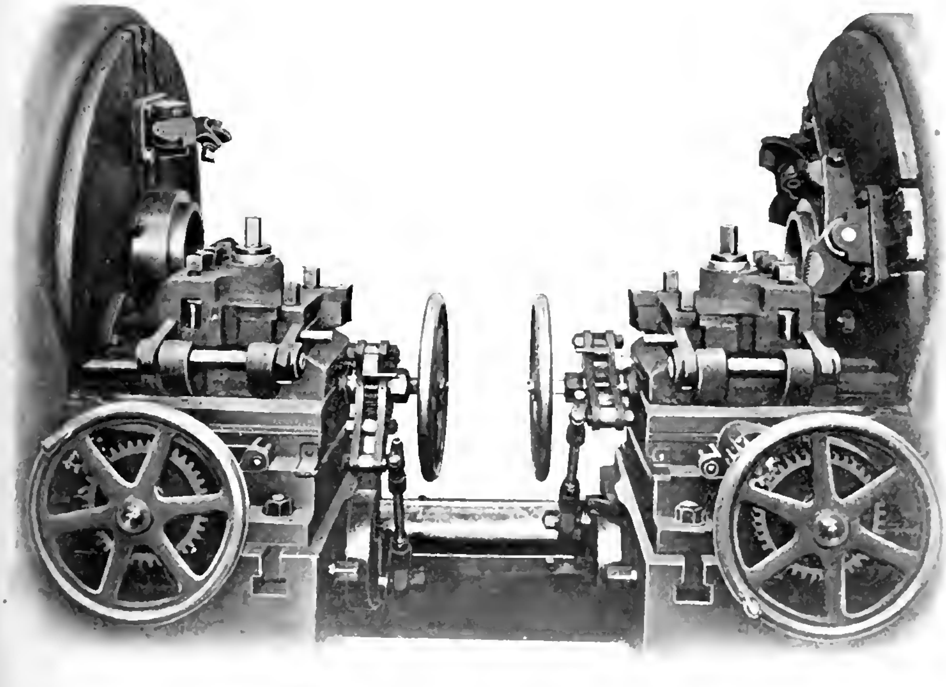


Fig. 3. Turret Tool Heads and Carriages, Sellers Car-wheel Lathe

Turret Tool Heads

The turret tool heads shown on an enlarged scale in Fig. 3 are noteworthy because of simplicity of design and effectiveness of action, aside from the fact that turret tool heads are provided on a lathe of this character. The need of means for easily and quickly changing from roughing to flanging to finishing tools has been apparent to those who have watched the operation of a modern wheel lathe equipped with the common four-bolt type of tool-post, when the lathe is pushed to the limit of its capacity. The labor of changing tools is exhausting, and the time required retards the production of turned tires. The present car wheel turret tool head is not as highly developed as the driving wheel lathe turret tool head previously described. The operator has to lock and clamp the turret by independent movements, whereas in this one all these functions are performed with one lever. The locking mechanism of the car wheel lathe turrets comprises two cams for each turret mounted on a short shaft supported in the bearings forming a part of the tool head support. The cams bear against the side of the square turret near the corners, thus locking it at the points furthest removed from its center of rotation. The cams are worked by a crank and the turret is turned by a wrench engaged with square bolt heads on the turret at or near each corner. The center bolt clamps the turret rigidly in place. The roughing tool is made of bar steck and is placed in a through slot, where it is clamped by four screws. The finishing tools are short sections and are mounted on ledges cast on the sides of the turret, where they are held in position by filister head screws.

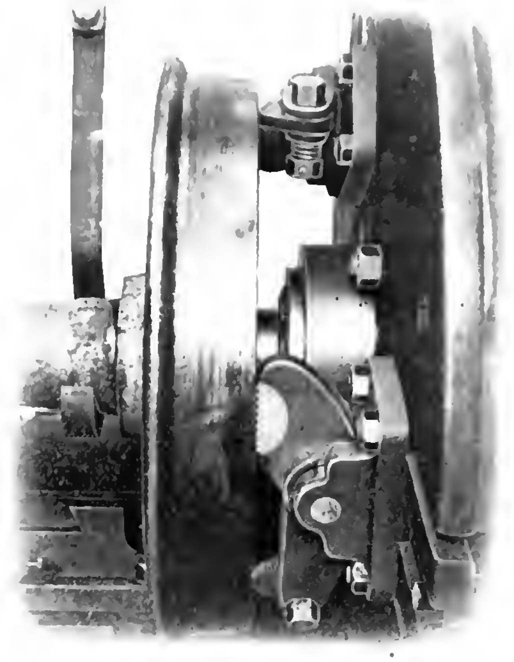


Fig. 4. Faceplate Driver engaged with Tire

Automatic Toggling Drivers

Three toggling drivers of the form shown in Fig. 4 are mounted on each face-plate, and drive by the engagement of serrated semicircular blocks forced into the edges of the tires. The drivers are mounted loosely on a pin near the center of the lever, and heavy trunnions support the thrust, the pins only acting to hold the levers in place. At the opposite ends of the levers are cams with teeth. When the

when it is brought into position the traversing motor forces the toothed blocks in the face-plate drivers into the tires, thus making initial engagement. The cams are then forced against the tires by wrenches fitting the hexagon head pins on which the cams are mounted. The cams force the steel blocks in the opposite ends of the drivers still further into the tire, and should the wheel slip, the cams roll on the tire forcing the serrations deeper and deeper into the tires, and effectually stop further slipping. Practically no evidence of slipping is noticeable, the first engagement being sufficient to drive. Each block has eight or nine serrations, and the depth the teeth sink is only about 1/32 inch.

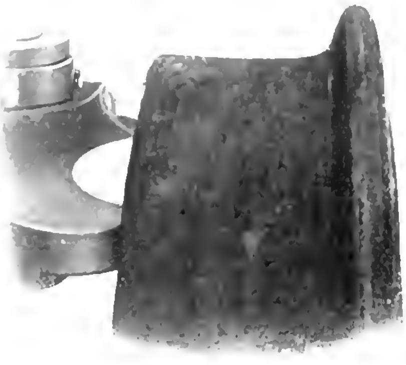


Fig. 5. Worn Tire as taken out of Service

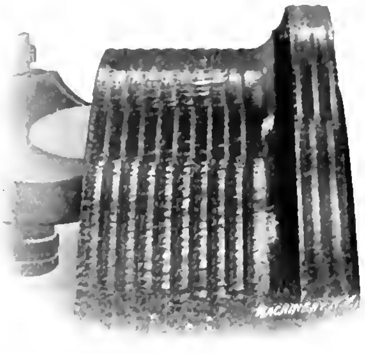


Fig. 6. Roughing Cut on Tread and Flange Completed

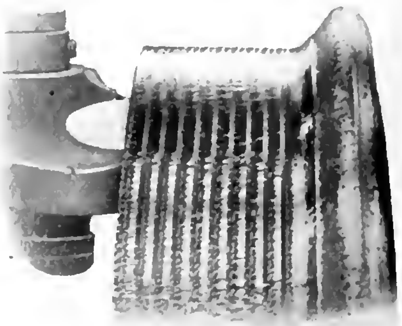


Fig. 7. Flange Roughly Formed

Controlling Apparatus

The lathe is driven by an adjustable speed motor of 25-30 horse-power, and is controlled by an automatic solenoid switch panel. The push button pilot switches are located in a position convenient to the operator. By the use of these switches he is able to start and stop the machine and reduce to an extremely low speed without stopping when required for passing hard spots. After the hard spots have been passed the lathe will resume the speed at which it was running by merely releasing the slow down switch. The perfect control of the cutting speed thus obtained has a marked effect on the productive capacity. Were it not possible to run the lathe at the slow speed necessary when cutting hard spots, the production, of course, would be much less than that possible when the maximum speed is used except when hard spots are being cut out.

Fig. 8 Flange and Tread Finished

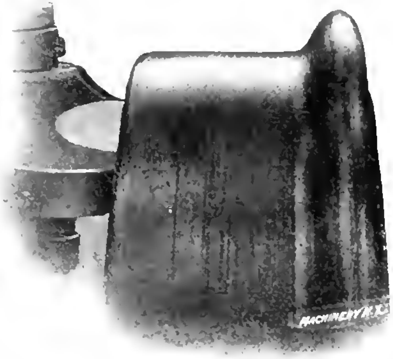


Fig. 9. Tread Tapered and Corner Chamfered; Tire Finished

Order of Operations

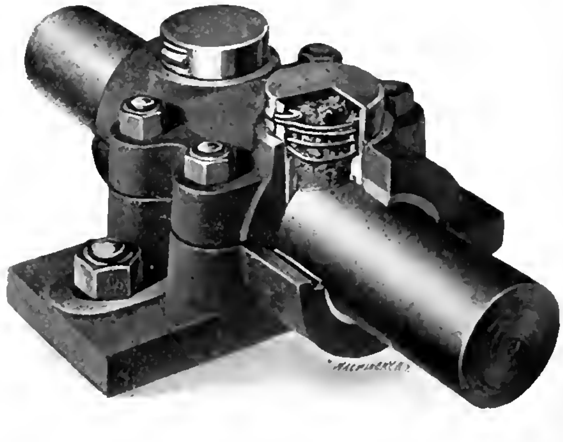
Figs. 5, 6, 7, 8 and 9 show the various stages from the worn to the finished tire. In Fig. 6 the roughing has been completed. The roughing tool has passed over the tread and flange with a feed of 3/8 inch and depth of cut of about 1/2 inch. In Fig. 7 the rough flanging tool has been brought into position and the corner of the tire roughed to shape. In Fig. 8 the finishing flanging tool has turned the flange and tread to shape, and in Fig. 9 the tread has been tapered off and the outer corner chamfered at one operation. Notwithstanding the speed at which the wheels were turned in the test, the appearance of the finished wheels was good and tests of diameters and contours left nothing to be criticised.

VAN DOREN AUTOMATIC SHAFT LUBRICATOR

The shaft bearing shown in the accompanying engraving is fitted with a Van Doren automatic lubricator, using grease as the lubricating medium. The method of lubrication insures the constant feeding of the material to the shaft at just the right rate to agree with the requirements, this being done automatically so long as the supply holds out; the device is thus very economical in the use of the grease. The C. J. Van Doren Co., 5 West Madison St., Chicago, Ill., is the manufacturer.

As shown in the engraving, this oiler comprises a metal shell or barrel fitted into the bearing cap, a cap covering its upper end, a spring, and a wooden gland. The distinctive feature of the apparatus is this wooden gland, which is forced by the spring down onto the shaft, conforming exactly to its contour. As shown, it is hollow and filled with grease, which lies on the shaft. A ring of felt packing in a circular groove cut in the bottom of the gland furnishes a smooth bearing surface and prevents the generation of any surplus friction on the wood, keeping the shaft wiped clean as well, and allowing only enough grease to escape to give proper lubrication. The spring holds the gland in contact with the shaft, the thrust being taken in slots in the barrel serving also as a locking device for the cap. The bearing should be drilled so that the barrel will fit snugly in the hole, where it is held in place by staking or calking the edge with an offset center punch. On ordinary bearings up to 4 inches in diameter and 12 inches long, two lubricators are necessary. For larger sizes and for extra heavy work more may be required.

The gland allows just enough grease to be taken away to make a proper coating for the shaft, and no more. It keeps the surplus always taken up. If for any reason the bearing should begin to heat slightly above the normal, the lubricant lying directly on the shaft has a tendency to run more freely,



A Lubricator for Supplying Grease in the Exact Quantity required

and so supply the extra amount needed until the bearing is restored to its normal condition. It might be expected that this melting of the grease from the heating of the bearing would occur suddenly, and would continue until all of it had been carried off. Such a provision would make the principle of the device impracticable. In use, however, it is found that the rise of temperature and the consequent softening of the grease is held under absolute check.

The advantages claimed for these bearings are numerous. They are inexpensive, easily applied and economical in the use of the lubricant, giving practically perfect lubrication at a nominal cost. Their cleanliness is also a strong point in their favor. It is unnecessary to provide drip pans, guards, or similar devices for keeping the machine and surrounding floor and ceiling clean, the lubricant being supplied so slowly that trouble on this score is obviated. The use of grease as compared with oil is objected to by some mechanics, but it is stated that lubricants of this character are now made having a coefficient of friction as low as those of the oils.

The economy derived from the use of this grease cup relates not only to the small supply of lubricant used as compared with the usual method of flushing with an oil can, but is important on the score of labor cost as well. One man can tend to a great many more bearings than is possible where liquid lubrication is employed. There is also said to be considerable economy in repairs and re-babbitting, due to hot boxes and similar causes. The makers of this device stand ready to send it on trial to responsible parties having use for such devices in their work.

MULTIPLE SPINDLE DRILL WITH VARIABLE SPEED DRIVE

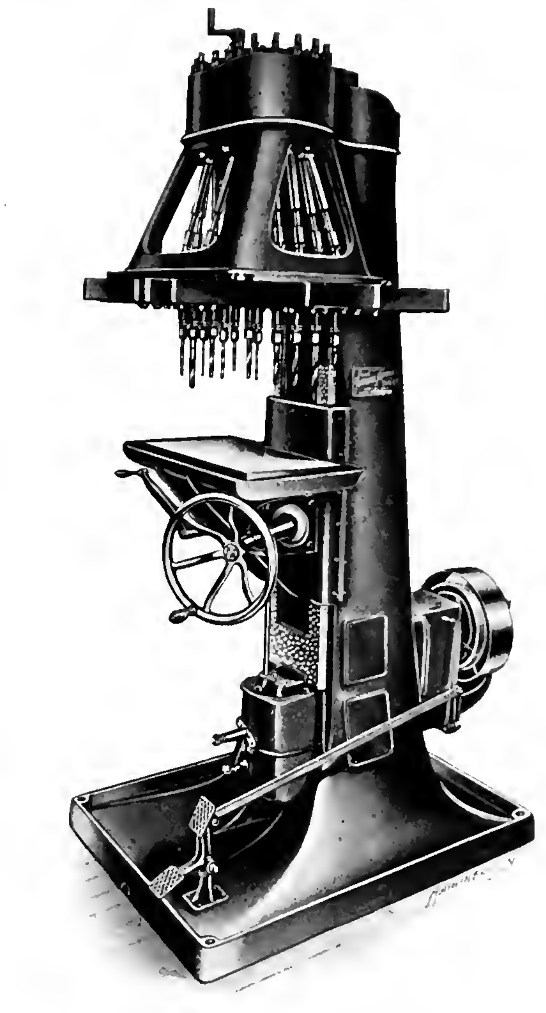
The weakness in the construction of the usual type of adjustable multiple spindle drill press is the fixed driving ratio between the different spindles, which require all to be run at the same rate, irrespective of whether a large or small hole is being drilled. The machine illustrated herewith, built by the National Automatic Tool Co., Ice Avenue and St. Clair Street, Dayton, O., is designed to overcome this difficulty. Each drill and tool may be revolved at its proper cutting speed. This is effected while still preserving the wide range of action, rigidity of construction and the close center distances which are expected on a machine of this type. The practical result obtained is an increased output on work having holes of different diameters.

Maximum Output

The power is delivered by a friction pulley through a change speed box and bevel gears to the main vertical shaft in the column. Five cone gears on this main vertical shaft in the head, by means of three separate series of compounds and idler gears, deliver the power to each independent spindle gear. These cone gears are thrown into commission by means of three sliding keys located in the shaft. One key engages the lowest gear, the next key the other two gears and the third, the remaining two gears. Thus three of them can be in commission at the same time, and deliver their respective speeds to the spindle driving gear. The combinations possible are 500, 750, 2,000; 500, 750, 1,500; 500, 1,000, 1,500; and 500, 1,000, 2,000 revolutions per minute respectively for the spindle driving gears. In addition to these triple combinations, any one of two speeds of those above given can be obtained on the spindle driving gear. Thus if only one size drill is being used, none of the other cone, compound and idler gears revolve if the sliding keys in the shaft are disengaged. These changes, together with the three in the speed boxes and those in the feed box will give any combination needed.

The spindle driving gears are keyed to their respective driving shafts by means of a bronze gear fork, through one end of which a spindle shaft runs and to the other end of which a screw is connected. The spindle driving gear is thus quickly raised or lowered for three different speeds or three neutral positions. By this means such spindles as are not in use can be placed in the neutral position and remain idle, thus saving wear on all the spindle parts. The screws are operated from the top of the machine, and indicators on each show exact position of the spindle driving gear within the head. With the initial speed in the change gear box fixed, any desired spindle speed can be obtained independently by the raising or lowering of the respective spindle gear within the head. One-sixteenth, ⅛, ¼, ⅜ and ½-inch drills can be run side by side, each at its proper cutting speed and maximum feed.

Ball races are placed between all the main driving, compound and idler gears in the head. Ring oilers are used in the speed boxes. Ball thrust bearings are provided at the top of the vertical shaft bearing in the column. All the gears are cut from the solid, and those in the head, feed box and speed box, and on the vertical shaft within the head, run in an oil bath. An oil pump keeps a continuous circulation of oil within the column on the change gear box. The bushings in the idler and compound gears in the head are hardened and ground and run on hardened and ground studs. The adjustable rails are made of cast steel, and are sufficiently rigid to prevent deflection of the drills even under the stiffest feeds. The spindles are of tool steel and run in hardened and ground bushings. Adjustment for different lengths of drills is provided within the spindle.



A Multiple Spindle Drill, in which the Speed of Individual Spindles can be varied

Attention is called to the unique construction of the universal joint. The cube and its four connecting pieces are made from a solid block of metal, thus obviating the use of screws for connecting the cube and the driving sides. All the wearing surfaces are hardened.

The work-table has a large oil groove and is so constructed that T-slots can be cut in it. It has a large bearing on the column, is counter-weighted and has both hand and power feed. There is a 16½-inch vertical adjustment between the end of the largest drill and the top of the table.

Speed Box

Three rates of feed are provided in the feed box, giving 1½, 3 and 4½ inches of movement per minute respectively. An automatic knock-out for the table feed is provided. An

pump and a large reservoir for the lubrication of the cutting edges of the drills is provided on this machine. This multiple drill is made in a number of different sizes, with a squared head carrying up to 12 spindles, and a rectangular head carrying up to 20 spindles.

LODGE & SHIPLEY LATHE WITH AUTOMATIC FEED STOPS

A patent head, quick-change gear engine lathe, as manufactured by the Lodge & Shipley Machine Tool Co., of Cincinnati, Ohio, is shown in Fig. 1. This lathe, as seen in the engraving, is equipped for machining malleable iron hubs for automobiles, two of which are shown on the floor beneath the machine. The particular feature, aside from the automatically revolving turret, which adapts this machine to work of this kind, is the arrangement of automatic stops which control the longitudinal movement of the carriage and the movement of the cross slide. The stops for controlling the length of the carriage travel, are seen mounted on the left end of a bar on which they are free to slide, which extends along the front of the bed. By varying the positions of these stops, which telescope into one another as shown, shoulders of any desired length can be obtained, for as the lever attached to the left end of the apron comes against one of these stops, the bar upon which it is mounted is given a slight longitudinal movement to the left thus throwing a clutch which disconnects the lead screw from its driving gears. A more complete description of the way in which these stops control the movement of the carriage travel will be found by referring to the article descriptive of the Lodge & Shipley crank-shaft lathe in the New Machinery and Tools department of the June number. The diameter gage, which is shown to the right of the cross slide in Fig. 2, consists of a slotted drum carrying adjustable stops that control the cross travel of the compound rest and stop the tool at any desired point. By turning this drum, different stops are brought into alignment with the tappet in the cross slide and in this way the stop is quickly set for different diameters.

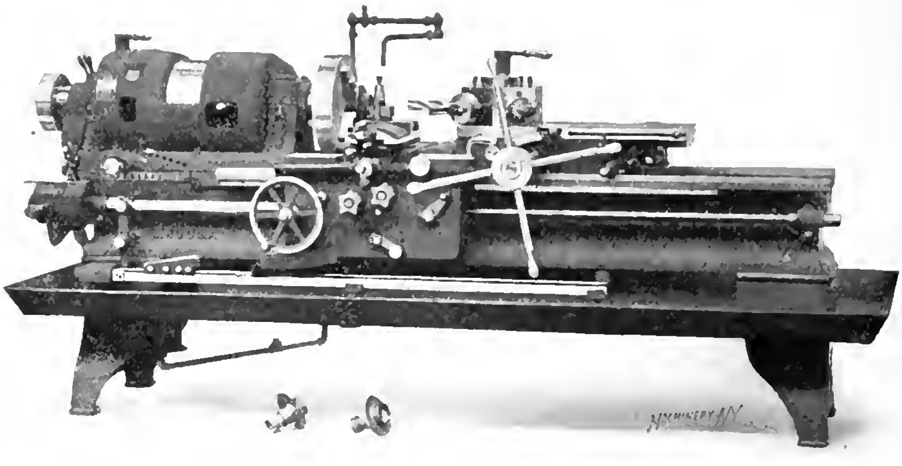


Fig. 1. Lodge & Shipley Lathe equipped with Automatic Stops for Controlling the Longitudinal and Cross Movements of the Turning Tools

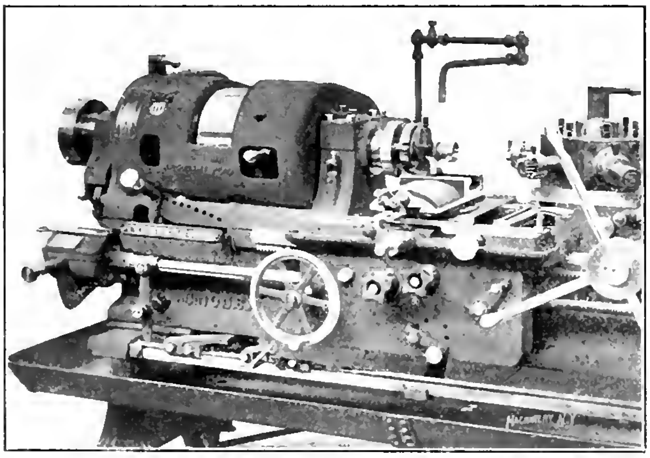


Fig. 2. View showing the Stops more in Detail

By way of illustrating the usefulness of this combination of automatic stops, a brief description of the various steps in machining automobile hubs, for both the front and rear wheels, will be given. The front hubs shown in Fig. 1, are $5\frac{1}{8}$ inches in length, $5\frac{1}{2}$ inches in diameter across the flange and $2\frac{1}{2}$ inches in diameter on the small end which is threaded. The rear hubs are similar, the main difference being that they are faced on both ends, finished more completely on the outside and have a ball race at one end only.

For the first operation on the front hub, the lathe is provided with special reamers, boring jigs and a 15-inch combination chuck. The hub is held with the flange against the chuck jaws, as shown in Fig. 1. The turret operations comprise boring a straight hole through the hub with a four-lip drill, boring the seat of the ball cup and reaming the seat of this cup. While the tools of the turret are in operation, the compound rest tool faces the end. This completes the first operation, and prior to the second, the holes in the flanges are drilled.

In Fig. 2, the method of holding and driving the work, and the equipment for the second operation is shown. The hubs are first mounted upon an expanding straight mandrel, which is inserted in the lathe spindle. The drive is from a pin which fits into a drilled hole in the flange. A seat for the ball cup is first bored and reamed, the correct depth being positively obtained. While the turret tools are performing this operation, the tool on the compound rest is facing the flange, its inward movement, of course, being controlled by the automatic stop referred to. The barrel of the hub is also turned, and the various diameters are positively obtained by means of the diameter gage. Cutting the thread completes the machine work for the front hub.

During the first operation on the rear hub, it is held in the chuck with its flange against the jaws, practically the same as shown in Fig. 1. The turret tools first bore and ream the seat for the ball cup and also face a seat for the dust washer. Simultaneously with these operations, the compound rest tool faces the brake pan on the flange and turns the flange diameter, all diameters and lengths being obtained from the positive stops. After the flange is drilled as in the first case, the hub is mounted upon a straight arbor, which is located in the hole of the lathe spindle, for the second operation. The work is additionally supported by a bar carried in one of the turret holes which makes coarser feeds and faster cutting possible and also gives truer work. All of the remaining operations are then performed by the tool in the compound rest.

IMPROVEMENTS IN WATSON-STILLMAN HYDRAULIC JACKS

One of the regular line of lifting jacks built by the Watson-Stillman Co., 192 Fulton St., New York City, has been provided with truck wheels and a handle to facilitate moving it from place to place. The wheels touch the floor only when the jack is tilted so they are not in the way during lifting operations. It can also be used in an angular position or flat on its side, without interference. This jack is made in eleven sizes, from 20 to 50 tons capacity, with lifts of from 12 to 18 inches, filling all the ordinary requirements of general shop work.

This firm has for some time built a jack in which the pump is separate from the ram, being connected thereto by flexible copper piping. This construction is convenient where it is difficult to work the lever of the usual apparatus, from lack of room or insufficient footing. This tool also requires much smaller head room than when the pump is included in the same mechanism. This jack has been re-designed and built from new patterns. An added improvement is furnished,

if desired, in the shape of a gage, which is not needed for ordinary lifting, but is useful in adapting the jack to testing purposes. When so equipped it may be used between two fixed platens for making compression tests, testing the tightness of forced fits, etc. The gage will be furnished to read in pounds per square inch, or in tons load upon the jack, or both as required. These jacks are furnished in fifty three sizes, ranging from 2 to 1,200 tons capacity. The rams of the various sizes have movements of from 4 to 8 inches.

MOORE & WHITE AUTOMOBILE CLUTCH

In Fig. 1 is shown a half-tone, and in Fig. 2 line drawing details, of an improved friction clutch of the multiple disk variety made by the Moore & White Co., 15th St. and Lehigh Ave., Philadelphia, Pa. While intended particularly for automobile work, this clutch should have a wide application for other similar uses. As designed for automobile use and as shown herewith, the clutch is contained within the balance wheel *A* of the motor; the inner cover *B* fastened to this balance wheel forms with it an oil reservoir in which the disks *C* are constantly immersed, thus being absolutely self-oiling and free from danger of destructive wear.

The disks *C* follow the usual construction of clutches of this type in being keyed alternately to the balance wheel *A* and to the driving spider *D*. The latter is keyed to the driven shaft, which is supported in the wheel on ball bearings *E*. The engaging device and the means for maintaining the pressure are extremely simple and powerful. The clutch is normally in its engaged condition, the disks being forced together by springs *J*, under a pressure determined by the adjustment of the ring *K*. For disengaging the clutch, sliding sleeve *H*, through the action of levers *G*, releases the pressure of spring *J*, so that the alternate disks revolve loosely on each other, and no motion is transmitted from the balance wheel to the driven shaft. An adjustable abutment for levers *G* is provided at *F*. As the rings wear, this is screwed up to keep the parts in their proper relative positions.

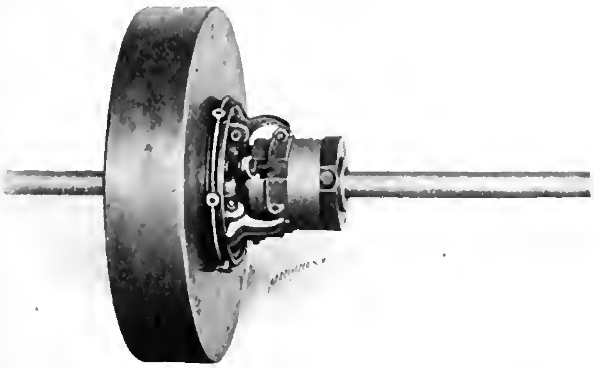


Fig. 1. A Multiple Disk Clutch especially adapted for Automobile Work

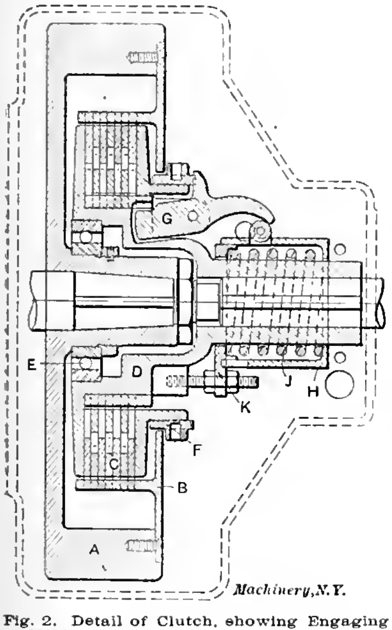


Fig. 2. Detail of Clutch, showing Engaging Mechanism and Provision for Oil Bath

BROWN & SHARPE STOCKING GEAR CUTTER

The formed cutter shown herewith is intended for stocking and roughing out the teeth of gears. It is of unusual construction, as may be seen, in that it is made up of alternating plain and stepped teeth. This construction has the advantage that it closely conforms to the shape of the finished tooth space, thus leaving little to be removed by the finished cutter; and at the same time breaks up the chip so that high speeds and feeds can be used without subjecting the cutter to great strains or heating. It is superior in this respect to both the plain formed cutter and to the design in which all the teeth are stepped

A Stocking Cutter with Alternating Plain and Stepped Teeth for Breaking the Chip, made of either Tool or High-speed Steel

The cutter shown is an unusually large one, being 13 inches in diameter and being intended for cutting teeth of 1 diametral pitch. In spite of its size, the way in which the chips are produced enables heavy cuts to be taken without undue strain on the teeth or the driving clutches.

MOORE & WHITE VARIABLE SPEED DRIVE

An interesting variation of the taper cone pulley type of speed changing mechanism, built by the Moore & White Co., 15th St. and Lehigh Ave., Philadelphia, Pa., is shown herewith. Instead of running the belts directly on the tapering surface of the cones, short supplementary belts are provided, built up of tapered segments, which furnish true cylindrical surfaces for the connecting belt to run on. The speed is changed by means of a belt shifter which receives its movement from a screw actuated by any suitable means, though usually by a chain and sprocket wheel from the operator's position. The belt shifter, thus operated, moves the supplementary belts and the connecting belt toward the large or small end of the driving cone, thus increasing or diminishing the speed of the driven cone. This device was originally brought out for use in paper mill machinery, where very fine gradations of speed have to be obtained while transmitting great horse-power; it has now been developed in smaller sizes for use in machine tool drives. A very convenient and compact form of the device is shown in Fig. 1. This takes up little more space than the ordinary counter-shaft. A still more compact arrangement, suitable for attachment to the wall, is shown in Fig. 2.

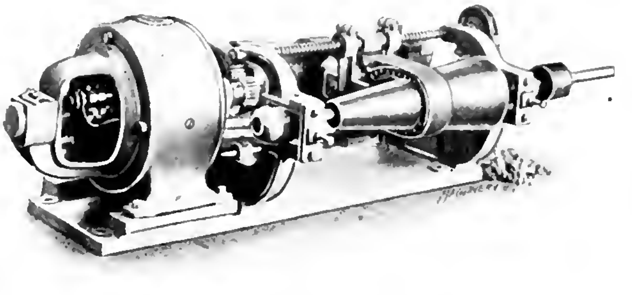


Fig. 1 Variable Speed Counter-shaft of the Taper Cone Type, giving Cylindrical Belt Contact

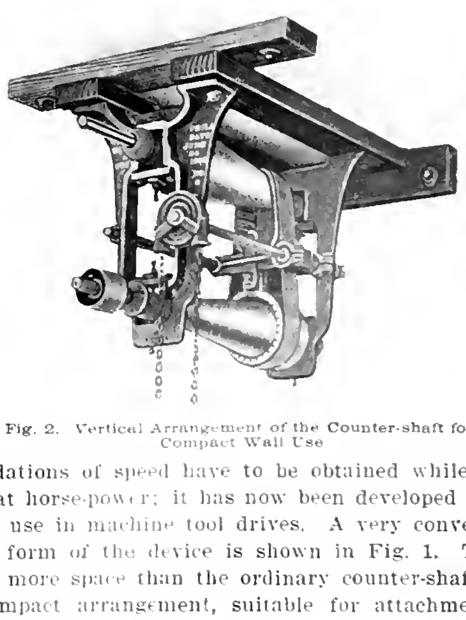


Fig. 2. Vertical Arrangement of the Counter-shaft for Compact Wall Use

RYERSON INTERNAL COMBUSTION RIVETER

One of the most interesting of the many machines and appliances shown at the June conventions of the American Railway Master Mechanics' and Master Car Builders' associations at Atlantic City was an internal combustion portable riveter made and sold by Joseph T. Ryerson & Son, Chicago. The principle of action of this riveter, which is applicable to many other machines in which the work is done by rectilinear motion, including punches, shears, bulldozers, etc., eliminates the power plant necessary for compressed air, hydraulic, or steam riveting installations, the power plant of each riveter being self-contained. An explosive mixture of air and any gas commonly used to operate gas engines is pumped into the work cylinder, thus forcing the dies against the hot rivets, and when a predetermined pressure has been reached the charge is automatically fired and the rivet set. The only outside power required is that necessary for operating the charging pump and firing the charge. This may be supplied, if required by the conditions of the work, from a storage battery.

Ryerson Internal Combustion Riveter for Steel Cars, Structural Work, etc.

The riveter in general appearance resembles the ordinary C-frame riveter in common use. It has a toggle action by which the pressure on the rivet dies is increased as the end of the stroke is neared. The piston is directly connected to the toggle action, and on top of the cylinder is mounted a small electric motor and direct-connected pump for charging the mixture of air and gas into the explosion chamber. On the side of the cylinder is the operating lever, and mounted on the same spindle is a pressure controlling handle by which the pump pressure is predetermined. The dial is numbered, each number representing an atmosphere or 15 pounds (nearly). If the indicator is set at, say, seven atmospheres, the charge will automatically explode when the pump has charged the cylinder to a pressure of about 105 pounds. The rise of pressure forces the dies firmly against the rivet so that the full power of the explosion is exerted in setting the rivet. As the charge is fired, the pump motor is cut out so that consumption of electric power is confined to the time actually required to charge and fire.

The piston is automatically returned by means of a coiled spring in the hub of the toggle links. The operation of charging, firing and releasing requires about one second on light work. On heavy work the time is longer, it then being necessary to hold the dies on the rivet for a short period. The dies are held against the rivet by simply waiting the desired time before moving the lever operating the exhaust valve. However, on steam-tight work, where the dies must be held for some time in order to let the rivet cool and thus grip the sheets with the utmost firmness, a hydraulic cylinder is interposed between the gas cylinder and the die, by which the pressure can be held indefinitely. This auxiliary cylinder for steam boiler work is necessary because of the fact that gases cool rapidly and reduce the pressure. The gas piston on the riveter shown which is designed for riveting steel cars, structural work, etc., is air cushioned, there being ports drilled in the cylinder head of the piston which are closed by the piston in its travel, and thus air is entrapped to act as a cushion to reduce the shock of the explosion and prevent knocking out the head in case the charge should be fired with nothing between the dies.

The machine is operated by a single lever the same as an air machine, and can be worked in any position. It is simple in construction and operation, and the upsetting action on the rivet is much quicker than in compressed air, steam or hydraulic machines. It is claimed that the necessity of uniform heating of rivets is obviated as the operator has absolute control of the pressure and may readily gage it to suit the heat of each rivet. The riveter will drive any commercial size rivet and requires approximately one gallon of gasoline for four thousand ¾-inch rivets.

MILLING ATTACHMENT FOR THE ACME MULTIPLE SPINDLE SCREW MACHINE

A simple, compact and time-saving device for finishing duplicate parts requiring milling or slotting, has recently been designed for use on the Acme multiple spindle automatic screw machine, manufactured by the National-Acme Manufacturing Co., Cleveland, Ohio. This is one of a number of attachments recently designed for this machine for eliminating the rehandling of parts for the purpose of drilling, milling, slotting or countersinking them.

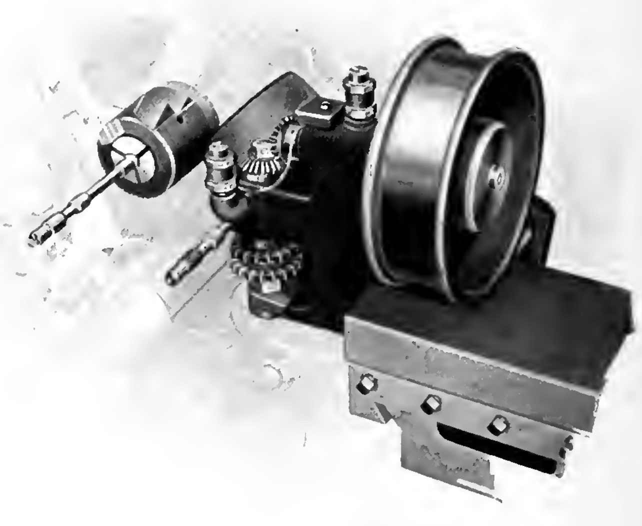


Fig. 1. An Attachment which enables Work to be milled in the Automatic Screw Machine, thus eliminating a Second Machining Operation

This attachment, which is shown in Fig. 1, is fastened to the top of the slide which carries the cutting-off tool. The engraving shows it arranged for milling the flat part on the piece shown in Fig. 3. This cold rolled steel piece is being made in the factory of the Cadillac Motor Car Co., of Detroit, at the rate of 53 pieces per hour. This number also represents the maximum output when the pieces are not milled. By the previous method of making these parts, less than one-

third as many per hour were produced, and milling the flats constituted a second operation. It will thus be seen that the entire cost of rehandling is saved by the use of this attachment. The way in which it is attached to a regular machine, and its general construction, will be seen by referring to the engravings. For milling the piece shown in Fig. 3 two milling cutters are set the required distance apart on the vertical arbor which is driven by bevel gears, which connect with a horizontal shaft carrying the driving pulley. This pulley receives its power through a belt from a "Simpul" countershaft. The feed of the cutters is controlled by the cutting-off cam, and the increased movement necessary is obtained by an auxiliary lever, which is seen to the left of the attachment in Fig. 2. This lever connects with the top cross slide which is dove-tailed to the slide beneath it. This second slide is also dove-tailed to the slide upon which it rests, and by its longitudinal movement, the cutters are adjusted to the proper location.

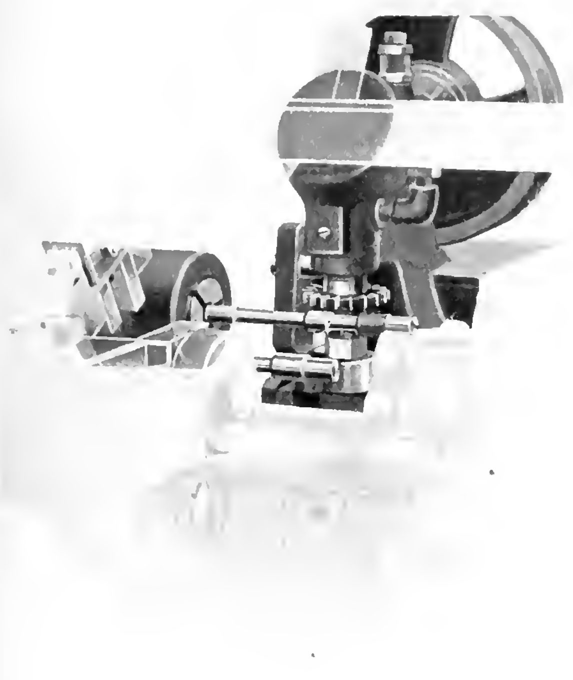


Fig. 2. Another View of the Milling Attachment


Fig. 3. An Example of the Kind of Work to which the Attachment is adapted

The milling operation upon the work takes place while it is in the third position, and at the same time that the thread is being cut. While this operation is taking place, the forming and box milling tools are at work in the first position. In attaching this device to a regular machine, it is only necessary to drill and tap two holes in the top of the cutting-off slide upon which the attachment rests. It is possible to drive this attachment without employing a special countershaft, by directly connecting it to the die spindle gears in the main tool slide, by a telescoping shaft, knuckle-joints and bevel gears. This makes it possible to drive the machine with a single belt or motor without any special over-head arrangement for the attachment.

MUMFORD WIRE BELT LACING DEVICE

Wire lacing for belts has of late years become the standard method of belt fastening in large establishments. The operation consists essentially of threading a coil of wire into the edge of each belt, flattening these coils down, interlocking them on the two edges and inserting a raw-hide pivot or pin to complete the hinged joint. About the only objection to this process in the ordinary shop is the expense of the apparatus required for coiling and inserting the wire. Mr. Harry T. Mumford of 258 West 22d St., New York City has invented and is placing on the market a device of great simplicity for performing this operation; it is so inexpensive that the smallest shops can afford to use it. This device is shown in use in Fig. 1.

A nickel and polished pattern plate is the essential feature of the invention. Into this the edge of the belt to be laced is placed, being held there by inserting two thumb tacks through holes in the upper lip, as shown. With the awl which is furnished with the outfit, the operator then pierces holes through the belt at the bottom of the slots formed in the turned up lip of the pattern plate. After all the holes have been pierced, a steel wire is threaded through them in helical form, over the wire mandrel which lies inside the lip of the plate, as shown. Fig. 1 shows this threading of the wire partly completed. After threading, the belt is removed from the plate and the mandrel removed from the belt. Then the wire lacing is squeezed in the vise flat and even with the belt, or pounded down flat on the bench. The ends of the wire are caught in and clinched to prevent them from loosening.


Fig. 1. An Inexpensive Tool for Inserting Wire Belt Lacing

The pattern plate is next reversed, and the other end to be joined is inserted in place. The slots on this other end of the plate are reversed, so that one of the wire coils will be right hand and the other left. This is necessary to permit them to interlock. The same operation of threading and pounding down is repeated with this end of the belt. The two ends may now be brought together with the coils interlaced, when a raw-hide pin or pivot is inserted, thus locking the joint, but leaving it hinged and flexible so as to be adapted for use on the smallest pulleys.

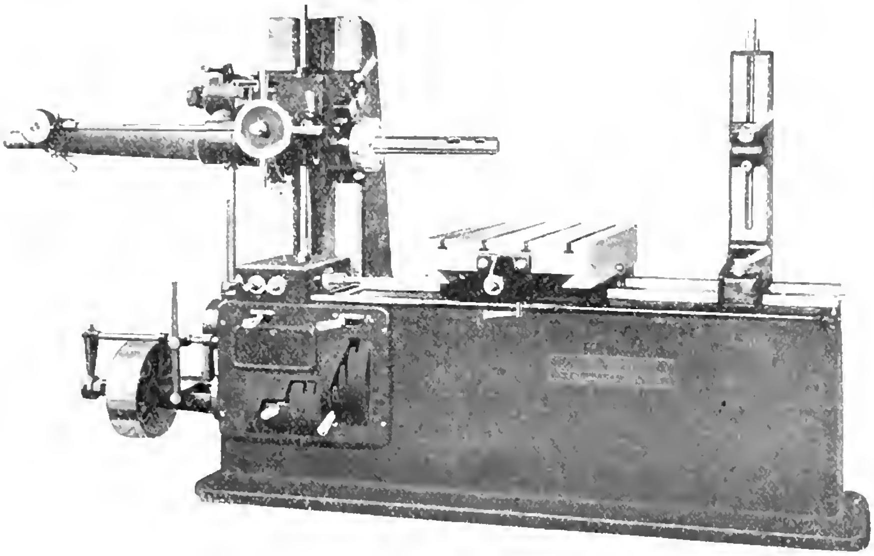

Fig. 2. The Rest of the Equipment Furnished with the Belt Lacing Device shown in Fig. 1

The outfit provided includes besides the pattern plate, awl and mandrel just described, a set of raw-hide pivots, a supply of wire lacing, extra awl points, thumb tacks, etc. This extra material is shown in Fig. 2. The plate may either be held in the vise, an attachment being provided for that purpose, or it may be held to the bench by means of buttons, also furnished with the outfit. It should be noted that by laying the belt crosswise in the lip, the side of the plate may be used as a gage for squaring up the ends, thus materially assisting in producing a serviceable and efficient joint.

CLEVELAND HORIZONTAL BORING, MILLING AND DRILLING MACHINE

The horizontal boring, milling and drilling machine shown herewith is built by the Cleveland Machine Tool Works, Cleveland, O. As may be seen, it is of the type in which the boring head is vertically adjustable on a stationary column, while the work is mounted on a table provided with cross and longitudinal movements. The main features of this particular design are its simplicity, the provision of gear boxes for the feeds and speeds, and its convenience of operation.

In regard to the matter of ease of operation it will be seen at once that all the various handles required for controlling the movements of the machine are within easy reach from the operator's position. The machine is driven by the constant speed pulley shown, which is provided with a friction clutch operated by the vertical lever. From here the power is taken to a speed change mechanism operated by the right hand one of the two gear box handles. Six speeds are provided at this point. This number is doubled by back gears in the head, giving 12 spindle speeds in all, in geometrical progression, ranging from 10 to 140 revolutions per minute of the spindle. The gear ratio from the vertical driving-shaft to the spindle is 7 : 4, with a back gear ratio of 12 : 1 for the slower speeds. The back gears are thrown in or out by a conveniently mounted lever on the head. Another adjacent lever stops, starts and reverses the spindle.



Cleveland Horizontal Boring, Milling and Drilling Machine

There are 16 feeds, applicable either to the vertical traverse of the head, the horizontal traverse of the work-table, or the longitudinal feeding of the boring bar. These vary in geometrical progression from 0.005 to 0.3 inch per revolution of the spindle. Eight of these are available for each position of the spindle back gear. Four changes are obtained by manipulating the handle of the right-hand gear box at the base of the machine, this number being doubled by the handle above it. All the feeds can be changed in direction by means of the reversing lever, and all the changes of feeds and speeds can be made without interference, while the machine is running.

The spindle is supported in solid taper bronze bearings with adjustments for wear. It has a face-plate to receive milling cutters, facing heads, etc., for heavy work. The fact that it can be stopped, started or reversed instantly makes the machine very convenient for facing, tap milling and similar operations. The spindle and back gear drive are located between the spindle bearings, bringing the power directly to the work with little strain to the mechanism. The spindle bar is 2½ inches in diameter, is provided with a No. 5 Morse taper hole and has a 22-inch traverse. It has a power feed in either direction, and can be securely clamped for face milling operations. The feed pilot wheel, by the shifting of the knob shown in its center, operates both the fine hand feed and the quick traverse for the boring bar.

The outboard support can be securely clamped to the bed and may be readily removed for overhanging work. It is aligned with the boring bar by means of scales and verniers reading to 0.001 inch. These scales also read directly to 1/64 and 1/100 inch, thus assisting in laying out bored holes to proper center distances. The box bed is very deep, with ribbing so designed as to make an expensive foundation unnecessary. Two chutes are provided for carrying away the chips. The platen has four ⅝-inch T-slots with a working surface of 20 by 36 inches, and a traverse of 24 inches. The platen and the carriage adjustments are made by means of micrometer dials.

The following additional dimensions will assist in giving an idea of the capacity of the machine. The maximum vertical adjustment of the head on the column is 20 inches, and the vernier adjustment is 18 inches. The greatest distance from the face-plate to the outboard support is 4 feet 6 inches. The floor space occupied over all is 11 feet 6 inches by 6 feet. The machine weighs about 6,000 pounds.

If required by the customer, special attachments for special work will be furnished with this machine. Among those for which provision is made are a revolving table, auxiliary table, special boring bars, and star feed facing head.

AUTOGENOUS WELDING EQUIPMENT FOR LIGHT WORK

In the October, 1908, issue of MACHINERY, we described the equipment provided by the Autogenous Welding Equipment Co., 92 Hayden Ave., Springfield, Mass., for operations such as welding, etc., requiring very high heat, using for that purpose the oxy-acetylene flame. In addition to the apparatus there described, this firm has recently placed on the market an inexpensive outfit adapted to the general run of work met with in the ordinary garage or small machine shop. While the apparatus previously shown is particularly suitable for jobbing work and manufacturing, that shown in Fig. 1 is adapted to general repair work in smaller establishments.

The apparatus includes one torch equipment, having an assortment of tips, which makes it possible to carry on a large variety of work. A gas generator is not included. It

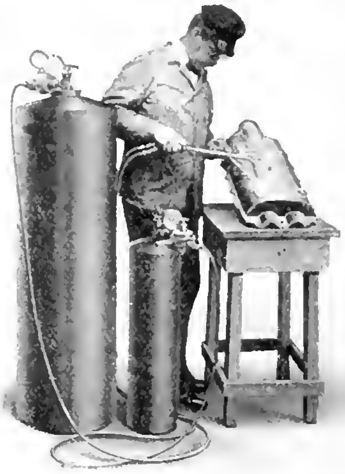


Fig. 1. Simple and Inexpensive Equipment for Autogenous Welding in Small Plants

would not be feasible for the majority of small plants to install a generator, this being rendered doubly difficult by the insurance regulations, which require it to be located outside of the building; for this reason the gas for this apparatus is supplied in cylinders of 125 cubic feet capacity. This gives a sufficient supply for performing a large number of jobs, and a full cylinder will be shipped to the customer immediately on receipt of the bill of lading for the empty one. The gas itself is furnished at a lower cost than is possible even when supplied for lighting purposes. An oxygen cylinder is also supplied with the equipment.

This outfit makes it possible to repair such expensive parts as cast iron cylinders, aluminum crank and gear cases, malleable axle housings, etc. While the operations are somewhat out of the range of the experience of the ordinary machine operator, complete instructions are furnished which will insure success in the hands of reasonably intelligent workmen.

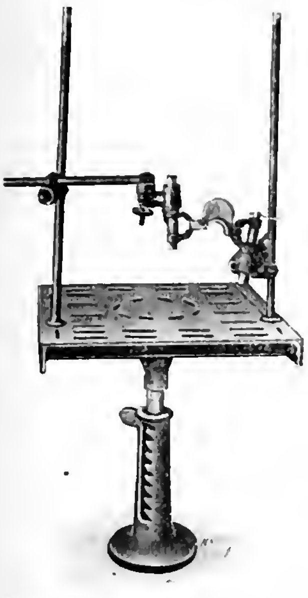


Fig. 2. Universal Table and Fixtures for Holding Parts for Autogenous Welding, Brazing, etc.

In Fig. 2 is shown a table which has been found especially adapted to the general line of work in small shops and garages. It has a substantial top, 30 inches square, with T-slots so arranged that the broken parts may be easily lined up and bolted into position. The table is carried on a ball and socket joint, so as to permit it to be tilted through a wide range of angles and fastened at that point. At any angular position the table can be revolved freely to bring the work to a position convenient for the operator. The pedestal is telescopic, so that the table can be raised and lowered as may be required. The edges are provided with flanges permitting the work to be clamped in a vertical position if desired. The top of the table is machined to permit accurate lining up of the work, and the underside is well ribbed, giving the necessary rigidity.

The universal clamping fixture for use in connection with this table, shown in place in the illustration, consists of a set of two universal vises, which can be held rigidly in any position by means of arms and clamps, so that broken parts of a wide range of shapes and sizes can be held together in the position required for welding or brazing. The provision of suitable clamping appliances is a matter of great importance in this work, as it has been found by experience that more time is consumed in setting up the work properly than in the actual welding or brazing, where suitable appliances are not provided.

ADDITIONS TO THE STARRETT LINE OF SMALL TOOLS

The L. S. Starrett Co., of Athol, Mass., has added a number of new instruments to its line of small tools. These additions are respectively, tool-makers' calipers and dividers, a universal bevel protractor with vernier scale, and sight attachments for the level.

The calipers and dividers, shown in Fig. 1, are particularly neat instruments, made from round stock with legs drawn down, giving the metal a hard and stiff quality. The fulcrum stud is hardened, the bows are of extra strength, the screw and nut are carefully fitted, and all the parts are finely finished. These tools are made with the solid nut only, in five sizes—2, 3, 4, 5 and 6-inch respectively.

An improvement in the well-known Starrett universal bevel protractor consists in the provision of a vernier scale which permits readings to be taken directly to as fine as 1/12 of a degree, or 5 minutes. Two verniers are used, so placed in relation to the graduated half of the circle as to make the protractor readable by vernier in any position. The protractor stock is 4 inches long, and is provided with either a 7 or a 12-inch blade, ½ inch wide. This is clamped by an eccentric stud against the edge of the disk. It may be slipped back and forth its full length and turned at any angle about its circle and firmly clamped where desired. The figures on the vernier are placed close to the lines, thus making it easy to read the tool when taking measurements. An attachment is provided for furnishing a reference edge at right angles to the regular blade. This, in connection with the beam of the protractor, will be found convenient in grinding short or long tapers to any angle or pitch.

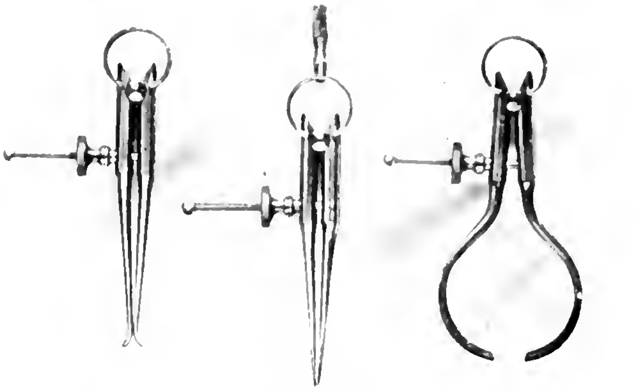


Fig. 1. A Neat Set of Outside and Inside Calipers, and Dividers for Toolmakers' Use

The attachments shown in Fig. 2 are designed to be used in connection with the makers' iron levels. They easily slip on or off the top side of the instrument, and are held in place by set screws. They are provided with sight holes as shown, the one at the left having a cross wire which is accurately lined and set parallel with the level. This attachment will be found convenient, as it permits the use of the ordinary iron level for leveling a plot of ground from a fixed point at long range. They are made to fit the 6, 9, 12, 18 and 24-inch, No. 132 levels.


Fig. 2. Sighting Attachments for Use with Spirit Level

BENNETT HANDY GREASE CUP

The Bay State Stamping Co., of Worcester, Mass., has recently designed the grease cup shown herewith. It is particularly intended for automobile use, but should find a wide application wherever grease cups are used, particularly on high-speed machinery subject to jar or vibration.

The cup itself is formed of sheet metal, with a hexagon the full diameter of the barrel, so that it may be screwed down close to the bearing and give a greater space for the grease without increasing the over-all height. The threaded cup is screwed down permanently, so that it will not jar off. It is provided with a thumb screw passing through the center, actuating a spring piston head, which binds on the inside of the cup to prevent it from turning. By screwing this down, the grease is forced into the bearing. The spring construction of this head makes a close joint, so that the grease, even if melted, is prevented from leaking out. This construction provides a neat, durable, and simply constructed cup for use on small or large bearings. It takes up little space, and may be quickly and easily operated.


A Simple Grease Cup

NEW DESIGN OF PEERLESS MULTIPLE SPINDLE AUTOMATIC SCREW MACHINE

In the department of New Machinery and Tools of the December, 1908, issue of MACHINERY, we illustrated and described a multiple spindle automatic lathe, or screw machine, built by the Peerless Automatic Machine Co., of Cleveland, O. This firm has recently developed a variation of the design shown at that time, possessing features which fit it to a more general line of work. These changes relate principally to the provision of a constant speed drive with geared changes for the spindle and feed mechanisms, the use of a knee-type tool-holder, and the provision of a supplementary swinging tool-holder, applicable to either the third or fourth spindle positions.

As the above changes have been made without altering the general construction, the machine will not be described throughout. It needs merely to be said that it is a multiple spindle machine of the type in which the work spindles revolve, and are indexed from one tool position to another successively, the tools being fed by the longitudinal movement of the holder in which they are carried. Two independent cross-slides are provided. The threading mechanism is of the differential type, in which the tap or die is backed off by being run in the same direction as the spindle but at a higher rate of speed. All the movements of the machine are controlled by the longitudinal feed drum shown beneath the tool-slide in Figs. 1 and 2, and by the various members keyed to the cam shaft at the rear of the machine in Fig. 2, this being geared with the longitudinal cam. The oil pump is connected by sprocket wheels and chain with the driving pulley, so that oil is always supplied to the cutting tools as long as the spindles are in motion.

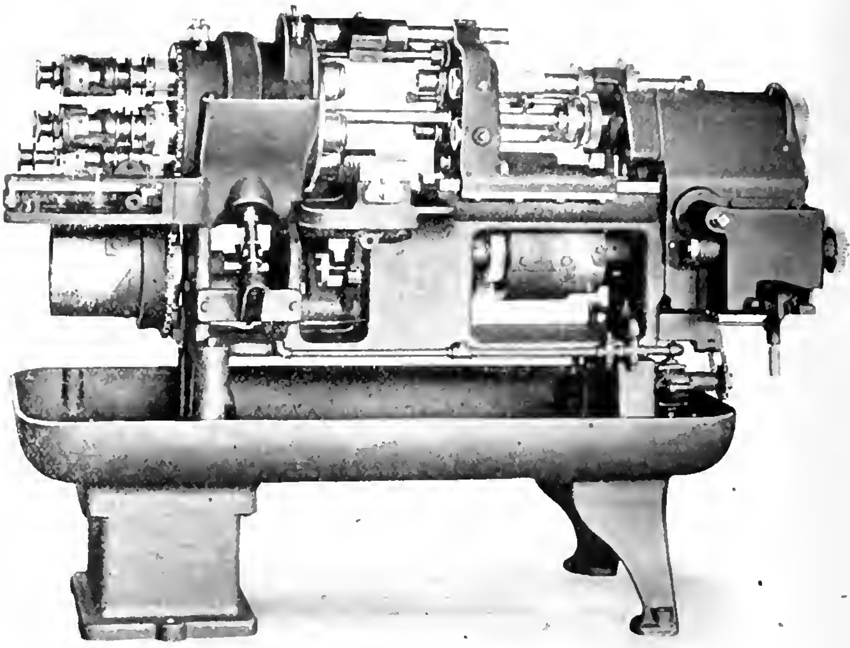


Fig. 1. Gear-driven Peerless Multiple Spindle Screw Machine

The arrangement of the single pulley, constant speed drive is most plainly shown in Fig. 3. The high-speed driving pulley operates the entire mechanism of the machine. It may be connected directly with a clutched pulley on the line-shaft or with tight and loose pulley counter-shaft if desired. It is connected through reducing gearing with the constant speed shaft at the same height with it on the left. Change gears, as shown, connect this shaft with the spindle driving shaft operating the stock spindles. The change gears provided give a wide range of speeds suitable for the different stock diameters and feeds. The cam mechanism is driven in one of two ways—either rapidly at constant speed from a direct connection with the constant speed pulley, or through change gearing at a slower speed. The former is used for the idle and changing stock feeding movements, and the latter for the feeding of the tool. The connection with the constant speed pulley, when the spindle head is being indexed, etc., insures that the machine shall always perform its idle movements at the maximum practicable speed, irrespective of the spindle speeds. The change from idle to operating feed is made by dogs, adjustably mounted on the circular plate at the end of the cam-shaft shown in Fig. 3.

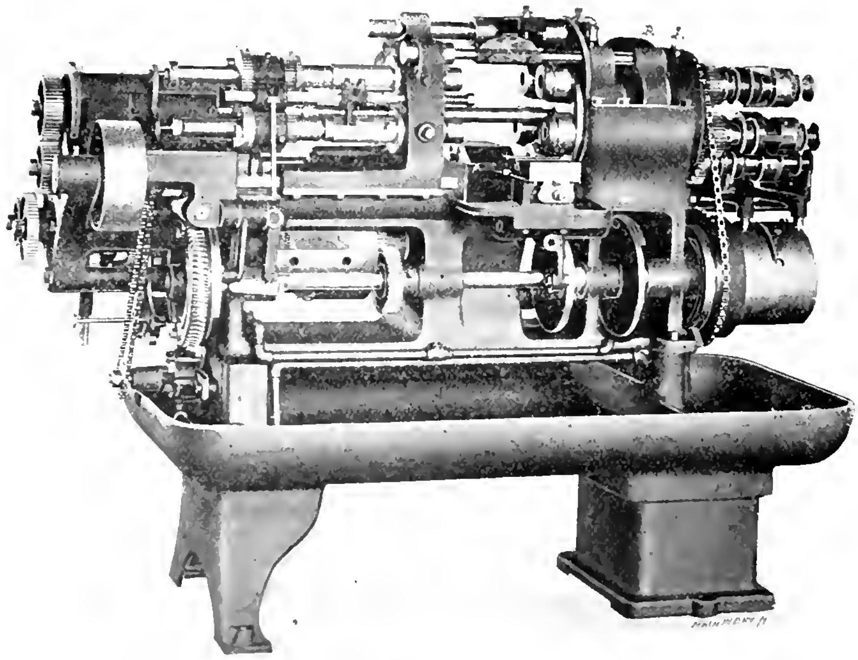


Fig. 2. Rear View of Machine, showing Oscillating Tool Holder

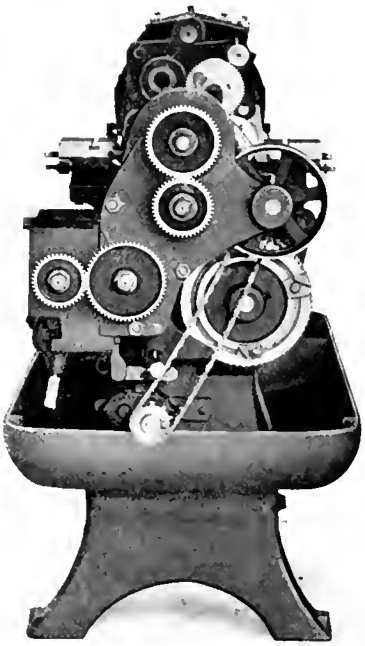


Fig. 3. End View, showing Speed and Feed Change Gears

For the feeding movements the cam mechanism is driven from the spindle driving shaft through the quick change gear box shown at the right in Fig. 1. This gives five changes of feed. By changing about the two gears shown on shafts in horizontal alignment with each other at the left of Fig. 3, five more feeds are obtained. By using an extra set of similar gears furnished with the machine, ten more feeds may be

obtained in the same manner, giving a total of 20 changes, ranging from 0.003 to 0.024 inch feed per revolution of the spindle. These feeds always bear a definite relation to the spindle speed, since they are driven from the spindle driving shaft.

The cam mechanism can be instantly disengaged and locked into disengagement by pushing inward the knob shown below the feed box in Fig. 2. This may be done during either the active or the idle movements of the machine. The cams can thus be hand operated by means of a crank handle attached to the squared end of the shaft projecting from the feed box, shown in Fig. 1. To set the cam mechanism into action again the knob is pulled outward, thus starting the feed. It is impossible to start the fast feed when the tools are in their operating position, or to start the slow-feed when they are in their idle position, so that there is never any danger of disaster on that account.

The auxiliary tool-holder, seen best in Figs. 1 and 2, is journalled on a bar held in the spindle bearing cap, and sliding in a seat on the upper side of the longitudinal tool-slide. This operates, as previously mentioned, on either the third or fourth spindle position. It is oscillated into the work by the cam shown in Fig. 3, adjustably carried by a rod fastened to and moving with the longitudinal tool-slide. A spring returns the auxiliary holder to its normal position.

All the moving parts of this machine are guarded wherever necessary. These guards are shown removed in the engravings, to permit a more complete view of the mechanism.

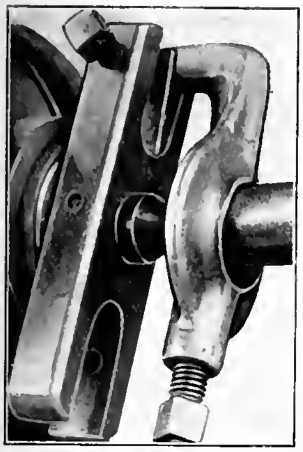


Fig. 1. Type of Dog Commonly Used

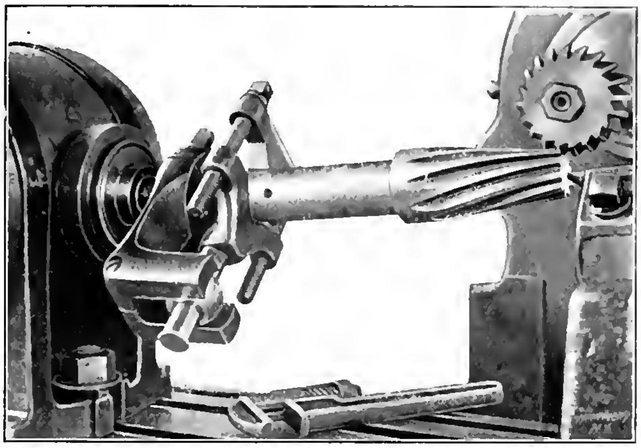


Fig. 2. A Dog which permits Indexing and Spiral Cutting on Taper Work

HILL MILLING MACHINE DOG

The common lathe dog ordinarily used in the milling machine is very unsatisfactory for indexing work on taper milling, as every mechanic knows, when the taper is obtained by raising the tail-stock center. Under these conditions the tail of the dog slides in and out of the driver slot, so that it either develops lost motion, or clamps in the driver, springing the work and throwing a severe strain on the centers. It is quite common to use a shim as shown in Fig. 1 to take up the varying looseness between the point of the screw and the shifting tail of the dog. The liability of this shim to drop out under ordinary conditions, and the practical certainty of its doing so when milling taper spirals, makes the device an uncertain one at the very best.

In Fig. 2 is shown a special milling machine dog made by the M. B. Hill Mfg. Co. of Worcester, Mass., which obviates in a very satisfactory way the difficulties just described. As may be seen, the device consists of a driver, clamped to the nose of the dividing head spindle or to the live center, depending on the construction of the head, and provided with grooved jaws in which slides the ball shown. The tail of the dog passes through this ball, moving up and down in it as the angle of the work varies, the ball at the same time moving in or out as required. The ball and the tail of the dog are hardened, ground and lapped to a close fit. The grooved jaws of the driver are split and provided with an adjusting screw for maintaining the proper fit of the groove on the ball.

It will be seen that the set-screw in the driver used in Fig. 1, which causes all the difficulty in work of this kind, is dispensed with. After the dog is placed in position on the centers, no further attention is required. It is held rigidly in the driver, while still permitting movement in any direction as required by the work. Its action is automatic, so that unskilled labor may be employed in operations of the kind to which it is adapted.

Not only does this device give a positive drive for taper work, which is lacking under the old conditions, but it mitigates the indexing errors due to the sliding of the tapered tail of the dog in or out of the slot, when set up as shown in Fig. 1. This accuracy of indexing permits the milling of rectangular tapers by the simple raising and lowering of the head center, a feature which is peculiar to this make of dog and driver.

POSITIVE BLADE STOP FOR LANG TOOL-HOLDER

The tool-holder made by the G. R Lang Co. of Meadville, Pa., illustrated in the department of New Machinery and Tools of last month's issue of Machinery, has been improved by the provision of a positive stop or abutment for preventing the blades from backing into the hole, even under the heaviest possible cuts. The change consists simply in drilling a row of pockets, which furnish successive seats for a commercial hardened steel ball. The ball is placed in that one of these pockets which agrees with the length of the blade in use. The blade is pushed back against it and is thus provided with a positive stop. In tests it has been found that a blade so held cannot be shifted from its position even when the clamp bolt is lost and the holder is placed in a vise with the weight of a heavy man on the handle. This device is now applied to all tool-holders of the style described, made by this company.

* * *

NEW MACHINERY AND TOOLS NOTES

Centering and Laying-out Tool: Max Jaeger, 109 No. Terrace Ave., Mt. Vernon, N. Y. This device may be used on circular work for finding the center, and laying out the positions of holes and surfaces therefrom.

Steel Tool Rack: Davis Mfg. Co., Milwaukee, Wis. This piece of shop furniture is made entirely of steel. It is provided with two shelves, a drawer and a bin for waste, etc. A tool-chest can be conveniently mounted on the top.

Socket Wrench: Frank Mossberg Co., Attleboro, Mass. This wrench is provided with a folding handle which permits storing the tool in a very small place. Removable sockets permit its use on a wide range of nuts and bolt-heads.

⅜-Inch Riveting Machine: Harvey Hubbell, Inc., Bridgeport, Conn. This riveting machine is of the maker's well-known rotary type, similar in principle to his smaller size, but designed for use up to and including 7/16-inch diameter.

20-Inch Roughing Lathe: Schumacher & Boye, Cincinnati, O. This lathe is of simple and rigid construction, provided with a two-step cone for a 6-inch double belt and double back gears. The feeds are gear-driven through a quick change gear box of the Emmes type.

Down Feed Attachment for Shaper: Queen City Machine Tool Co., Cincinnati, O. This attachment is operated by a worm-wheel and ratchet mechanism, controlled by dogs adjustably mounted in a slot in the holding-down gib, for the ram. The mechanism is very compact and simple.

Friction Clutch: Edgemont Machine Co., Dayton, O. This clutch is of the type in which a split rim is expanded by a lever movement against the inside of the pulley rim. An improved construction gives flexibility to the friction ring without decreasing its holding power.

Payzant Block Lettering Pen: Keuffel & Esser Co., Hoboken, N. J. This pen is made in a variety of sizes, any one of which gives a line of definite width, no matter in what direction the pen is moving. A reservoir is provided to permit the use of the pen for a long time without refilling.

Combination Depth Gage and Square: Wm. J. Gillard, 3617 Chicago Ave., Minneapolis, Minn. This tool consists of a pair of telescoping scales and a clamp, so arranged that the scales may be used either as a depth gage or as a square, set to any desired dimensions within the range of the tool.

Horizontal Spring Testing Machine: Thomas Carlin's Sons Co., Pittsburg, Pa. This tool applies the pressure by means of a horizontal pneumatic cylinder mounted on a framework of convenient construction for handling the springs. It may be profitably used also as a bull-dozer for light work.

Turret Lathe: Meriden Machine Co., Meriden, Conn. This turret lathe has a 20-inch swing, and is provided with friction head and back gears. The turret slide is adjustable vertically and longitudinally for centering the tool. An automatic chuck is provided, and an overhead brace is employed for stiffening the turret stud.

No. 1 Gear-Driven Plain Miller: Hendey Machine Co., Torrington, Conn. This milling machine is gear-driven, with a double back-gear connection. The feeds, as well, are positive and gear-driven. The mechanism is a modification of the well-known Norton gear box. Fifteen spindle speeds are obtained and twenty-one changes of feed.

Gang Drill with Tapping Mechanism: Rockford Drilling Machine Co., Rockford, Ill. This gang drill is composed essentially of three of the maker's regular drill presses, provided with tapping attachments. A single belt drive is used for the three, and the frames are connected by stiff cross bracing. A special fast feed is provided for reaming.

Rotary Hot Swaging Machine: Langelier Mfg. Co., Providence, R. I. This tool is similar to the makers' well-known rotary cold swaging machine, with the addition of a pneumatic holding device for the work, and the provision of an air blast for blowing the scale away from the dies. An oil pump gives continuous lubrication to the working parts.

Lemley Friction Clutch: W. A. Jones Foundry & Machine Co., 800 Noble St., Chicago, Ill. This is a clutch of the type in which a radial flange is compressed between two rings of wood, the compression being obtained by means of a powerful toggle mechanism, easily operated. The adjustment is simple. The clutch is made in both the pulley and cut-off coupling styles.

Helical Wire Coiling Machine: F. B. Shuster Co., New Haven, Conn. This machine is of the three-roll type, adjustable to produce helical coils out of wire ⅛ to ⅜ inch in diameter, in coils of 4 to 30 inches in diameter, and in lengths up to 16 feet. The pipe mandrel by which the helix is supported revolves in such a way as to reduce the friction usually required for driving the coils.

Radius Milling Machines: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. These machines are made in both vertical and horizontal styles, for milling radii up to 100 inches, and arcs up to 68 inches in length. While adapted to a general line of radius milling, they were originally developed for steam turbine work, on which they have been found very effective.

Gang Punch with Spacing Table: Long & Allstatter Co., Hamilton, O. This gang punch will use eight 13/16-inch punches and dies simultaneously. These may be spaced to any convenient lay-out, and each may be rendered individually operative and inoperative as required. The spacing table permits the longitudinal indexing of the work accurately to the dimensions given on the lay-out.

20-Inch Drilling Machine with Positive Feed and Double Spindle Attachment: Mechanics Machine Co., Rockford, Ill. This drill press is provided with a double spindle attachment, positive feed and built-in tapping attachment. In the double attachment the two spindles may be adjusted through a wide range of center distances, being held in a circular slot and driven by a gear mounted in the end of the main spindle.

Improved Drafting Machine: Universal Drafting Machine Co., Cleveland, O. This well-known instrument has been redesigned in its details, while retaining the same principles employed in the older models. The principal change relates to the provision of ball bearing joints. A number of improvements have also been made in the supporting mechanism, adapting the tool for use on boards of the largest size, under a wide range of conditions.

High-Duty Face Mill: Cincinnati Milling Machine Co., Cincinnati, Ohio. This face mill has a body and a backing ring of machine steel, carrying cutters made of ½ by 1¼-inch stock, fastened by a flattened taper pin in front of the cutting edge. The height of the latter is adjusted by small screws at the back of the head. This cutter has been found by the makers to produce results on face milling work hitherto unattainable for tools of the same size.

Multiple Starters for Large Direct Current Motors: Westinghouse Co.'s Pub. Dept., Pittsburg, Pa. These starters are much more effective and safe for large motors than those of the rheostat type used for the smaller sizes. The motor is started by the closing of series of switches, interlocked so as to prevent their closure except in the proper order. All the precautions necessary have been taken to prevent danger from overloads under all possible conditions.

Machine for Finish Grinding the Teeth of Gears: Gear Grinding Machine Co., Detroit, Mich. This machine employs a formed emery wheel for shaping the teeth of gears. While especially devised for finishing gears after hardening, it has been found profitable to use it in place of a finish cutter on soft gears, and also for giving the proper shape to cast gear teeth. An automatic truing device is provided which keeps the wheel constantly formed to the correct outline.

Six-Foot Radial Drilling Machine: Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa. This tool resembles the makers' older design in its general lines, but has been greatly strengthened and stiffened throughout, presenting an unusually powerful appearance. The machine has been re-designed from data collected in the past two years from a number of prominent shops. It is designed to produce results superior to anything hitherto obtained in the way of output.

Elapsed Time Recorder: International Time Recording Co., Flat Iron Building, New York City. This instrument is of remarkably ingenious construction, being employed for stamping on a ticket the date and hour at the beginning of a job, and at its completion, stamping the time of completion and the elapsed time—in other words, the time it has taken to do the work. It will do this over a period of several days, taking into account only the hours when the shop has been running and leaving half-holidays and Sundays out of consideration. Its use should thus greatly facilitate cost-keeping calculations.

Fourteen-Inch Engine Lathe with Gear Box: W. P. Davis Machine Co., Rochester, N. Y. This lathe is equipped with a quick-change gear box, giving 30 possible changes ranging from 3 to 30 threads per inch. Special or fractional threads may be cut by changing gears at the end. The tail-stock is offset to allow the compound rest to be swung parallel with the bed, and it is provided with a set-over for turning tapers. The carriage has a deep bridge, and the cross-feed screw collar is graduated to read to thousandths of an inch. With a six-foot bed the lathe swings 37 inches between centers and 9½ inches over the carriage. The cone diameters range from 4⅛ to 9 inches, and the back gear ratio is 10 to 1. The net weight of the lathe is 1,600 pounds.

Liquid Sealed Annealing Box: Raymond H. Kinnear, 2 Rector St., New York City. This annealing box is of unique construction, in that it is rendered air-tight without requiring a luting of clay or similar material. The form of the box and its cover provide a trough, which is sealed with molten lead, effectually preventing the entrance of the air and the consequent oxidization of the work. When the box has cooled, the cover is readily withdrawn. The outward passage of gas generated in the interior is not restrained by this construction. The lead remains in the groove and is always ready for subsequent heats. A small quantity of graphite floating on the top prevents its oxidization.

Accelerating Cut Planer: Powell Tool Co., Worcester, Mass. This tool of which mention was made in the article entitled "Improvements in High-Speed Steel," in the April, 1909, issue of Machinery, employs the novel principle of starting the work against the tool at about the ordinary rate of speed, and then accelerating it to a cutting speed much higher than ordinarily found possible. The economy from this operation lies in the fact that the limiting cutting speed on a planer is usually determined by the impact of the tool on the stock at the beginning of the cut, consequently the rate may be increased after this dangerous impact has passed. While there has been a recent tendency to increase the reverse of the planer table, it is evident that this increase of the rate on the cutting stroke means much more in the way of increase of output.

* * *

A POPULAR RESOLUTION

At the recent convention of the National Machine Tool Builders' Association, held in Milwaukee, some wag brought down the house by having Secretary Montanus read the following resolution:

Whereas: The designs of machine tools are rapidly changing and improving, and,

Whereas: The manufacturer who uses tools of obsolete design is doing himself and his employes a very great wrong, and,

Whereas: There does not seem to be any method so far developed to convince the user of obsolete machine tools of the wrong he is doing himself and the community; therefore, be it

Resolved: That this association, through its members, urge upon the legislatures of the various States to pass laws making the use of a machine tool for a period longer than ten years a crime punishable with suitable penalties.

A. R. M. M. AND M. C. B. ASSOCIATIONS CONVENTIONS

The forty-second annual convention of the American Railway Master Mechanics' and the forty-third annual convention of the Master Car Builders' associations were held at Atlantic City, N. J., June 16-23 inclusive. Following the custom of alternating the conventions in the matter of priority, the Master Mechanics' Association convention was held June 16, 17 and 18, and the Master Car Builders' Association convention followed on June 21, 22, and 23. Simultaneously with these conventions was the exhibition of railway supplies and apparatus, machine tools, etc., under the auspices of the Railway Supply Manufacturers' Association on Young's New Pier. This is one of the most important exhibits annually held in the United States, in point of capital represented, comparing favorably with many national expositions that are widely advertised.

The general technical program of the Master Mechanics' Association was made up as usual consisting largely of reports made by committees interspersed with individual papers, as follows:

June 16.—Discussion of reports on: "Mechanical Stokers"; "Revision of Standards"; "Motor Cars."

Topical discussion: 1. "Is the additional cost of flexible stay-bolts justifiable?" opened by H. D. Brown, Erie R. R. 2. "Is the usual front row of crown bolts in a locomotive boiler beneficial or otherwise?" opened by C. A. Seley, Rock Island Lines.

Discussion of individual paper on "Bank vs. Level Firing," by E. D. Nelson, Pennsylvania R. R.

June 17.—Discussion of reports on: "Castle Nuts"; "Safety Valve"; "Superheaters."

Discussion of individual paper, "Locomotive Performance under Saturated and Superheated Steam," by Prof. W. F. M. Goss, University of Illinois.

Topical discussion: 1. "Vanadium steel—Have the advantages claimed and shown in laboratory tests been substantiated in practice, particularly as regards the strengthening of locomotive parts?" opened by W. C. A. Henry. 2. "Are bypass valves necessary on piston valve locomotives?" opened by H. T. Bentley, Chicago & Northwestern Ry.

Discussion of reports on: "Widening Gages on Curves"; "Steel Tires."

June 18.—Discussion of reports on: "Tender Trucks"; "Fuel Economies"; "Lubricating Material Economies."

Individual paper: "The Transfer of Heat," by Prof. Charles E. Lucke, Columbia University.

Topical discussion: 1. "Is previous railway experience of advantage to locomotive firemen? If so, how may this be handled in a practical manner?" opened by D. R. MacBain, N. Y. C. R. R. 2. "Brick arches and water tubes, their value and influence on fuel economy," opened by J. F. Walsh, Chesapeake & Ohio Ry.

The meeting was conducted by President H. H. Vaughan, assistant to the vice-president of the Canadian Pacific Ry.

The following officers were elected:

President, G. W. Wildin, N. Y. N. H. & H. R. R.
First vice-president, C. E. Fuller, Union Pacific Ry.
Second vice-president, H. T. Bentley, C. & N. W. Ry.
Third vice-president, D. F. Crawford, Pennsylvania Lines.
Treasurer, Angus Sinclair, *Railway and Locomotive Engineering.*
Executive Committee: C. A. Seley, C., R. I. & P. (two years); D. R. MacBain, N. Y. C. & H. R. R. R. (two years); F. M. Whyte, N. Y. C. & H. R. R. R. (one year).

The program of the Master Car Builders' Association convention was made up in the usual manner consisting of topical discussions and individual papers as follows:

June 21.—Discussion of reports on: "Revision of Standards and Recommended Practice."

Topical discussion: 1. "Wheel defects—Is a brake burn due to prolonged brake application properly an owner's defect? How is it to be distinguished from the defect known as shelled out?" opened by H. D. Taylor, P. & R. Ry. 2. "Application of suitable lugs to steel or steel underframe cars for jacking up car bodies, and application of suitable push pole pockets to avoid damage to cars," opened by Thomas Paxton, El Paso & S. W. Ry.

Discussion of reports on: Train Brake and Signal Equipment"; "Brake Shoe Tests."

June 22.—Discussion of reports: "Tests of M. C. B. Coupler"; "Revision of Rules for Loading Long Materials"; "Rules of Interchange," including report of arbitration committee on "Revision of Freight and Passenger Car Rules"; also reports of committees on "Freight Car Repair Bills and Air-Brake Hose"; "Cast Iron Wheels"; "Splicing Sills"; "Tank Cars"; "Safety Appliances"; "Side Bearings and Center Plates."

June 23—Discussion of reports: "Freight Car Trucks", "Painting Steel Cars"; "Side and End Door Fixtures", "Train Pipe and Connections for Steam Heat"; "Classes of Cars"; "Salt Water Drippings from Refrigerator Cars"; "Revision of Constitution and By-Laws"; "Subjects."

Topical discussions: 1 "Wheel mounting pressures for various sizes of cast iron and steel wheels," opened by W. T. Gorrell, P. & R. Ry. 2. "Cleaning triple valves and brake cylinders on freight cars to meet Interstate Commerce Commission requirements," opened by T. L. Burton, C. R. R. of N. J.

The meeting was conducted by President R. F. McKenna, master car builder of the Delaware, Lackawanna and Western R. R. The following officers were elected:

President, F. H. Clark, C. B. & Q. R. R.
First vice-president, T. H. Curtis, L. & N. R. R.
Second vice-president, LeGrand Parish, L. S. & M. S. Ry.
Third vice-president, A. Stewart, Southern Ry.
Treasurer, John Kirby, Adrian, Mich.
Executive Committee: D. F. Crawford, Pennsylvania Lines; F. W. Brazier, N. Y. C. & H. R. R. R.; C. A. Schroyer, C. & N. W. Ry.; J. D. Harris, B. & O. R. R.; C. E. Fuller, U. P. R. R. (hold over); H. D. Taylor, P. & R. Ry.

The Mechanical Exhibits

The exhibit of machine and railway appliances comprised a seemingly larger proportion of machine tools and accessories for the machine shop than any previous exhibit, there being about fifty concerns represented out of a total of 228 exhibiters, who manufacture machine tools, machinists' hand tools and other accessories that are used in metal working. The exhibits were arranged on Young's New Pier in the same general order as in past years. Machinery Hall on the east side of the pier near the entrance was mostly filled with machine tools and would have been entirely filled had the management given the concerns space in this section where they properly belonged. A passenger car vestibule, steel car, and a few other examples of rolling stock equipment were clearly out of place and should have been grouped in another part of the exhibit with related exhibits.

The matter of proper segregation of exhibits is important. In the business districts of large cities, the tendency is for competitive lines to gather in the same localities, and the same idea should be followed in managing exhibits of machinery and tools. Lathes, planers, shapers, grinding machines, boring, drilling and milling machines, upright and radial drills, boring mills, automatic screw machines, nut tappers, plain grinding, cylinder boring machines, twist and flat drills, reamers, and all metal-working tools necessary for locomotive building and repair work should be grouped in one section so far as possible. Blacksmith shop tools and boiler shop tools should form a section intermediate with the purely machine tools section and the sections in which the rolling stock equipment and appliances are shown. In this section should be shown flue welders, flue rattlers, furnaces, riveters, pneumatic tools, etc.

Many of the machine tools were in operation and when all were working together the scene was animated, indeed. The tests of the power of radial drills using flat twisted high speed drills, attracted a great deal of attention, and some startling results were obtained in heavy high speed drilling. High speed shapers also received their share of attention and many remarked that the modern shaper is a very healthy competitor of the planer. The turning, boring, grinding, and threading operations did not lack for attention, but whether it was bestowed by railway officials intelligently or not, future sales only will show.

Exhibitors of Metal-working Machines and Accessories

Ajax Mfg. Co., Cleveland, Ohio. Improved bolt head upsetting and forging machine; high speed bulldozer and bending machine; reclaiming rolls for re-rolling scrap; hot sawing and burring machine.

American Blower Co., Detroit, Mich. Blowers for forges and furnaces; heating and ventilating apparatus, mechanical draft apparatus; vertical enclosed, self-oiling steam engines; Sirocco blowers.

American Specialty Co., Chicago, Ill. "Use-Em-Up" drill sockets and sleeves; Collis high-speed flat and flat twisted drills, universal adjustable blade reamers.

American Tool Works Co., Cincinnati, Ohio. Engine lathe, 24-inch by 12 foot, driven by Northern direct-connected motor;

multi-speed planer 36 inches x 36 inches by 10 feet, driven by direct-connected Westinghouse motor; 25-inch crank shaper with speed box, driven by direct-connected General Electric motor, 5-foot triple-geared high speed plain radial drill, driven by direct-connected Crocker-Wheeler motor; 2-foot high speed ball bearing radial drill with tapping attachment, driven by direct-connected Lincoln motor; Willey motor-driven water tool grinder with 2-inch x 16-inch wheel.

American Vanadium Co., Pittsburg, Pa. Vanadium ores, alloys, and steels, both wrought and cast, comprising saws, tires, axles, crank-shafts, locomotive frames, etc.

Armstrong-Blum Mfg. Co., Chicago, Ill. Power hack saw machine, portable grinder for lathes and planers, lever punch and shear.

Armstrong Bros. Tool Co., Chicago, Ill. Tool holders, ratchet drills, vises, C-clamps, knurling tools and other machine shop specialties.

Besly & Co., Charles H., Chicago, Ill. Besly spiral disk grinder, spiral circles, taps, oil and babbitt.

Boker & Co., Hermann, New York. "Novo Superior" steel and other high-speed steels, including "Intra" steel.

Brown & Sharpe Mfg. Co., Providence, R. I. Plain milling machine, vertical milling machine, and attachments for milling machines. Machines in operation.

Bullard Machine Tool Co., Bridgeport, Conn. Vertical turret lathe, in operation.

Carborundum Co., Niagara Falls, New York. Carborundum wheels, sharpening stones, rubbing bricks, carborundum paper and cloth and other abrasive products.

Celfor Tool Co., Chicago, Ill. High speed drills, reamers, counter-sinks, three-lipped drills, chucks, etc. These drills were in use on several drilling machines in the exhibit.

Chicago Penumatic Tool Co., Chicago, Ill. Air compressor.

Chisholm & Moore Mfg. Co., Cleveland, Ohio. Differential chain hoists in various sizes, including a 30-ton hoist.

Cincinnati-Bickford Tool Co., Cincinnati, Ohio. High speed 24-inch upright drill; high speed 20-inch upright drill; 5-foot high speed radial drill. Radial drill in operation.

Cincinnati Planer Co., Cincinnati, Ohio. Forge planer 37 inches x 37 inches x 8 feet with four heads and variable speed motor drive, in operation.

Cleveland Twist Drill Co., Cleveland, Ohio. Twist drills, taps, reamers, sockets, etc.

Coe Brass Mfg. Co., Ansonia, Conn. Extruded brass in various cross sections, used in the manufacture of locks, pinions, ratchets, gears, etc.

Cooper-Hewitt Electric Co., New York. Cooper-Hewitt mercury vapor electric lamp for shop lighting.

Davis-Bournonville Co., New York. Oxy-acetylene welding and cutting plant comprising torches, generators, and compressors. Demonstration of process.

Davis Expansion Boring Tool Co., St. Louis, Mo. Expansion boring tools, lathe tools, planer tools, etc.

Dudgeon, Richard, New York. Hydraulic jacks, comprising car inspector's railway, plain, base, claw, independent claw, horizontal and traversing jacks; electrical power pump, and several types of hand-operated pressure pumps.

Foster, Walter H., New York. Bolt turning machine, Lassiter stay-bolt threading and reducing machines, stay-bolt hole squaring machine; Potter & Johnston automatic machines; Lassiter bolt drilling machine, stay-bolt nipper, automatic nut tapper.

Goldschmidt-Thermit Co., New York. Exhibit of thermit-welded locomotive frames, driving wheels, connecting rods; and fire brick molds shaped to fit various locomotive parts used in thermit welding.

Gould & Eberhardt, Newark, N. J. 24-inch high duty shaper, driven by a direct-connected Northern variable speed motor. Machine in operation.

Greene-Tweed & Co., New York. "Favorite" reversible ratchet wrench and other specialties.

Hill, Clarke & Co., Inc., Boston, Mass. 5-foot triple geared high speed radial drill; Milwaukee plain milling machine; Milwaukee full universal milling machine with various attachments; Universal horizontal boring machine. Milling machines in operation.

Hammett, H. G., Troy, New York. Radius grinder for locomotive links, and other specialties.

Harrington, Edwin, Son & Co., Inc., Philadelphia, Pa. Geared and differential hoists, and I-beam trolley.

Keystone Drop Forging Works, Chester, Pa. Drop forgings for locomotive and car work.

Landis Tool Co., Waynesboro, Pa. Plain and universal grinders.

Landis Machine Co., Waynesboro, Pa. Motor-driven bolt and pipe threading machines, demonstrating high speed threading. Machine in operation.

Linde Air Products Co., Buffalo, New York. Oxy-acetylene welding and oxy-coal gas cutting apparatus.

Link-Belt Co., Philadelphia, Pa. Renold machine driving chains.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. Engine lathe, 24-inch x 12 foot patent head, motor-driven; engine lathe 18-inch x 8-foot head, motor-driven. Machine in operation.

Manning, Maxwell & Moore, New York. Lathe, shaper, drills, inspirators, valves, and other specialties.

National-Acme Mfg. Co., Cleveland, Ohio. Automatic multiple spindle screw machine in operation.

Newton Machine Tool Works, Inc., Philadelphia, Pa. High duty radial drilling machine; cold saw cutting off machines; rapid production bolt threading machines.

Niles-Bement-Pond Co., New York. Pratt & Whitney toolroom lathe, tire gages, coupler gages, tire tapes, Pond rigid turret lathe, rapid action tool clamp for Niles driving wheel lathe, etc.

Norton Co., Worcester, Mass. Alundum grinding wheels.

Norton Grinding Co., Worcester, Mass. Norton gap grinding machine for locomotive work and other specialties. Machine in operation.

Queen City Machine Tool Co., Cincinnati, Ohio. 24-inch motor-driven shaper with gear-box driven by direct-connected Westinghouse motor. Machine in operation.

Revolute Machine Co., New York. Continuous electric blueprinting machine. Machine in operation.

Royersford Foundry & Machine Co., Royersford, Pa. Punching and shearing machines.

Russell, Birdsall & Ward Bolt & Nut Co., Portchester, New York. Finished and semi-finished castellated nuts, hexagon nuts, finished case-hardened nuts, etc.

Ryerson, Joseph T., & Son, Chicago, Ill. Rotary bevel shear, high speed friction saw, portable automatic key-seating machine, crank pin truing machine, flue welding machine, internal combustion riveter, etc. Riveter in operation.

Sellers & Co., William, Philadelphia, Pa. Line shaft hanger with cast iron boxes; photographs of new car wheel lathe, locomotive injectors, etc.

Standard Tool Co., Cleveland, Ohio. Twist drills, reamers, milling cutters, taps, and chucks.

Stoever Foundry & Machine Co., New York. Motor-driven automatic pipe-bending machine, in operation; motor-driven pipe-threading and cutting-off machine, in operation.

Tindel-Morris Co., Eddystone, Pa. High-duty cold sawing machine and inserted tooth high-speed steel saw blades.

Underwood & Co., H. B., Philadelphia, Pa. Portable cylinder boring bar; portable crank-pin turning machine, vertical boring machine for small gas engine cylinders, etc.

Watson-Stillman Co., New York. Hydraulic jacks, car wheel and crank pin presses, hydraulic rail benders and jacks, and turbine pumps.

Western Tool & Mfg. Co., Springfield, Ohio. Lathe and planer tool holders, expanding mandrels, etc.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Electric motors and other electrical apparatus.

Westinghouse Air Brake Co., Pittsburg, Pa. Cross-compound air pump, 8½ inches in section, driven by duplicate pump.

Yale & Towne Mfg. Co., New York. Electric hoists, chain blocks, I-beam trolleys and other specialties.

* * *

PERSONAL

C. E. Chambers has been appointed general master mechanic of the Central Railroad of New Jersey.

C. L. Cook, formerly of the Fairmont Coal Co., has been appointed chief engineer of the Fairmont Mining Machine Co., Fairmont, West Virginia.

Edward S. Pomeroy has been promoted from the position of foreman to master mechanic at the Smith & Wesson, Inc., revolver manufacturers, Springfield, Mass.

Harold Wesson has been appointed assistant superintendent at the Smith & Wesson, Inc., revolver manufacturers, Springfield, Mass.

Richard B. Cavanagh has entered the firm of Macdonald & Macdonald, patent lawyers, 50 Church St., New York, and the firm name hereafter will be Macdonald, Macdonald & Cavanagh.

H. R. Swartley, Jr., who has been the New York manager for the Electric Service Supply Co., Philadelphia, Pa., has taken charge of the Chicago office of the Variable Speed Clutch Co., of Milwaukee, Wis.

E. W. McKeen, for many years connected with the mechanical department of the Union Twist Drill Co., Athol, Mass., has been appointed manager of the company's New York store at 54 Warren St.

H. F. Frohman, general manager of the S. Obermayer Co., Cincinnati, Ohio, read a paper at the May meeting of the American Foundrymen's Association of Cincinnati, entitled "Standardizing Foundry Facings."

Harold A. Richmond, president of the American Emery Wheel Works, Providence, R. I., sailed for Europe June 17 on the *Friedrich der Grosse*. Mr. Richmond will visit the company's agencies in Berlin, Vienna, Paris, and Copenhagen.

F. W. Jackson, who has been connected with the engineering and sales department of the Harrisburg Foundry & Machine Works, Harrisburg, Pa., for a number of years, has been appointed district manager of the company for the Baltimore district with headquarters at 1415 Continental Trust Building.

Curtis Dougherty, formerly superintendent of the Springfield division of the Illinois Central Railroad, has been promoted to the position of superintendent of the Queen & Crescent Route and Alabama Great Southern R. R., with headquarters in Cincinnati, Ohio. Mr. Dougherty left the Illinois Central R. R. February 1, 1907, to go to the Queen & Crescent Route as assistant general engineer to Mr. H. E. Warrington, who has just resigned.

W. A. Hopkins, who has had charge of the electric construction work of the Wabash Railroad, and who was the real organizer of the electrical department, has resigned, and is now in charge of the southwestern branch of the New York Safety Car Heating & Lighting Co., covering territory extending from St. Louis to the Gulf of Mexico and west to the Pacific coast including Mexico, and as far north along the coast as Washington. The company now employing Mr. Hopkins has for a number of years had exclusive control of the Pintsch lighting system, but now will push the electric lighting system of trains also.

* * *

OBITUARIES

Benjamin F. Jones, for forty-two years the timekeeper for the Collins Co., Collinsville, Conn., died May 14, aged seventy years.

John W. Brawn, of Brawn & Sellers, Holyoke, Mass., manufacturers of wire cloth, Fourdinier and dandy rolls, died at his home in that city June 3, aged sixty-nine.

George W. Hall, foreman of the polishing room in Smith & Wesson, pistol manufacturers, Springfield, Mass., died May 29, aged fifty-one years. Mr. Hall was treasurer of the factory relief association.

* * *

COMING EVENTS

July 8-10.—Massachusetts State Convention of the National Association of Stationary Engineers at Springfield, Mass. Exhibit of steam specialties and engineers' supplies in Graves Hall.

July 10-17.—Winnipeg (Manitoba) Industrial Exhibition from July 10 to 17. A. W. Bell, manager and secretary, Winnipeg, Manitoba.

August 9-14.—Seventeenth National Irrigation Congress, Spokane, Wash., for the consideration of an action on irrigation, drainage, forestry, good roads, deep waterways, and home building. Arthur Hooper, secretary, Board of Control, Spokane, Wash.

September 25-October 9.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the *Tribune* building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

October 4-8.—Annual conventions of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants' Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

Armour Institute of Technology, Chicago, Ill. Bulletin No. 4 on the summer session which comprises courses in electrical engineering, chemical engineering, civil engineering, practical shop work, physics, mathematics, mechanics of engineering and drawing. Address for further information Dean of Engineering Studies, Armour Institute of Technology, Chicago.

Museum of Safety and Sanitation, 29 West 39th St., New York, announces the election of Arthur Williams to the board of trustees. Mr. Williams is the general inspector of the New York Edison Company and a member of the American Institute of Electrical Engineers. In 1907 he was decorated by the French Government. He is a member of the American section of the International Housing Congress and was a member of the Eighth International Congress of Social Insurances at Rome, 1908. Mr. Williams will serve on the lecture committee of the museum.

NEW BOOKS AND PAMPHLETS

Proceedings of the Twenty-eighth Annual Convention of the American Water Works Association Held at Washington, D. C., May 11-16, 1908. 800 pages, 6 x 9 inches. Published by the secretary, J. M. Diven, 14 George St., Charleston, S. C.

On the Rate of Formation of Monoxide in Gas Producers. By J. K. Clement. 47 pages, 6 x 9 inches. Published by the University of Illinois Experiment Station, Urbana, Ill., for free distribution.

Engine Lathe Work. By Fred H. Colvin. 180 pages, 4½ x 7 inches, 127 illustrations. Published by the Hill Publishing Co., New York. Price $1.

The work treats of the engine lathe, circular lathe work, driving the work, tools for turning, face-plate work, chucks and chucking, boring tools, taper turning, thread turning, test indicators, care of lathes, etc. It is partly made up of elementary articles published in the monthly edition of the *American Machinist*. It will be found generally useful by apprentices, students and trade schools and others desiring to obtain elementary knowledge of the construction, use and operation of the engine lathe.

Westinghouse E-T Air Brake Construction Pocket Book. By W. W. Wood. 242 pages, 5 x 7 inches, illustrated. Published by Norman W. Henley & Son, New York. Price $2.

This instruction pocket book on the Westinghouse E-T air brake equipment differs from other works on the air brake, in that it is not of the catechism form, which has been the popular method of explaining air brake apparatus and other apparatus used in railway and stationary engineering. The new E-T equipment is described in detail. In this equipment the entire apparatus, including the engine and tender brake, has been reconstructed, and although the principle of the common triple valve has been retained, the general construction of the new equipment is so different from the older form that railway men must study its construction in order to understand its operation and action. The book is illustrated with numerous colored diagrams showing the pipes, cylinders, reservoirs, etc., the pressures in the various parts of the apparatus being indicated in colors so as to make the study of the apparatus convenient and easy.

Gas Engine Theory and Design. By H. C. Mehrtens. 256 pages, 5 x 8 inches, illustrated. Published by John Wiley & Sons, New York. Price $2.50.

The increase in importance and general interest in the gas engine is to some extent indicated by the number of new books that have been published in the last few years. The book in review has been prepared for students, draftsmen, engineers and men who operate gas engines, and is based on the author's instruction work at the Michigan Agricultural College. It treats of the general principle of operation, heat, thermodynamics, combustion, fuel, laws of gases, gas engine efficiency, explosive mixtures, mixing valves and carbureters, governing, ignition, cooling, exhaust, selection of type, determination of the principal dimensions, forces acting in the gas engine, design and dimensions of parts, gas engine manipulation, testing designs. Tables are given on the physical properties of materials, petroleum distillates, properties of fuel gases, volumes and specific heats of gases, efficiencies at different altitudes, strength of materials, heat and power units, volume, pressure and temperature curves. The work has the appearance of being a practical and carefully prepared book that will appeal more to the student, draftsman and engineer than to the general run of men operating gas engines. We would not recommend it to the latter class unless they are interested in the problems concerning design and the thermodynamics of gas engines.

Calculation of Change Wheels for Screw Cutting Lathes. By D. De Vries. 83 pages, 5½ x 8½ inches. Published by Spon & Chamberlain, New York. Price $1.50.

In this work the author has handled the problem of change gearing of lathes in a very ambitious manner, but one discouraging to machinists who would buy a work of this character to obtain simple directions for gearing engine lathes. For a designer of machine tools who wishes to study the method for calculating approximate fractions at length he will find this part carried out in great detail. The book is divided into three chapters. The first describes the change mechanism of the engine lathe; the second and longest chapter is divided into heads, as follows: System; what change wheels are to be found on a lathe; the cutting of metric threads with a metric lead screw; the cutting of English threads with a metric lead screw; the cutting of English threads with an English lead screw; the cutting of metric threads with an English lead screw; the wheel with 127 teeth; method of calculating approximate fractions; the proof of the sum; fixing up the wheels; thread cutting with double compound threads; the cutting of left hand threads. In the third chapter the forms of thread sections, types of threads, screw cutting tools, etc., are discussed. We believe that the book would be better appreciated by the mass of machinists if the section on the method of calculating approximate fractions and finding the approximate fraction were simplified and made much shorter.

CATALOGUES AND CIRCULARS

American Blower Co., Detroit, Mich. Catalogue of Sirocco fans.

Skinner Chuck Co., New Britain, Conn. Pamphlet illustrating Skinner chucks.

Ball & Wood Co., Elizabethport, N. J. Catalogue of Rateau-Smoot low-pressure turbines and generators.

Emerson Electric Mfg. Co., St. Louis, Mo. Bulletin No. 3908 on factory sewing machine electric motors.

Waltham Machine Works, Waltham, Mass. Leaflet illustrating escape wheel cutting machines for watch work.

Linde Air Products Co., Buffalo, N. Y. Descriptive pamphlet of "Pyrokopt" apparatus for cutting metals.

Phillips Pressed Steel Pulley Works, Philadelphia, Pa. Blotter advertising Phillips pressed steel pulleys.

General Electric Co., Schenectady, N. Y. Bulletin No. 4662 of Thompson recording watt meters for switchboard service.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Small catalogue of Westinghouse electric motors for the office, store and shop.

Jones & Lamson Machine Co., Springfield, Vt. Pamphlet containing detailed description of chip breaking turner for the flat turret lathe.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 114, superseding Bulletin No. 77 on coupled type alternating current generators.

H. G. Hammett, Troy, N. Y. Leaflet illustrating radius grinder for locomotive links and link blocks. The machine can also be converted into a surface grinder.

S. Obermayer & Co., Cincinnati, Ohio. Pamphlet advertising Obermayer foundry products and containing a guide to points of interest in and adjoining Cincinnati.

Tindel-Morris Co., Eddystone, Pa. Bulletins Nos. 1, 2, 4 and 5 of Tindel high-duty inserted tooth cold saw blades, crank-shaft lathes and crank-shaft grinding lathes.

W. S. Rockwell Co., 50 Church St., New York. Pamphlet illustrating Rockwell melting furnace for copper, brass, bronze, aluminum, silver, gold, iron, steel, etc.

Electric Welding Products Co., Cleveland, Ohio. Booklet illustrating electrically welded gas engine valve stems and other welded products largely used in the manufacture of automobiles.

Warner & Swasey Co., Cleveland, Ohio. Pamphlet illustrating the Warner & Swasey turret lathe, telescopes, binoculars and other products exhibited at the recent Cleveland Industrial Exposition.

Gisholt Machine Co., Madison, Wis. Leaflet for loose leaf binder illustrating operations of finishing street-car motor pinions on the Gisholt 24-inch big bore turret lathe with 5-inch spindle hole.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet on care of belting, containing illustrations showing methods of lacing belts and giving practical pointers on general care of belts and application.

Richard Dudgeon, Broome & Columbia Sts., New York. Catalogue No. 6 of hydraulic jacks and power pumps made in a great variety of styles and sizes for all classes of service.

Cincinnati Iron & Steel Co., Cincinnati, Ohio. General catalogue of shears, punches, hoists, travelers, etc., for structural, boiler, machine, wagon, blacksmith, sheet, metal, and other shops.

Richard W. Jefferis Co., Camden, N. J. Folder illustrating Jefferis pressed steel lockers for use in armories, gymnasiums, factories, clubs, stores, offices, schools, shops, etc.

Hess-Bright Mfg. Co., Philadelphia, Pa. Catalogue of propeller thrust, ball bearing blocks for marine engines and other service requiring efficient thrust bearings.

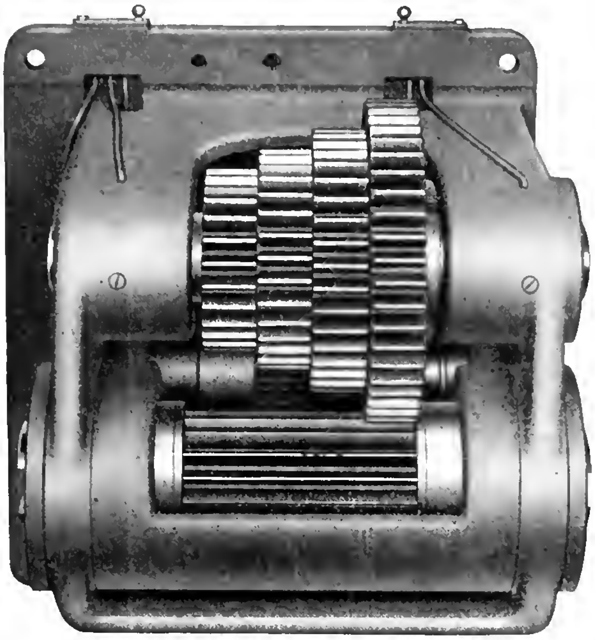
Cincinnati-Bickford Tool Co., Cincinnati, Ohio. Folder describing the Cincinnati 24-inch high-speed shaft-driven drilling and tapping machine with motor and gear box drive.

Consolidated Safety Valve Co., 85-89 Liberty St., New York. Reprint of paper by Philip G. Darling on safety valve capacity read before the American Society of Mechanical Engineers, February 23, 1909.

Electric Welding Products Co., Cleveland, Ohio. Booklet illustrating finished steel bolts and screws having the heads electrically

Severe Service Demands Substantial Construction

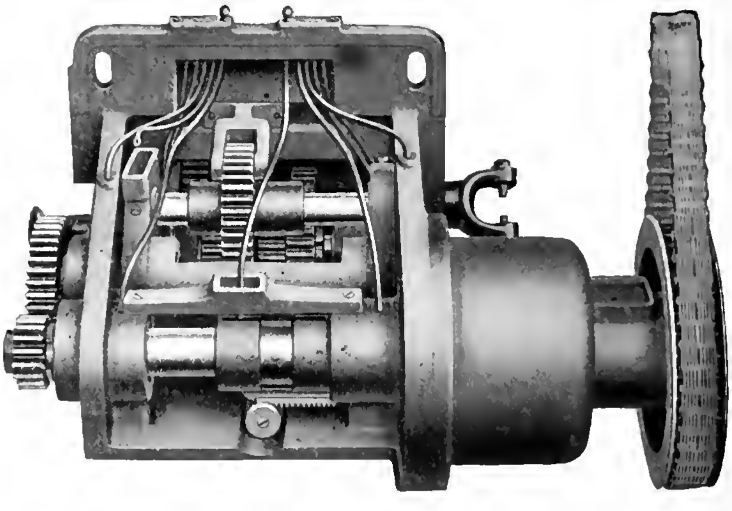
That is why so much care is given to the design and construction of each part of B. & S. Milling Machines.



THE accompanying cuts show excellent examples of the strong and rigid constructions employed in the **spindle speed** and **feed cases** of the

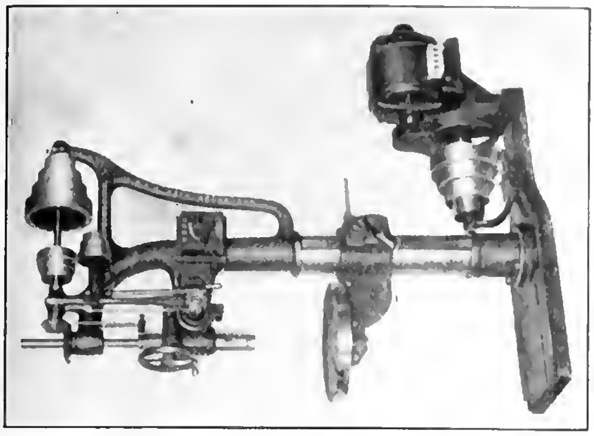
B. & S.
Constant Speed Drive Milling Machines

NOTE the rigid mounting of change gears and the compact and heavy proportions of supporting parts—All shafts are of steel, hardened and ground and run in bronze bearings—All gears are of hardened machinery steel and have long pointed teeth to afford instant engagement without employment of any auxiliary mechanism—The holes in all gears are ground concentric with the pitch circle after hardening; silent running is thus assured—The simplicity of the oiling arrangement is plainly apparent in both cuts.



Brown & Sharpe Mfg. Co.

PROVIDENCE, R. I., U. S. A.



This is our New 21" Power Feed Automatic Stop Drill

MOTOR DRIVE

This machine is accurate, powerful, and quickly operated. Will drill 1¾" hole in solid cast iron. It is equipped with 1 H. P. General Electric D. C. Motor. Great drill for light manufacturing purposes. For sale by Manning, Maxwell & Moore New York City.

J. E. SNYDER & SON
WORCESTER, MASS.

Sizes 20", 21", 23", 25", 28", 30" and 36".

Selling Agents: Manning Maxwell & Moore Inc. New York City, Boston, Chicago, Cleveland, Detroit, Syracuse, Atlanta, Pittsburg, Philadelphia, Mexico City, Tokio, Japan, Birmingham, Hong Kong, China.

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A long line of satisfied users endorse the Robbins Patent Chain Tongs as the best device of its kind.

Manufactured by

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40 YEARS ON THE MARKET

Our trade mark on every tool is a guarantee for strength, safety and efficient service.

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WRITE FOR RED BOOKLET—SHOWING WALWORTH PIPE FITTING TOOLS

WALWORTH M'F'G CO.
TOOLS and SUPPLIES for STEAM WATER and GAS USERS
BOSTON MASS.

ESTABLISHED IN 1887

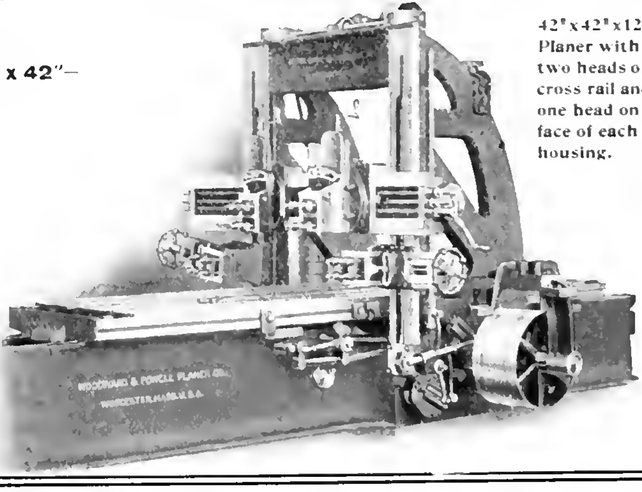
PLANERS: 24" x 24"—27" x 27"—30" x 30"—36" x 36"—42" x 42"—48" x 48"—60" x 60"—any length.

Textile Feed Roll Fluting Planers. Frog and Crossing and Switch Point Planers. Locomotive Connecting Rod Planers 48" x 17" x 16". Duplex Planers, cutting a full stroke both ways 46" x 18" any length.

Manufactured by

Woodward & Powell Planer Co.
WORCESTER, MASS.

Manning, Maxwell & Moore, New York City, Philadelphia, Chicago, Ill., Milwaukee, Wis., Seattle, Wash., Portland, Oregon, St. Louis, Mo., Pittsburg, Pa., Cleveland, Ohio, Boston, Mass., Birmingham, Ala., Mexico City, Mexico, Yokohama, Japan, Canton and Hongkong, China. Henshaw, Bulkley & Co., San Francisco, Cal. and Los Angeles. Fenwick Freres & Co., Paris, France; Belgium, Italy, Switzerland and Spain. Herman Haelbig, Dresden-A 3, Germany and Austria.



42" x 42" x 12' Planer with two heads on cross rail and one head on face of each housing.

P. & W. Vertical Surface Grinder

will grind from 12 to 20 times faster than any other surface grinder. Cup shaped wheel covers full width of work insuring perfect flatness together with rapid reduction.

Furnished with magnetic chuck (as shown) for holding flat work or with revolving table for discs, rings, collars, etc.

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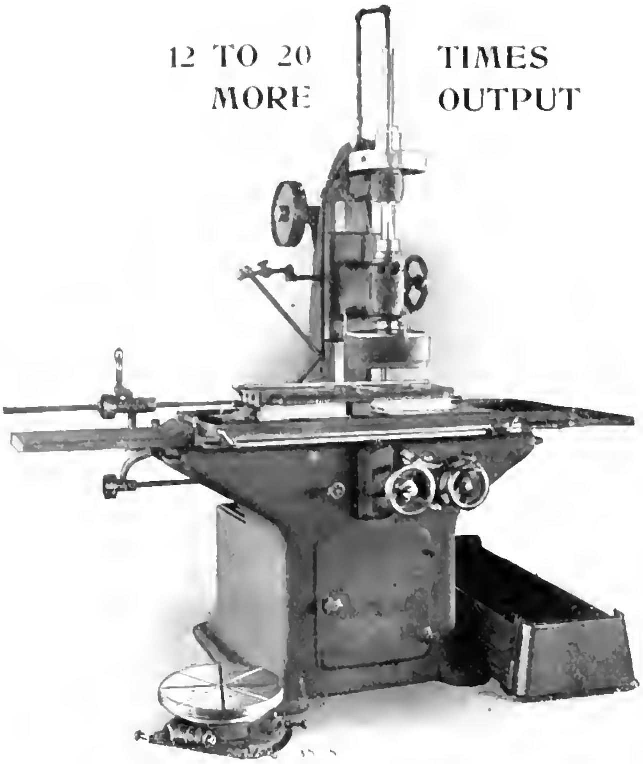


The P. & W. Vertical Surface Grinding Machine

Multiple Spindle Drilling Machine

with adjustable spindles for drilling simultaneously a number of holes in a great variety of work from an automobile hub to heavy vault plates.

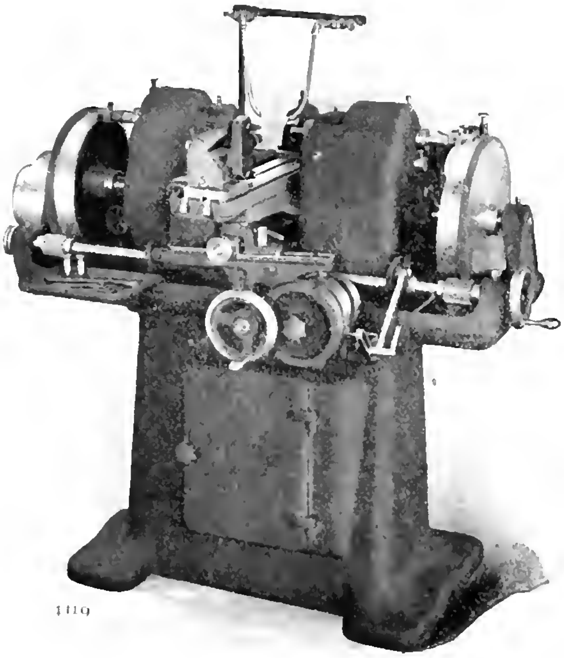
The P. & W, Adjustable Multi Spindle Drill

Slot Milling

The P. & W. Spline Milling Machine is an entirely new machine for milling slots with closed ends, keyways and an endless variety of other work—greatly reducing the cost of production.

Machine is automatic, very rapid and accurate.

Complete Illustrated Catalog "The Spline Milling Machine," mailed on request

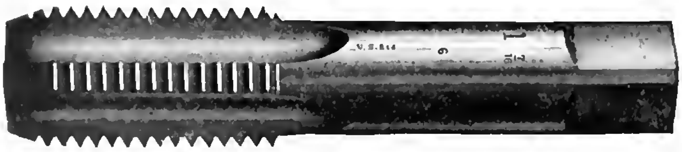


The P. & W. Spline Milling Machine

MACHINISTS' SMALL

Taps, Dies, Die Stock Sets, Solid and Adjustable
Renshaw Ratchets, High Speed Drills, Boiler

Write for Small



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OFFICES—**New York, 111 Broadway.** Boston, Oliver Bldg. Philadelphia, **21st and Callowhill Sts.** **Pittsburgh, Pa., Frick Bldg.** **Chicago, Commercial** National Bank Bldg. St. Louis, Mo., 516 No. 3d St. Birmingham, Ala., Brown-Marx Bldg. Agents for Canada, The Canadian Fairbanks Co., Ltd. Montreal, St. John, Toronto, Winnipeg, Calgary and Vancouver. London, E. C., Buck & Hickman, Ltd., 2 and 4 Whitechapel Road

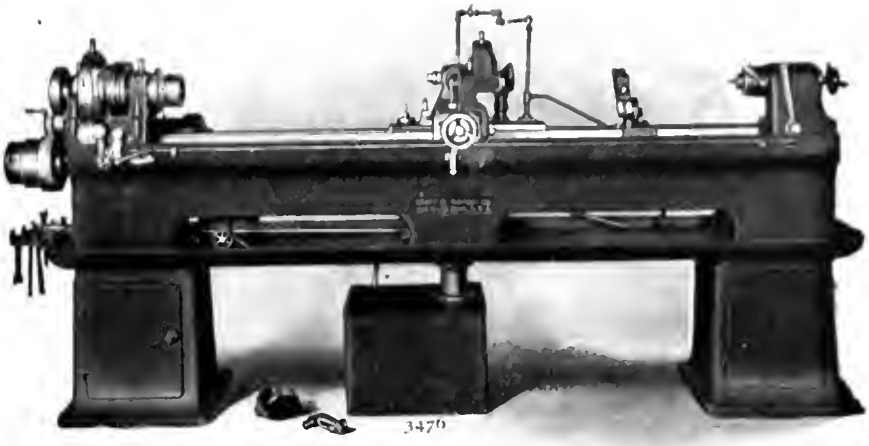
MILLING THREADS

is the modern way insuring greatest accuracy as well as increased output.

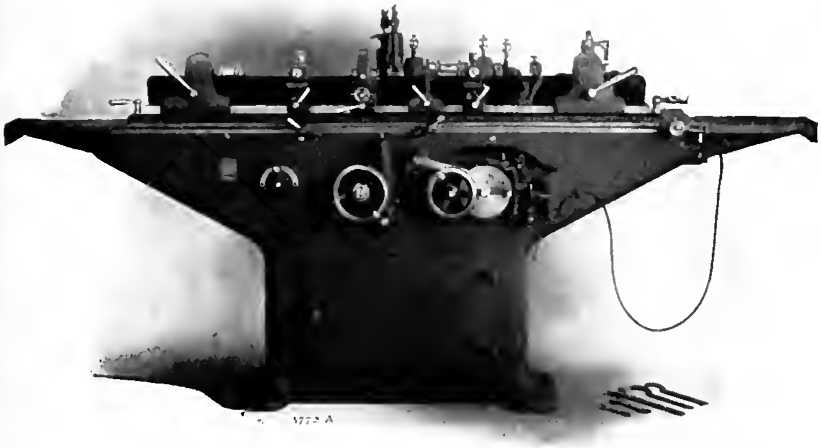
Soft or hard spots in the stock are not torn or chipped.

For screws, spiral gears, worms, flexible shafts, etc., the lathe cannot compete in accuracy, finish or output.

Write for Catalog "Thread Milling Machines"



6x80 Inch P. & W. Thread Milling Machine Built in 6 Sizes



The 5x48 P. & W. Automatic Sizing Grinder

AUTOMATIC GRINDING TO WITHIN .0001 INCH

Removing the last thousandth, usually the most expensive part of a grinding operation, is done on the P. & W. Automatic Sizing Grinder at practically no cost.

The heavy coarse feed is automatically changed to a fine feed and work is quickly ground with a fine finish to exact size without calipering.

Machine measures faster and more accurately than any man can do it.

Wear of emery wheel has no effect whatever.

Write for Illustrated Circular.

The Open Turret

Solid backing for tools as well as a solid seat.

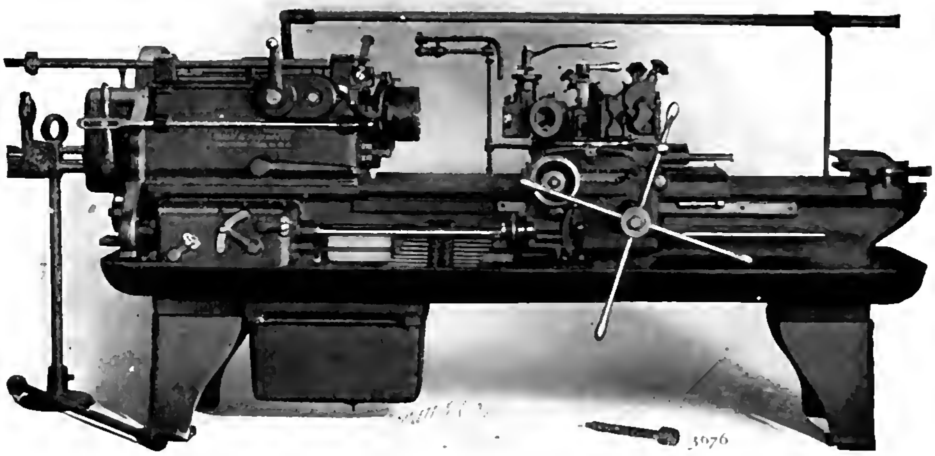
30% heavier than any turret lathe of its size.

Cross sliding turret with a broad base and narrow guide.

Stationary head stock, most practical and convenient for either belt or motor drive.

Positive turret binder.

Write for Catalog "The Open Turret Lathe."

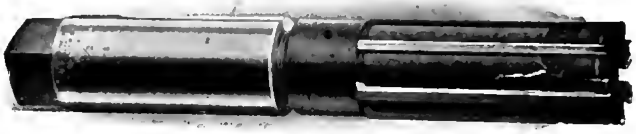


2½x26 P. & W. Open Turret Lathe—Cross Sliding Turret

TOOLS AND GAUGES

Reamers, Solid and Inserted Blade Milling Cutters, Punches Taper Pins, Slitting Saws, Flue Beaders.

Tool Catalog.

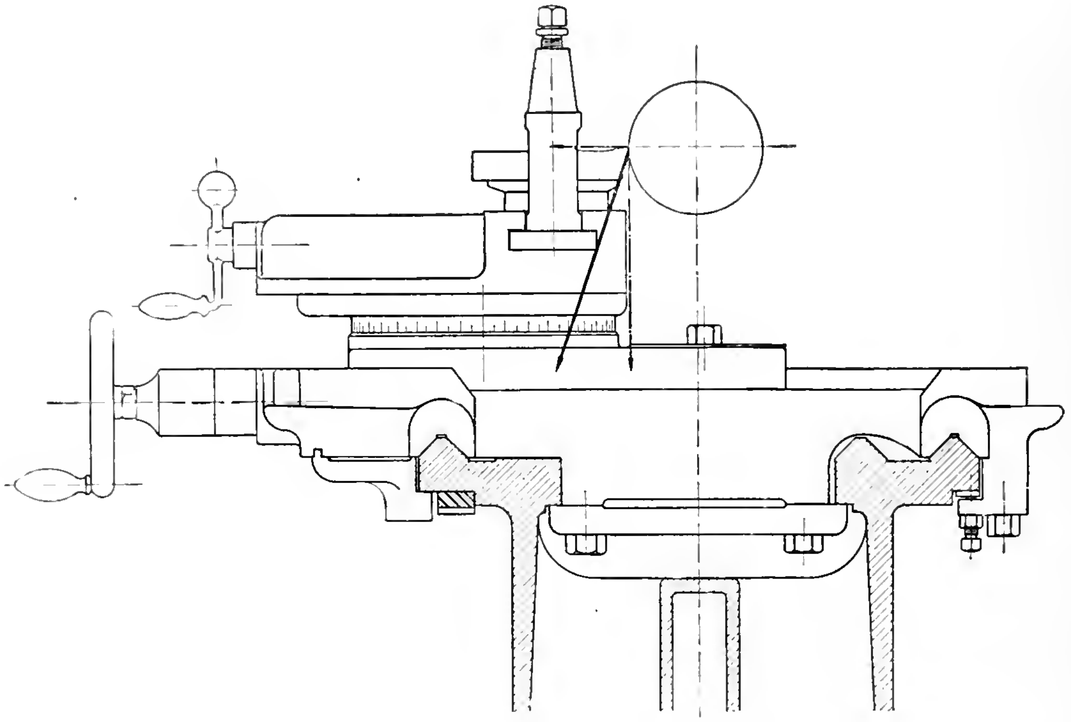


Hartford, Connecticut, U. S. A.

London, S. W., Niles-Bement-Pond Co., 23-25 Victoria St. Paris, Fenwick Freres & Co., 8 Rue de Rocroy, Agents for France, Belgium and Switzerland. Japan, F. W. Horne, 70-C Yokohama. Italy, Ing. Ercole Vaghi, Milan. Germany, F. G. Kretschmer & Co., Frankfurt, a. M. Van Rietschoten & Houwens, West Zeedijk 554 Rotterdam, Holland.

Tool Thrust

A LIGHT bridge will answer for light cuts on large diameters with the tool point directly above the front shear. But stresses are of a different sort when the lathe is under heavy cut on a small diameter.



The illustration shows the position of tool and compound rest on the 24" Patent Head Lathe when taking a 15 H.P. cut on work of 5" diameter. Heavy arrow indicates direction of pressure due to cut. Note the large bearing against the top and inside of bed directly in line with the tool thrust, in addition to the full length bearings of carriage upon front and rear V's. This extra bearing gives a solid support to the bridge just where it is needed, and positively prevents deflection or distortion even under the heaviest cuts.

The Lodge & Shipley Machine Tool Co.

CINCINNATI, OHIO, U. S. A.

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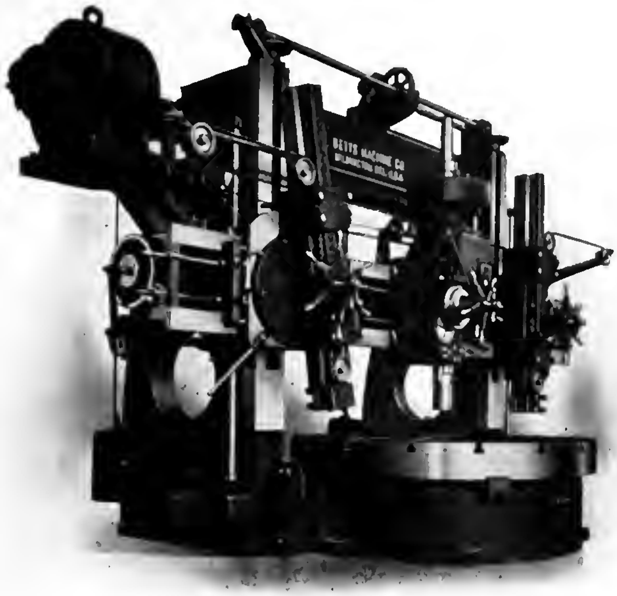


The BETTS 8-foot Boring Mill arranged with Motor Driven Central Boring Head for The Frick Company. Waynesboro, Pa.

Vertical Boring Mills

in sizes from

5-feet to 20-feet Swing

EXTENSION MILLS, TIRE MILLS, DOUBLE DRIVE MILLS

Horizontal Boring Machines

Usual Sizes

FLOOR BORERS, CHORD BORERS

BETTS MACHINE CO.

Wilmington, Del., U. S. A.

MAKERS OF

Heavy Machine Tools

For High Speed Steel

Slotting Machines

in sizes from

8-inch to 26-inch Stroke

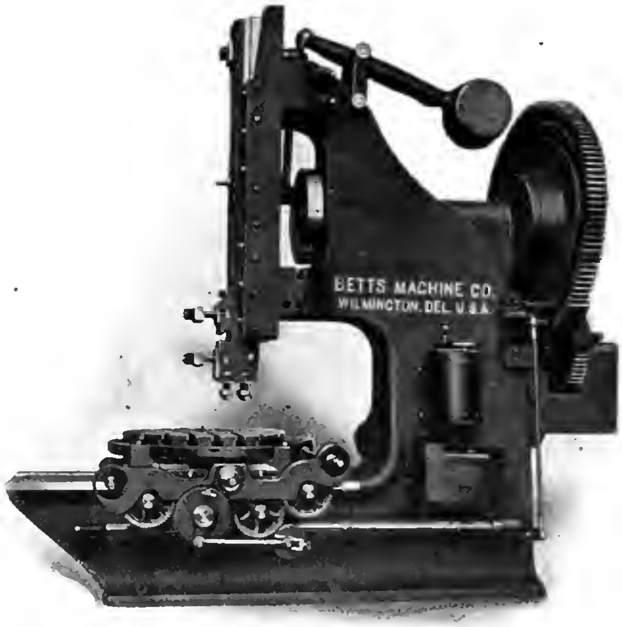
Planing Machines

in sizes from

36-in. sq. to 144-in. sq.

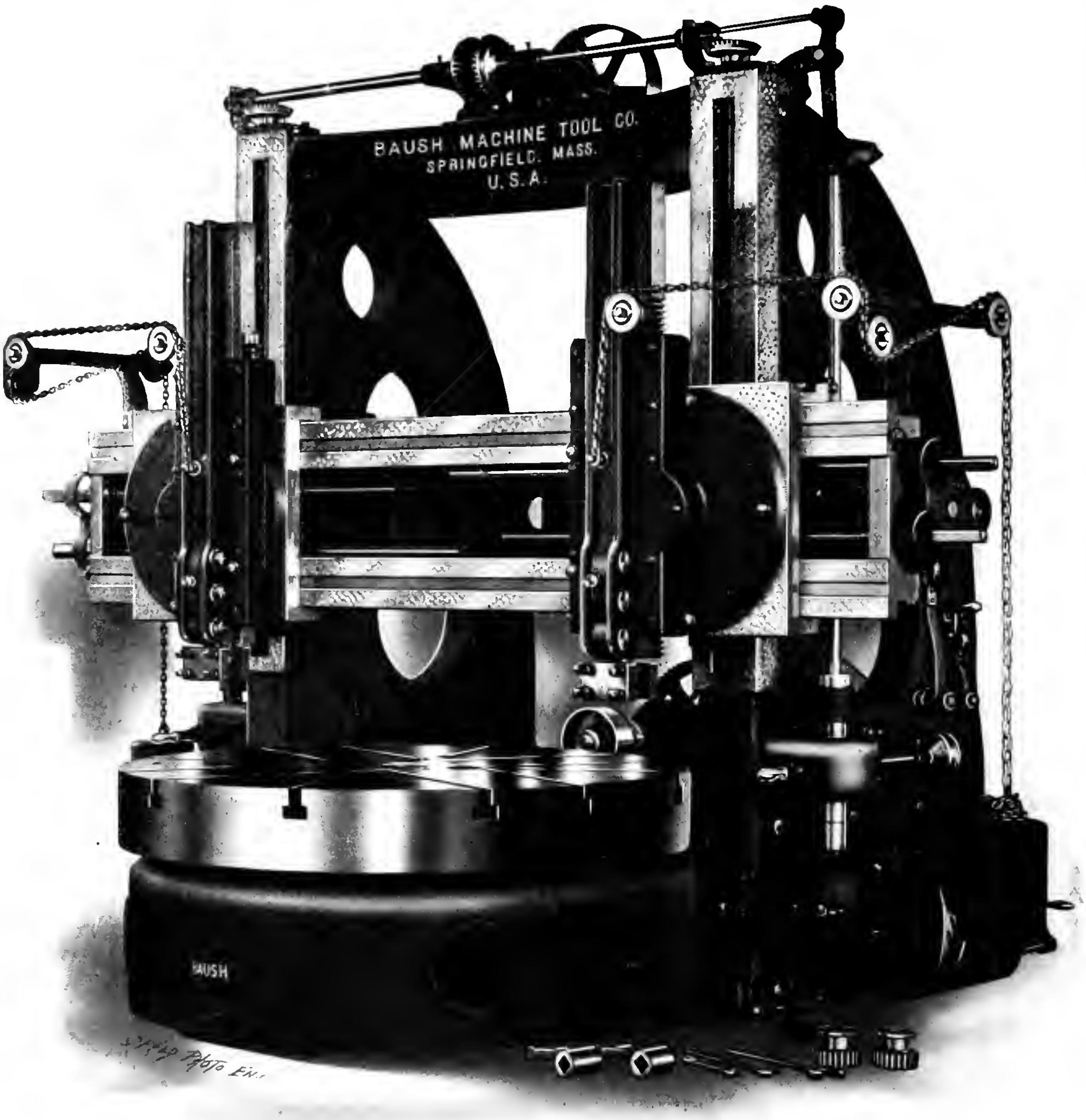
Any Length

STEEL GEARS, PNEUMATIC DRIVE



The BETTS 15-inch Slotting Machine, front view, as arranged with Motor Drive for the Cananea, Yaqui River & Pacific Railroad, Sonora, Mexico.

Baush Rapid Production Boring Mills



61-inch Boring and Turning Mill with Power Rapid Traverse.

Not only can a larger daily output be secured with Baush Machines, but the accuracy of work produced is above question. The latest improved features are incorporated in their design, they have ample power for any line of work, broad table bearings with automatic oiling device, and wide range of speeds.

Sizes 30" to 61". Special circulars on request.

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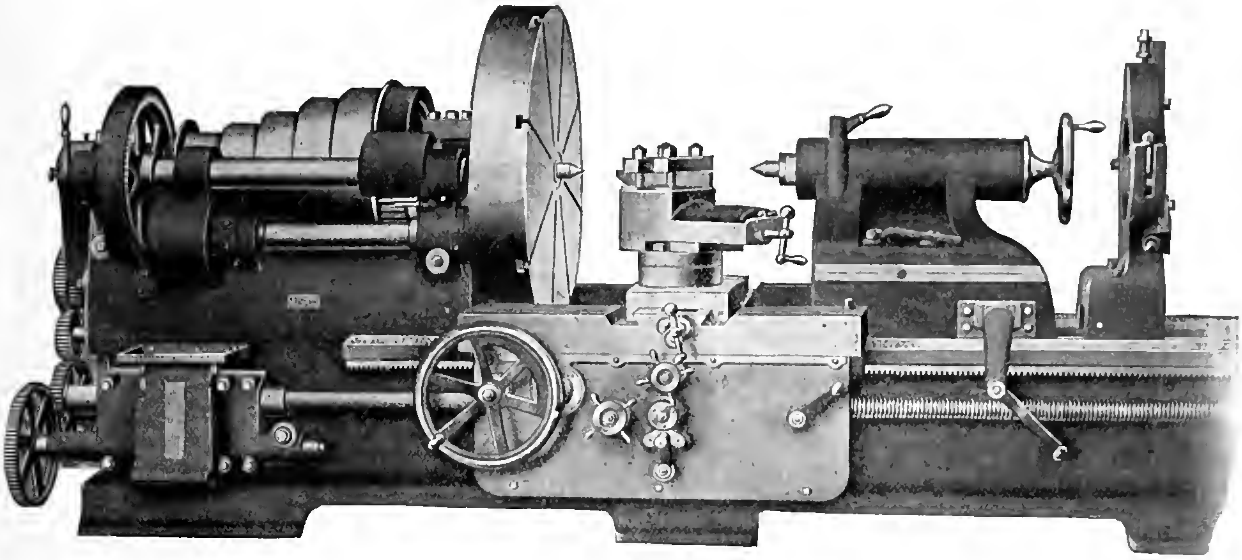
High Speed Steels and Modern Methods

put such a strain on metal working machine tools that only those of the strongest and most rigid design will meet the demands made upon them.



The Bradford 42-inch Lathe

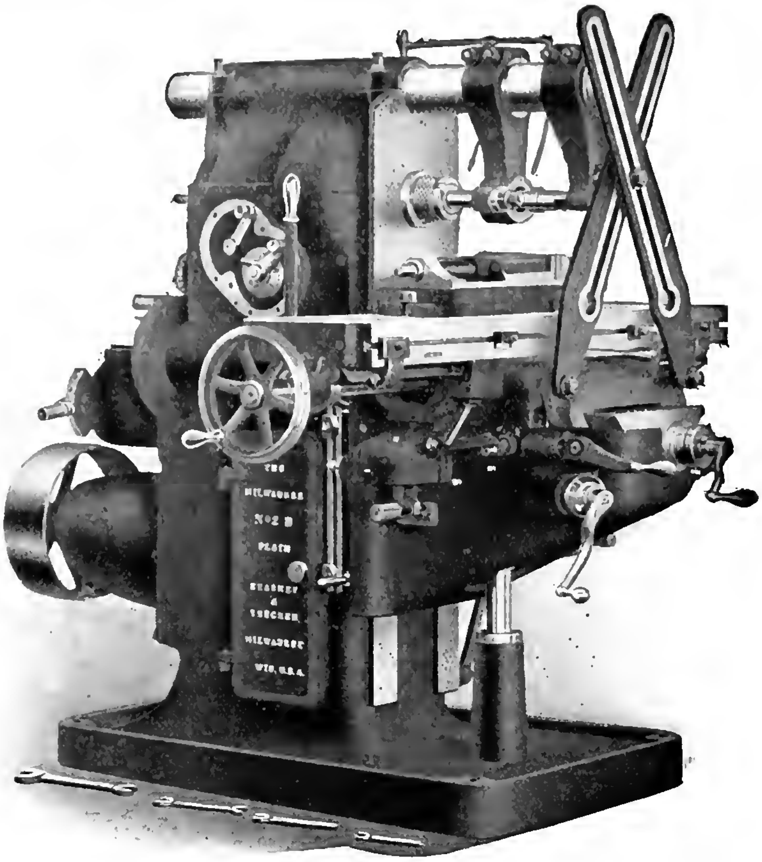
shows strength and power in every line and is adapted for the heaviest classes of work. It is triple geared with feed through a splined screw, with non-interfering reverse in the apron, and three rapid changes without removal of a gear. The spindle has 15 speeds, progressing in geometrical ratio; thread cutting range is from ½ to 24 per inch. All gears are machine cut and small gears and pinions are cut from bar steel. It is easily operated, fitted with every time and labor saving attachment and will give long, continuous service.

Write for the Bradford Catalogue. Lathes from 14 to 42-inch, inclusive.

The Bradford Machine Tool Company

CINCINNATI, OHIO, U. S. A.

AGENTS—Vandyck Churchill Co., New York and Philadelphia. The H. A. Stocker Machinery Co., Chicago, Ill. J. W. Wright & Co., St. Louis, Mo. Somers, Fitler & Todd Co., Pittsburgh, Pa. Pacific Tool and Supply Co., San Francisco, Cal. F. W. Horne, Yokohama, Agent for Japan, China and the Far East. Chas. Churchill & Co., Ltd., London, Birmingham, Glasgow, Newcastle-on-Tyne. Schuchardt & Schutte, Berlin, Vienna, Stockholm, Copenhagen, Budapest and St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona.



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Milling Equipment
if your machines
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name plate.

MILWAUKEE MILLERS

have the advantages of simplicity, power, strength and capacity. They are equipped to turn out the work at the least possible cost and at the same time secure high grade product. The drive is through a single pulley without countershaft or overhead belts. Automatic forced lubrication of all gears and bearings reduces friction and wear to the minimum. Every machine is provided with pump for cooling and lubricating the cutters, and arrangements are made for return of the oil to the reservoir in the base of the machine. All adjusting and feed screws have ball thrust collars. Machines have extra wide tables, run noiselessly and smoothly and are adapted for hard, continuous service.

Plain and Universal Machines, Belt or Motor Driven

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We carry a stock of high grade machine tools and shall be glad to demonstrate any of them, or to answer any questions on the machine tool subject. You can bank on the quality of our line of tools—you can rely on information from our selling force.

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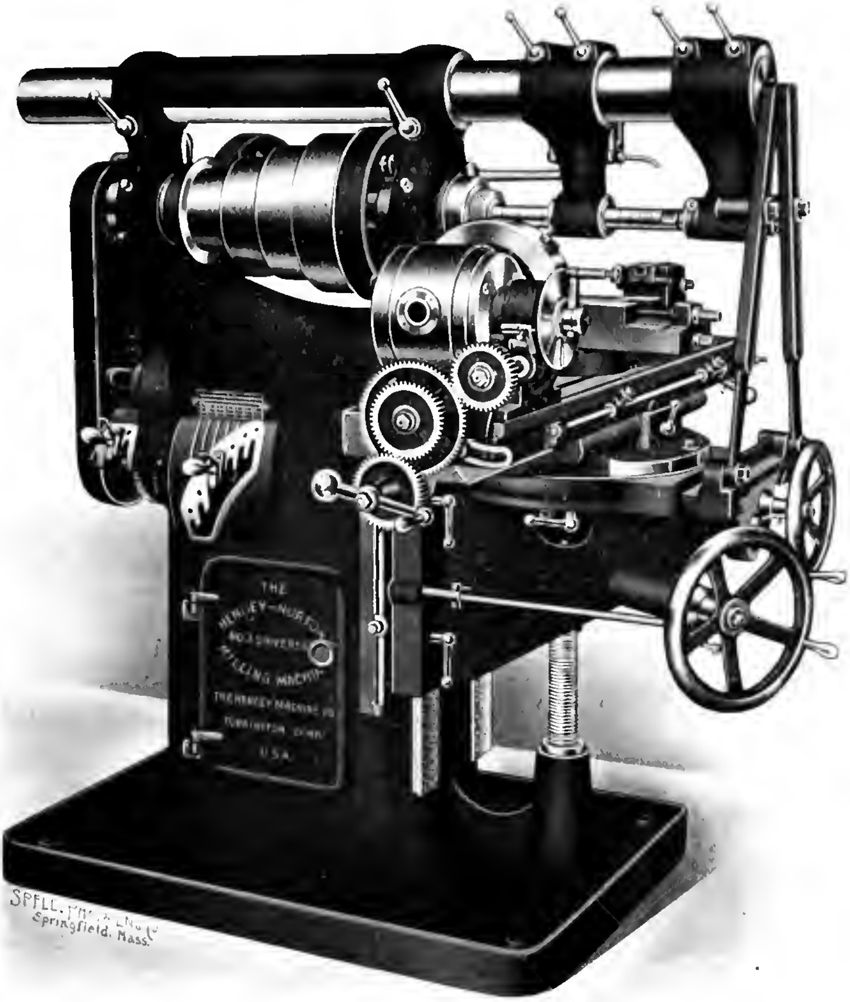
HENDEY No. 3 UNIVERSAL MILLER



Bearings for spindle are annular in form. Journals of spindle are tapered. Efficient lubrication is maintained by ring oilers for both bearings. Front bearing 5½″ long with taper diameter of 3⅝″ to 2⅞″.

Automatic Feeds to table, saddle and knee. 21 changes of feed, driven through heavy roller chain.

Working surface of table 48¾″ x 11″,

Range of feeds 30″ x 10″ x 19″.

Ball bearing thrusts to telescopic knee and table feed screws.

Knee is rigidly reinforced and has projected bearing on column.

Dividing head travels through an arc of 216 degrees. Has tool steel worm which runs in oil. Divisions of head are tested for accuracy on an 8″ diameter plate.

Swivel vise is quick acting with cam binder in base operated from front of vise and can be loosened and rotated without disturbing base binding bolts.

Each machine furnished complete with two speed friction pulley countershaft, wrenches, arbor and draw-in bolt, dividing head and foot stock centers, with raising block, center rest, universal chuck with extra plate, change gears, index plates for head, swivel vise, guard for nose of spindle, bushings in pendant for arbor, and instruction cards.

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RESULTS—NOT TALK

THE "AMERICAN" WAY

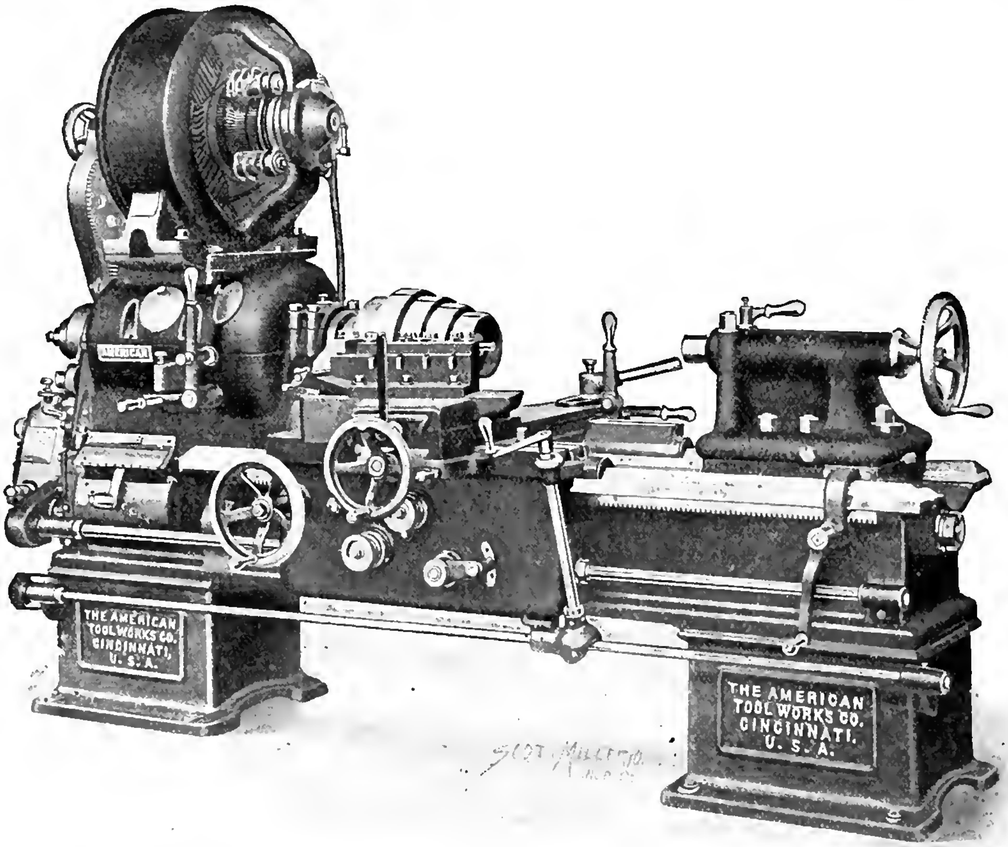
The 24-inch American Geared Head Lathe, shown below, equipped with Multiple Tool Rest and Crowning Device, is possessed of such ENORMOUS POWER that all steps of the cone pulley, being worked upon, are ROUGHED—FACED—CROWNED—FINISHED, consecutively, at ONE SETTING OF THE TOOL, resulting in the following remarkable reduction of shop cost on the job.

**OLD TIME
160 Min.**

This Great Power is Worth Much to You

THINK IT OVER

**NEW TIME
38 Min.**



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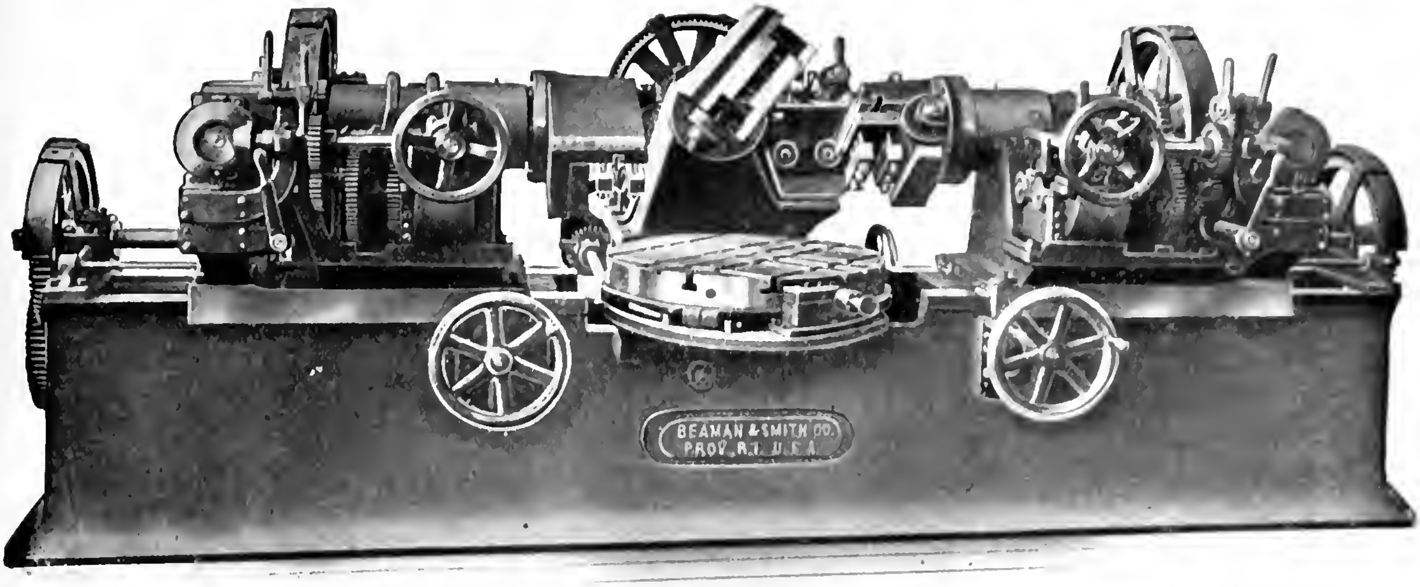
CINCINNATI, U.S.A.

LATHES-PLANERS-SHAPERS-RADIAL DRILLS.



No. 3 THREE-WAY FACING MACHINE WITH REVOLVING TABLE.

When you are in the market for a Boring or Milling Machine or a metal working tool to meet some unusual requirement, write us, we make a specialty of machines of this character.

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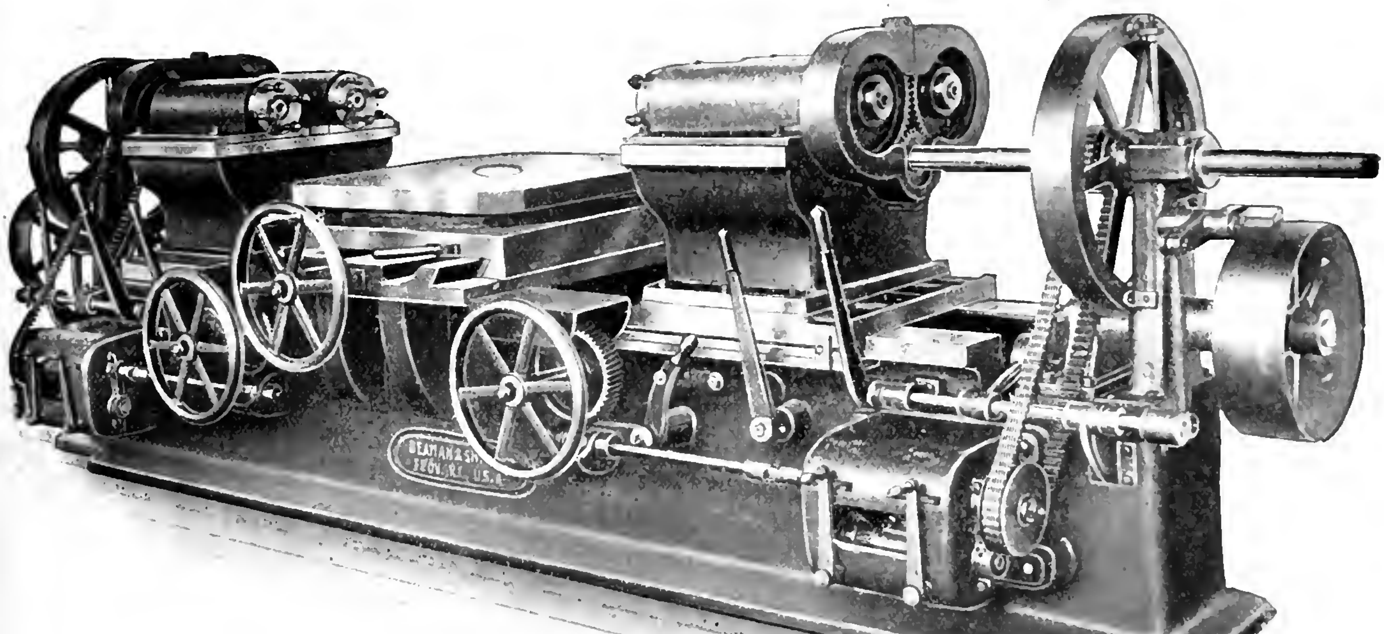
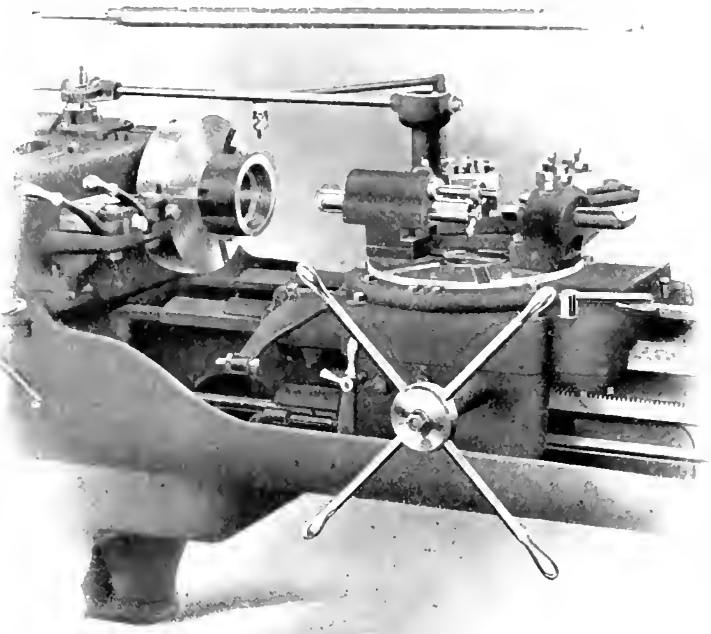
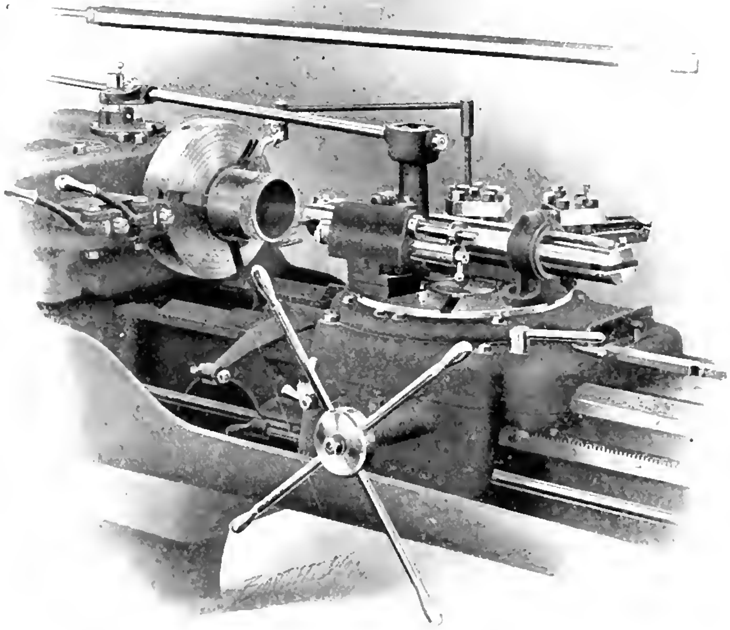
AGENTS: Ludw. Loewe & Co., Berlin. Fenwick Freres & Co., Paris. Chas. Churchill & Co., London.



FOUR SPINDLE CYLINDER BORING MACHINE.
Revolving table 3 ft. square, four indexed positions. Cross adjustment of 10 inches by hand. A strong and effective tool.
Primarily intended for Automobile Cylinders, whether cast single or in pairs, and any center distance.

Thread Chasing on the





Our thread chasing device provides a means for producing accurate screw threads on chuck work that excels anything known to the art.

The only plea that can be made for continuance of the old methods must be made to our inborn tendency to stick to old methods, even though they were designed for conditions that have passed away.

The old scheme of chasing a screw thread by moving the entire carriage by a complicated system of gears and a long, or even a short lead screw, belongs to the engine lathe, and was intended to cut all

Springfield, Vermont,
U. S. A.

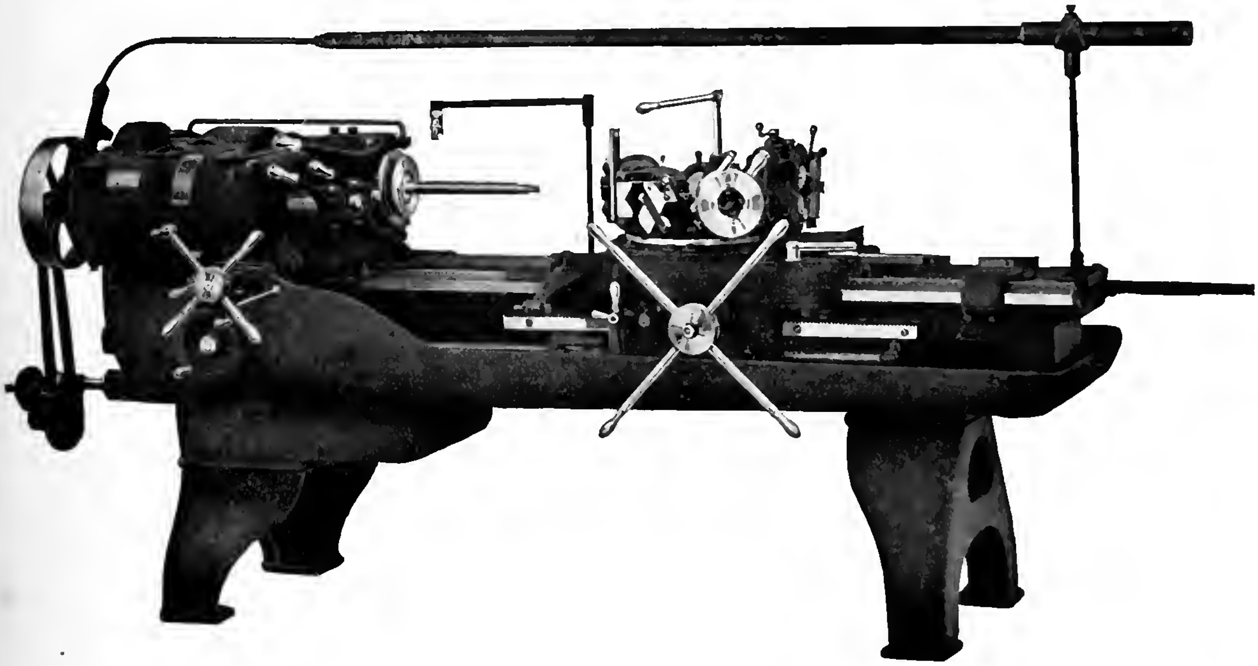
JONES & LAMSON

Germany, Holland, Belgium, Switzerland, Austria-Hungary, M Koyemann, Charlottenstrasse 112, Dusseldorf, Germany.

FLAT TURRET LATHE

kinds of screws, from long screws to short; whereas the present chucking machines are only required to chase short threads, seldom over four or five inches long.

There is no reason for sticking to the old method which is too slow, and as every one knows, is unreliable in the control of the tool. Every machinist knows that the first and last threads of a screw are "large." That means that they must be turned off after the screw has been chased, and it also proves that the scheme is unreliable in control of the threading tool, which is liable to dodge away from a hard spot in the work; and last but not least, the thread chasing attachment of our machine is the most rapid as well as the most reliable in control of tool.



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London, England

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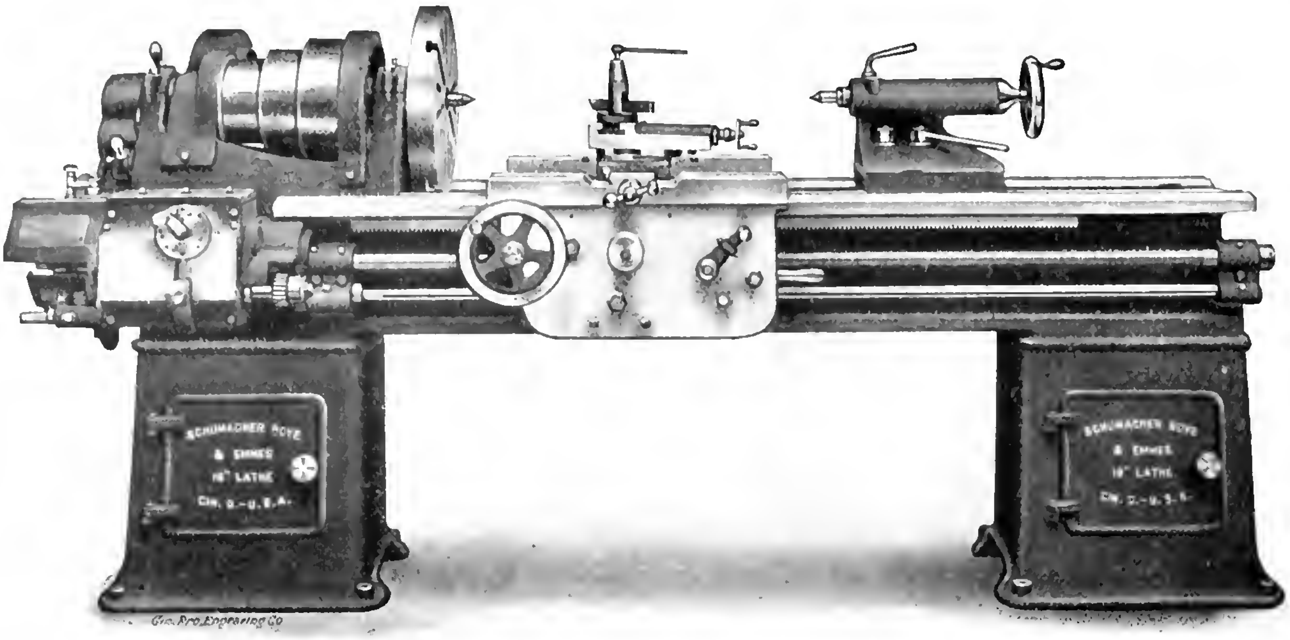

Eighteen-inch Double Back Geared Instantaneous Change Gear Engine Lathe

SCHUMACHER & BOYE

ENGINE LATHES
18" TO 48" SWING

CINCINNATI, OHIO, U. S. A.

DOMESTIC AGENTS—Manning, Maxwell & Moore, New York City, Chicago, Boston, Syracuse, St. Louis, Atlanta, Philadelphia. The Baird Machinery Co., Pittsburg, Pa. The Strong, Carlisle & Hammond Co., Cleveland, Ohio, and Detroit, Mich. Henshaw, Bulkley & Co., San Francisco, Cal. The Pacific Coast Mfg. Co., Los Angeles, Cal. The Perine Machinery Co., Seattle, Wash. F. W. Cook, Spokane, Wash. Kellogg & Co., Toronto, Ont.

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CLEVELAND, OHIO, U. S. A.

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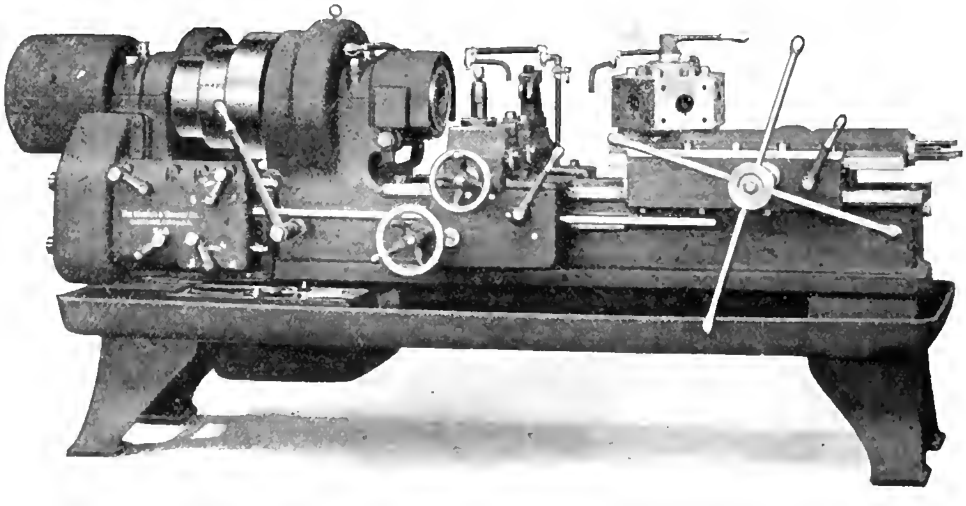
Warner & Swasey Turret Lathes embody the experience of more than twenty-five years in designing and manufacturing high grade machine tools.

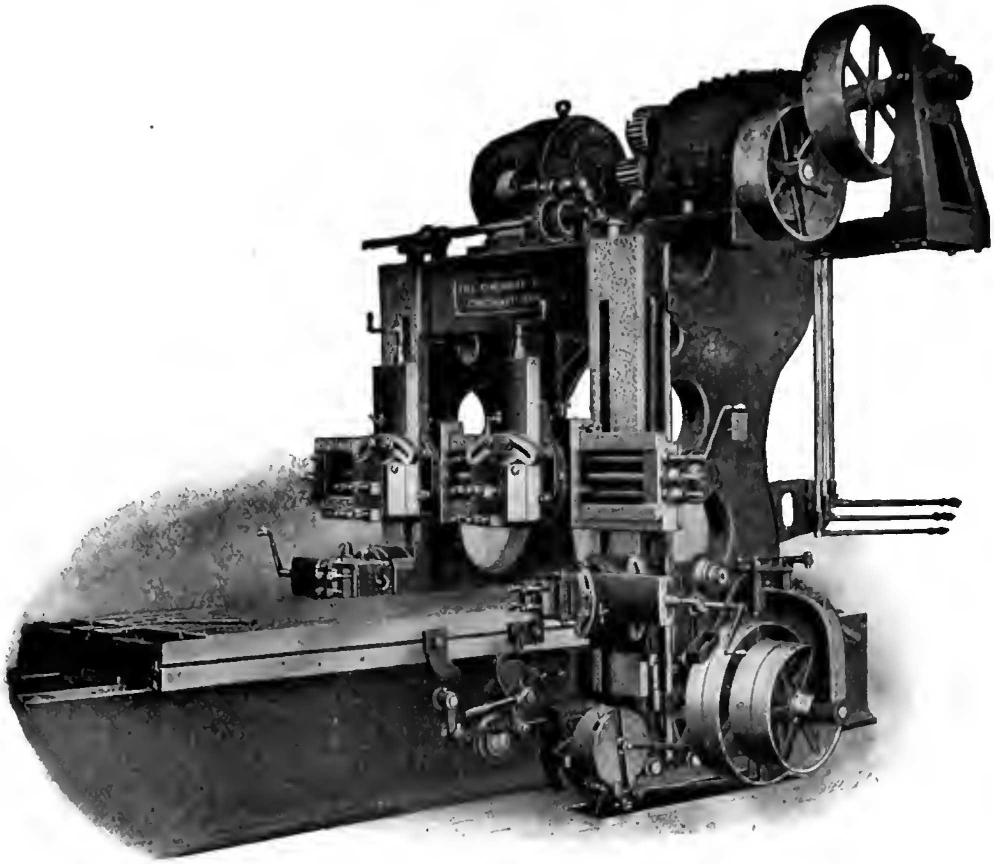
Complete catalog sent on request.



No. 8 TURRET SCREW MACHINE. SWING 20"—AUTOMATIC CHUCK CAPACITY 3⅝" DIAMETER.

TURRET LATHES

MANY SIZES
AND STYLES



The Simplicity of the

Cincinnati Variable Speed Planer

is only Second to its Increased Efficiency

The variable speed drive consists of a speed box mounted at the top of the housings. It is completely enclosed, holds several gallons of oil, and as all gears and driving hubs are submerged in oil they run noiselessly and with very little wear. The bearings are also automatically lubricated so the speed box requires almost no attention. Speed changes are made by simply moving the levers at the side of machine, indexes being provided to show various speeds—no two speeds can be engaged at the same time.

THE CINCINNATI VARIABLE SPEED PLANER with a range of speeds from 15' to 50' per minute—constant return—permits planing at the exact and proper speed to suit the metal or the character of the work, has strength and rigidity for the heaviest cuts, and assures an every day saving of from 30 to 50 per cent. on operating costs and a very considerable reduction in maintenance expenses.

Write us for full description.

The Cincinnati Planer Co., Cincinnati, O., U.S.A.

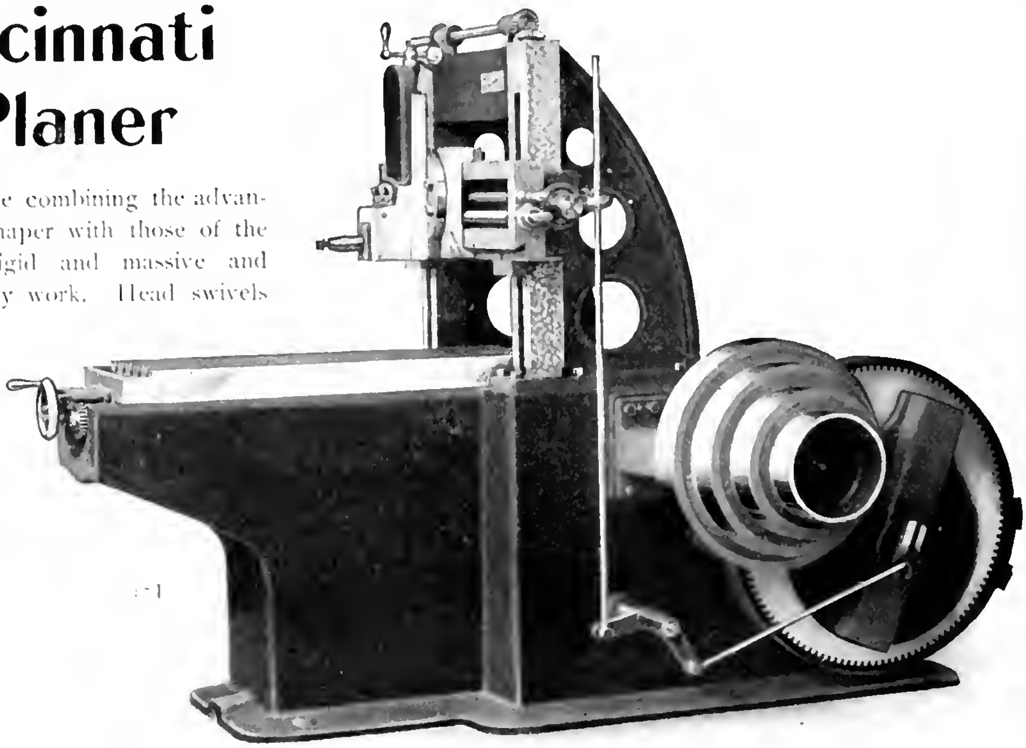
DOMESTIC AGENTS—Prentiss Tool & Supply Co., New York, Syracuse, Boston and Buffalo. Marshall & Huschart Mchy. Co., Chicago, St. Louis and Indianapolis. Motch & Merryweather Mchy. Co., Cleveland, Cincinnati and Detroit. W. E. Shipley Mchy. Co., Philadelphia, Pa. Baird Mchy. Co., Pittsburg, Pa. Harron, Rickard & McCone, San Francisco and Los Angeles, Cal. Hallidie Mchy. Co., Seattle and Spokane. Robinson, Cary & Sands Co., St. Paul and Duluth. Zimmerman, Wells, Brown Co., Portland, Oregon. Utah Mining Mchy. & Supply Co., Salt Lake City. M. E. Dewstoe, Birmingham, Ala. Morrison Mchy. & Supply Co., Richmond, Va.

FOREIGN AGENTS—Ludw. Loewe & Co., Berlin and Paris. R. S. Stokvis & Zonen, Rotterdam, Holland and Brussels, Belgium. J. Lambercier & Co., Geneva, Switzerland. Ing. Ercole Vaghi, Milan. E. H. Hunter & Co., Osaka, Japan. Thos. McPherson & Son, Melbourne, Australia.

The Cincinnati Crank Planer

A high grade machine combining the advantages of the crank shaper with those of the standard planer. Rigid and massive and capable of very heavy work. Head swivels each side of vertical for angular planing. Stroke adjusted by conveniently placed crank wrench and hand wheel. Feeds operated automatically by power or by hand. Dimensions 20" x 20" x 24".

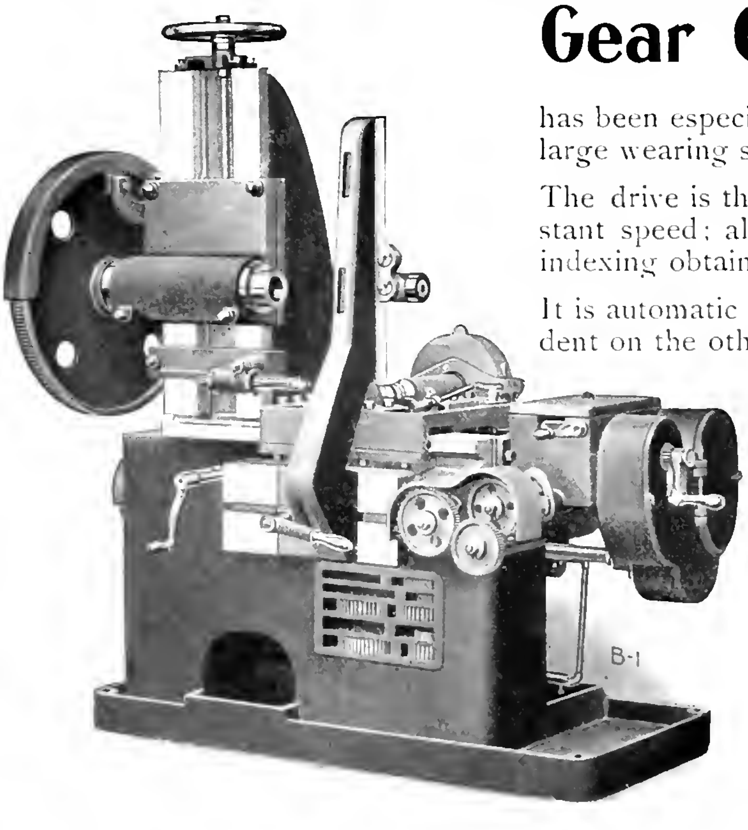
Ask us for the details.



THE CINCINNATI SHAPER CO., Cincinnati, O., U.S.A.

AGENTS—Manning, Maxwell & Moore, Inc., New York, Philadelphia, Chicago, Boston, St. Louis, Syracuse, Birmingham, Detroit, Milwaukee, Mexico City and Tokio. Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on Tyne, Glasgow. A. H. Schutte, Brussels, Cologne, Bilbao, Paris, Liege, Milan. Schuchardt & Schutte, St. Petersburg, Vienna, Budapest, Berlin, Copenhagen, Stockholm. Thos. McPherson & Son, Melbourne.

The Design of the Cincinnati Automatic Gear Cutting Machine



has been especially directed toward securing rigidity, large wearing surfaces and simplicity of parts.

The drive is through a single pulley running at constant speed; all feed and speed changes, as well as indexing obtained through change gears.

It is automatic in all movements, and as each is dependent on the other, each movement must be completed before another can take place.

A rapid, accurate and economical machine for Spur Gears only.

Write us for particulars.

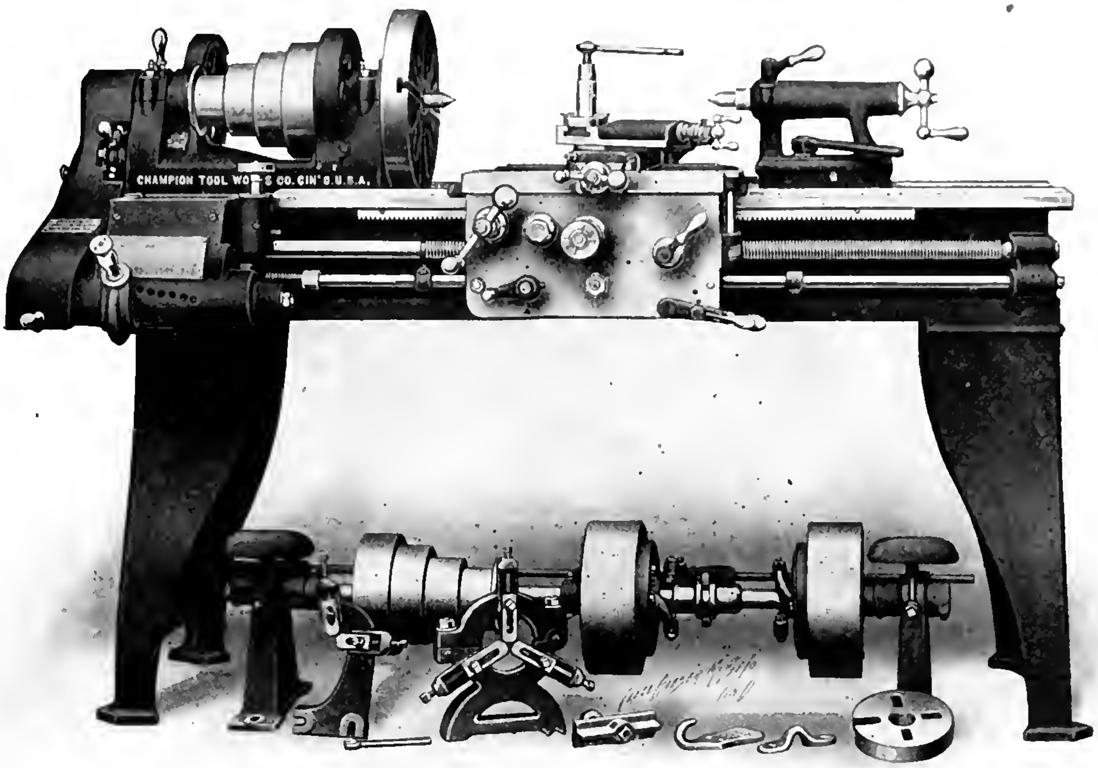
THE CINCINNATI GEAR CUTTING MACHINE CO.

CINCINNATI, O., U.S.A.

Manning, Maxwell and Moore, Inc., New York, Boston, Chicago, Philadelphia, Pittsburgh, St. Louis, Cleveland, Syracuse, Atlanta, Buffalo, Mexico City, Milwaukee and Detroit. Agents.

CHAMPION

12-in. Quick Change Gear Engine Lathe



For factory or tool room purposes is not surpassed, and is of that type of rigid construction which admits of the use of high speed cutting steels. The accuracy of the lathe is of the highest character.

IMPORTANT: There are not a few 10-inch lathes manufactured to swing 12 inches, and some 12-inch lathes to swing 14-15 and 16 inches, but do not get our **Standard 12-inch Lathe,** which swings 13⅛ inches, confounded with these tools, as they may be offered you as 11-12-13-14-15 and 16-inch lathes, when in reality they are only standard 10 and 12 inch lathes.

The Automatic Stop to longitudinal feed on the Champion Quick Change Lathes operates in either direction, and the screw and rod feeds cannot be engaged at the same time. The feed reverses from the apron, and with the **chasing dial** on carriage the operator can catch threads instantly without having to return the carriage by reversing the countershaft or stopping the lathe.

40 changes of feed and threads without the removal of a gear, including 11½ and all standard threads from 2 to 56 per inch. Feeds are 3½ times the threads. All changes made while the lathe is running, and every gear is covered.

Remember the **Champion does it quicker and better.**

Write for our printed descriptions.

5 sizes: 10, 12, 14, 16 and 18-inch Swing.

Champion Tool Works Co.
2422 Spring Grove Ave., CINCINNATI, O., U. S. A.

Ingersoll Flexibility

Our 22 years' experience building Milling Machines exclusively, of all sizes and types, embodying every combination of Spindles, enables us to design machines that are really flexible. Our catalogue will show you that.

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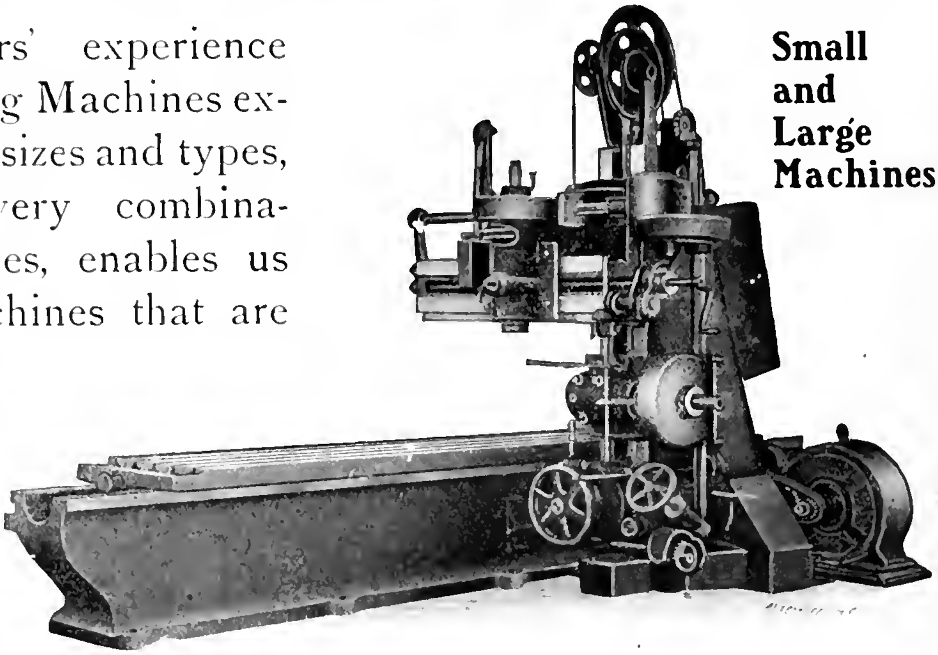
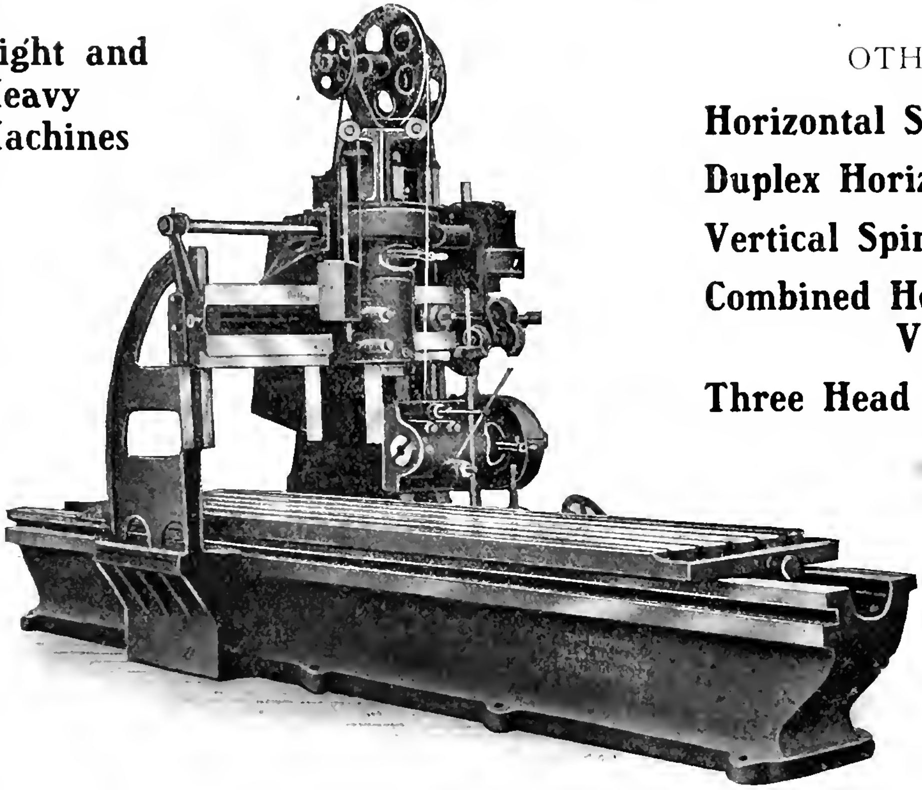


Shows Outer Housing Removed

Light and Heavy Machines



Combined Horizontal and Vertical Spindle Machine with Removable Housing

OTHER TYPES

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FOR EVERY PURPOSE

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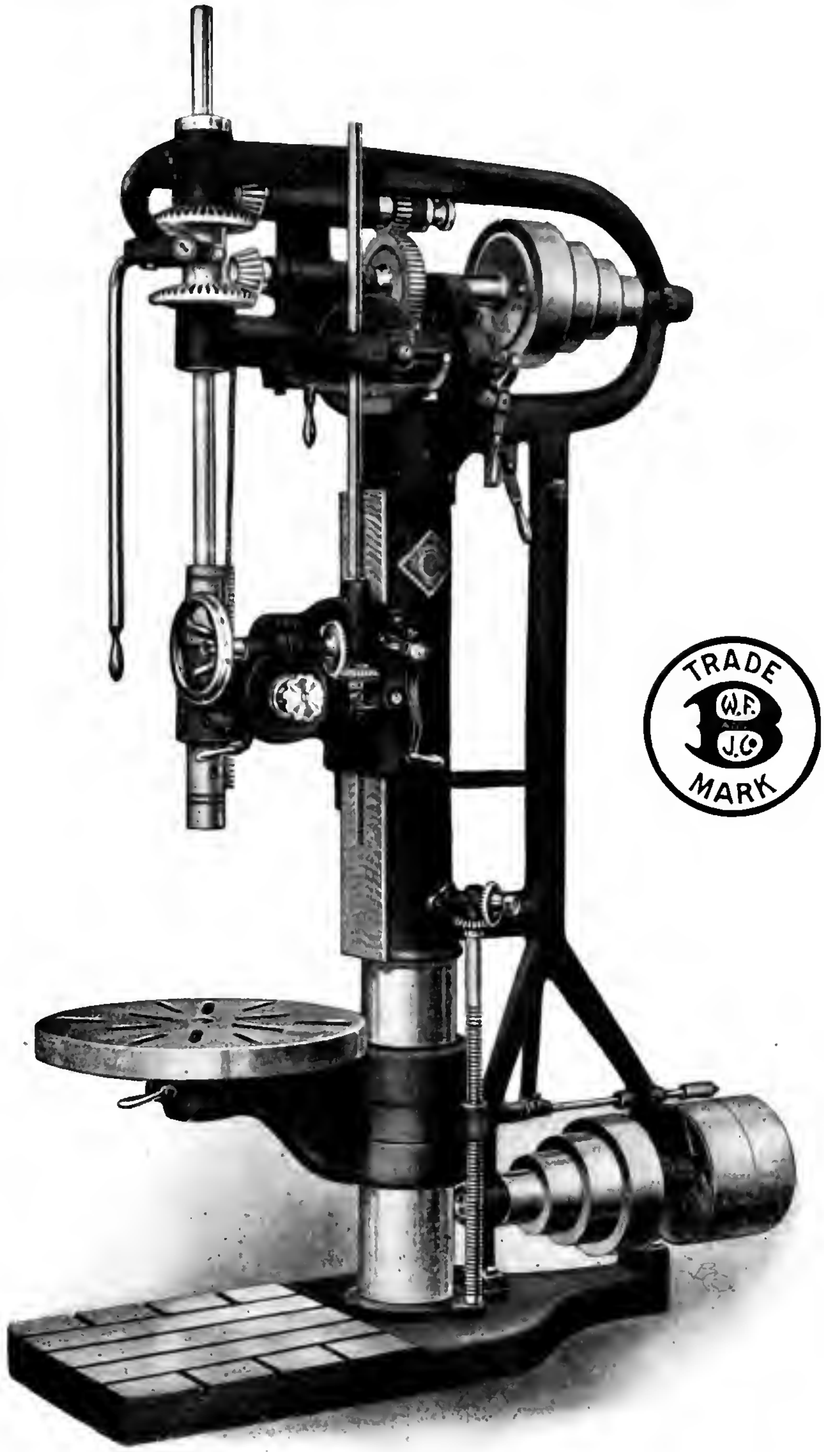

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The "BARNES"

Our Combined Drill and Geared Tapping Attachment—works directly on the spindle; has positive clutch for engaging forward and backward motions and reverses 2 to 1. Long bearings—steel gears and hardened steel clutches. Any of our drills from 22 to 50 inch swing can be furnished with this tapping attachment. Prompt delivery. **Complete line, 8 to 50 inch Swing Drills.**

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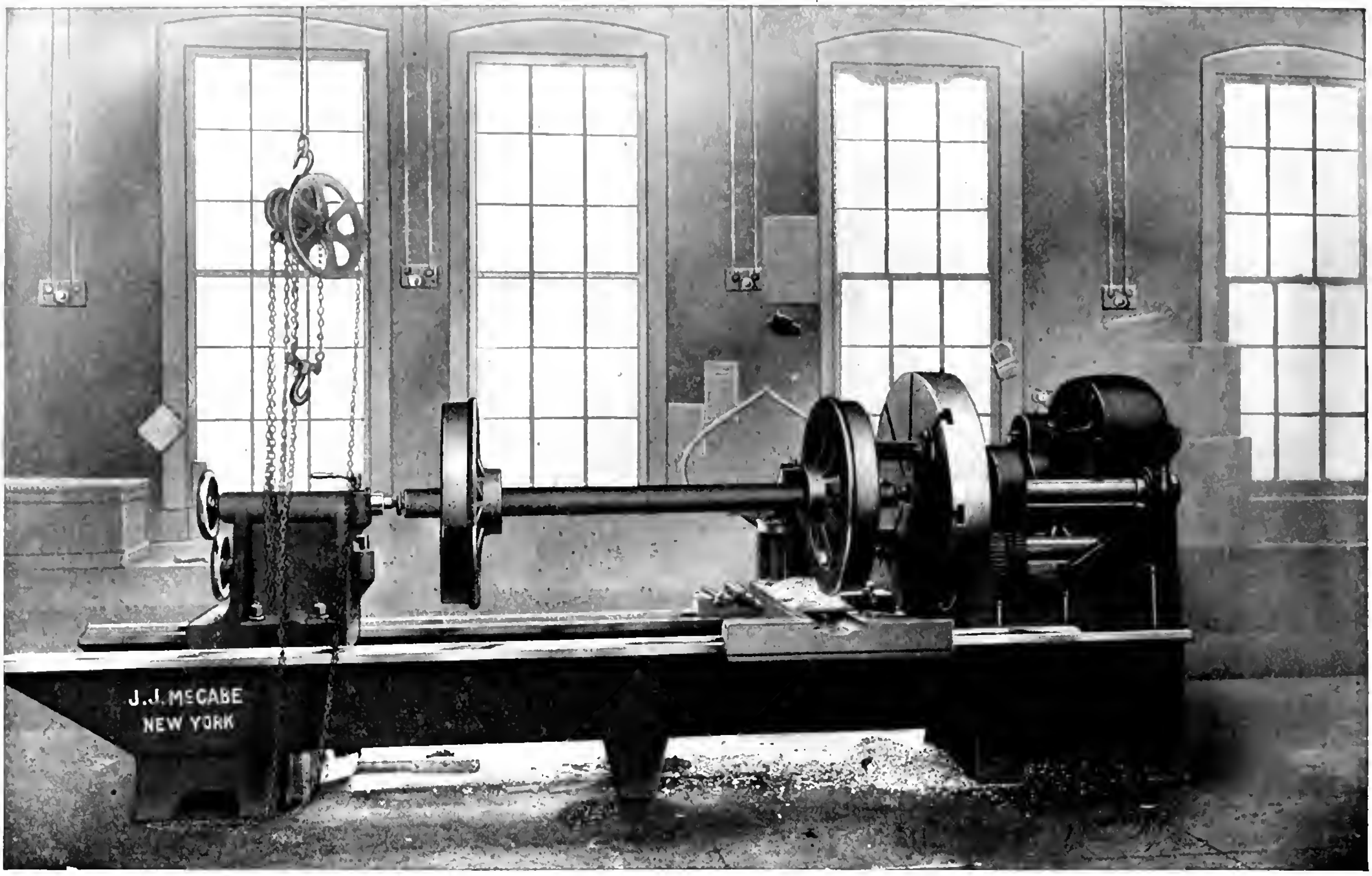

Rear view of Lathe Altoona and Logan Valley R.R. Co. are using, Altoona, Penna. Shops

The Lathe that made Machine and Repair-shops complete

TWO-IN-ONE
TO-DO-EVERYTHING

With the "supplementary Lathe," in addition to the big size, **McCABE'S "2-in-1"** supplants the regular style large Lathe.

When the choice is wholly a question of merit, it is **McCabe's "2-in-1" DOUBLE-SPINDLE LATHE** every time. It will do small work, every time you've nothing big.

When the choice is wholly a question of price, it is **McCabe's "2-in-1" DOUBLE-SPINDLE LATHE** every time.

It is not part a big Lathe, and part a small Lathe. **McCabe's "2-in-1" Lathe** is both.

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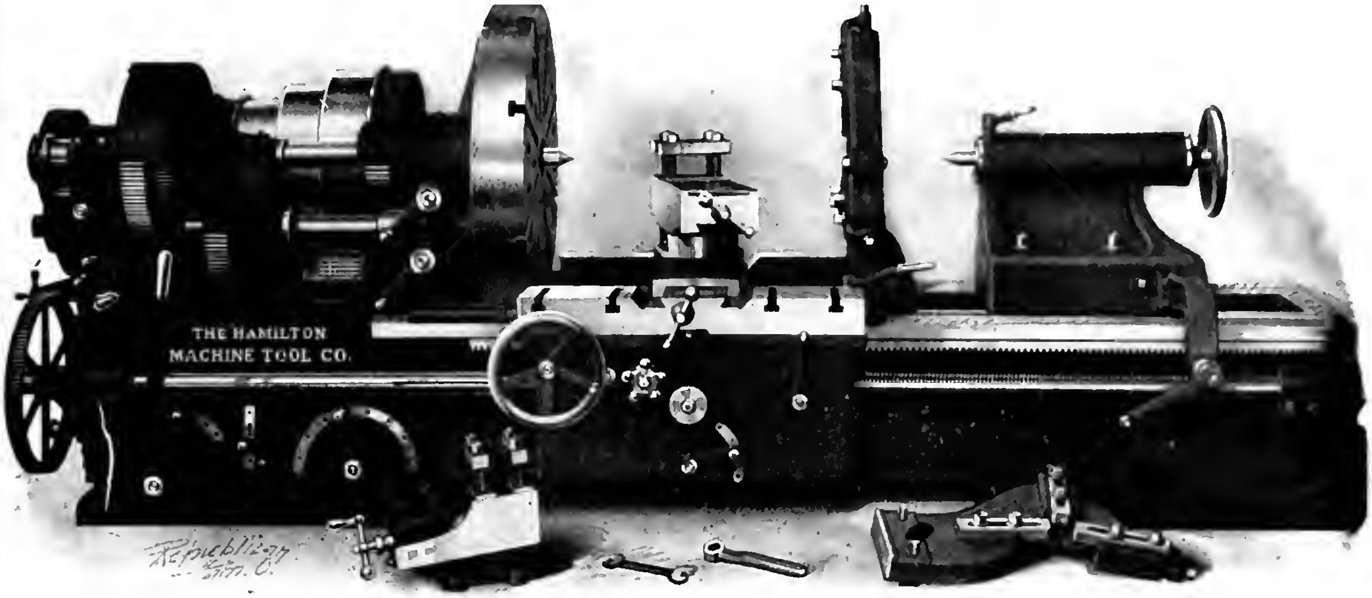
Lathes, Planers, Shapers, Upright and Radial Drills



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LIBERALLY PROPORTIONED.

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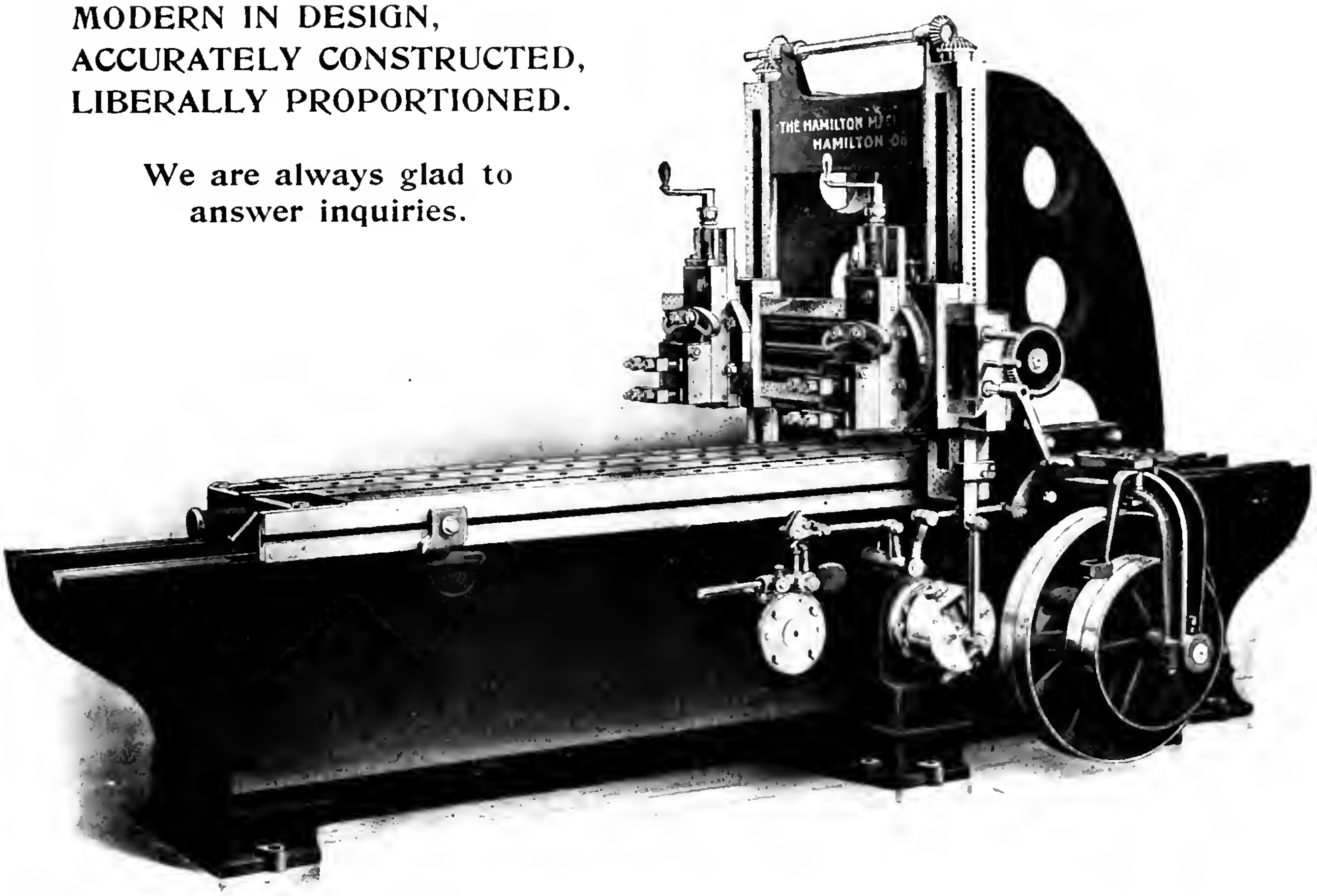

The Hamilton Machine Tool Co., Hamilton, Ohio

CLEVELAND STORE: 202-204 St. Clair Ave., N. E., W. H. Welch, Manager

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METAL DRILLING MACHINERY

THE BICKFORD IMPROVED RADIAL DRILL

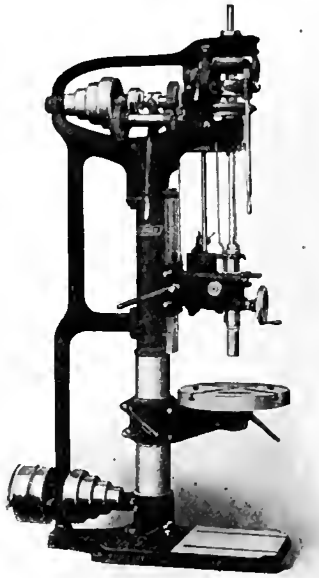
formerly made by

The Bickford Drill and Tool Company

THE CINCINNATI UPRIGHT DRILL

formerly made by

Cincinnati Machine Tool Company



THE CINCINNATI

21" Sliding Head Drill with Patent Geared Tapping Attachment.

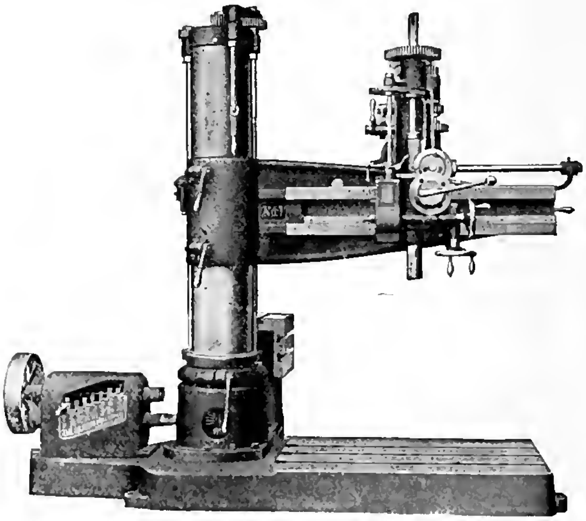
This is the largest and most complete line of UPRIGHT, PLAIN RADIAL, SEMI-RADIAL, HALF and FULL UNIVERSAL RADIAL DRILLS, also MULTIPLE DRILLS, GANG DRILLS and TAPPING MACHINES made in the world.

Bickford Radial Drills are made in six sizes and twenty-four styles, the sizes ranging from 2½' to 6'. These machines are furnished with three styles of drive, cone, gear and motor and with any style of table, such as box, swinging or swiveling.

The design of these machines is simple. They are rigid in construction, easily manipulated, have durability of wearing parts and will produce a volume of output and accuracy of work greater than any other drill on the market.

The Cincinnati line of Upright Drills consists of machines ranging from 20" to 42" and these machines can be furnished in every possible construction used in Upright Drill building. The Patent Geared Tapping Attachment on the Cincinnati Upright Drills is located directly on the spindle and is the most perfect attachment of this kind ever made. It can be completely disengaged when no tapping is to be done.

One feature found on the Cincinnati Upright Drills, and on no others, is an instantaneous stop for the spindle without stopping the machine to make changes of chuck or drills.



The Bickford Improved Radial Drill.

The Cincinnati Bickford Tool Company

Cincinnati, Ohio, U. S. A.

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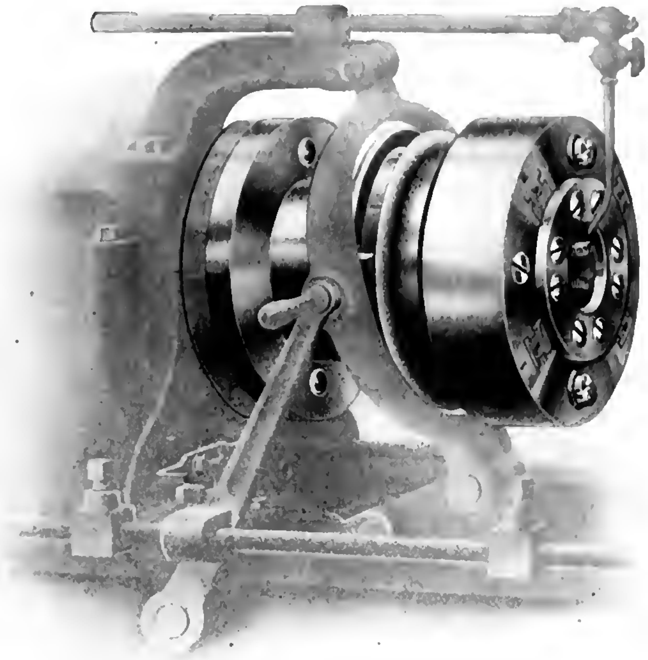
NATIONAL MACHINERY CO
TIFFIN OHIO USA



Tell Us the Ailments of your present Threader!

THE HEAD WITH A "POSITIVE" LOCK.
Used on all National Open Die Bolt Cutters.

Are you bothered with taper end-threads?

Are you compelled to recut off size bolts, and continually "gauge" thread when large lots are cut, and readjust the head to maintain "size"?

And does lost motion in other parts of the machine affect thread accuracy?

In other words, are you securing threads that satisfy your wants and those of your customers on a basis that makes your bolt cutter a paying proposition?

If not, would you be interested in "talking" new bolt cutter or re-equipping your present machine with a new head if it insured 100 per cent. better bolt cutter service than you are now securing?

The National Bolt Cutter

will do that, and give you a larger range in thread cutting besides, and a National Head on your present machine will give you next-best results. **The largest bolt manufacturer in the world is equipping his threaders with the National Head,** and that's one reason why **YOU** should be interested.

If we knew your needs, we could tell you what 'twould cost to secure 100 per cent. bolt cutter efficiency.

THE NATIONAL MACHINERY CO.
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Bulletins No. 10 on Single and No. 20 Multiple Spindle Bolt Cutters will be sent on receipt of your present address.

Sample Key Seats.

Key-seats cut in tool steel milling cutters—fifteen pieces, 3/8 inch thick—job finished in three minutes.

A 2 TO 1 Key-Seater

And by two-to-one we mean that while you are fastening, ready for key-seating, just one piece in your present machine, the

Giant Key-Seater

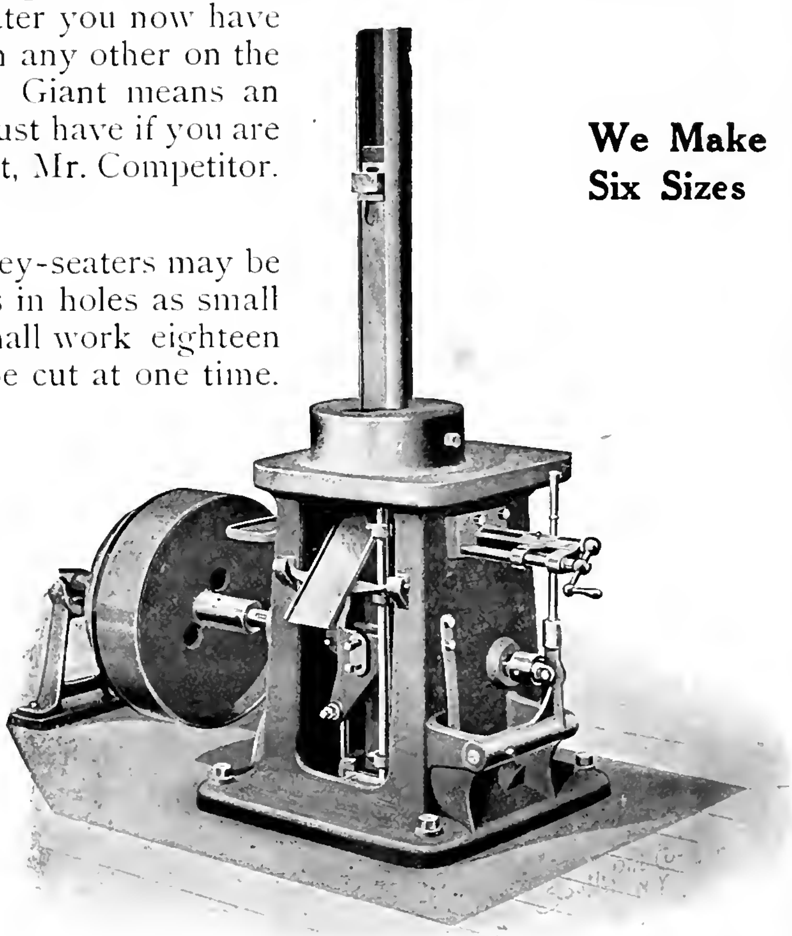
has finished two ordinary key-seats, producing perfectly true, straight key-ways, whether the hole is straight or taper, or the hub faced true, or left rough as it comes from the foundry.

And the "why" is to be found in the grooved post which holds the work and forms a guide for the tool. You won't find this feature on the key-seater you now have—you won't find it on any other on the market. Hence, the Giant means an advantage that you must have if you are going to meet, and beat, Mr. Competitor.

It means profit, too.

On special work our key-seaters may be fitted to cut key-seats in holes as small as ½ inch, and, on small work eighteen or more pieces can be cut at one time.

We Make Six Sizes



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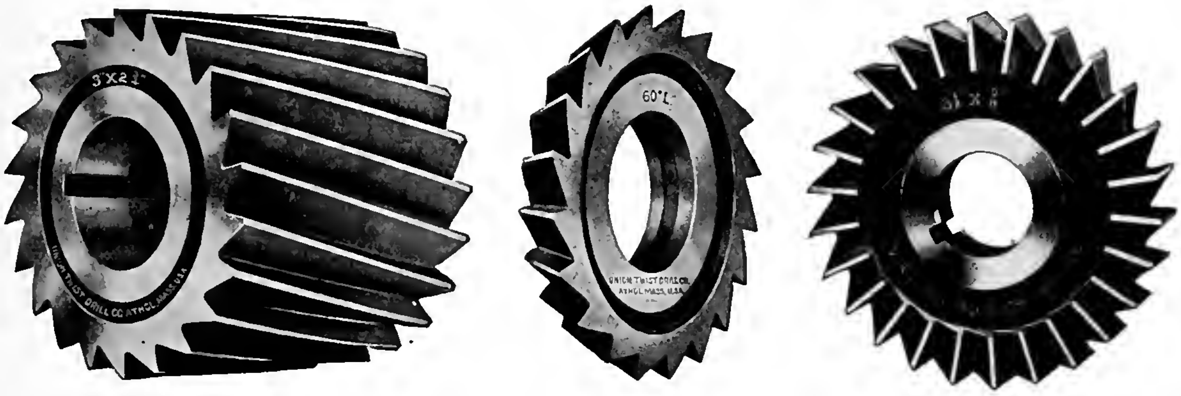
The most expensive cutters, no matter how low their cost, are those which fail to satisfactorily perform the service required of them.

Their failure may be due to several reasons.

We have a thorough knowledge of the reasons, as our experience in the use of cutters as well as their manufacture is very extensive.



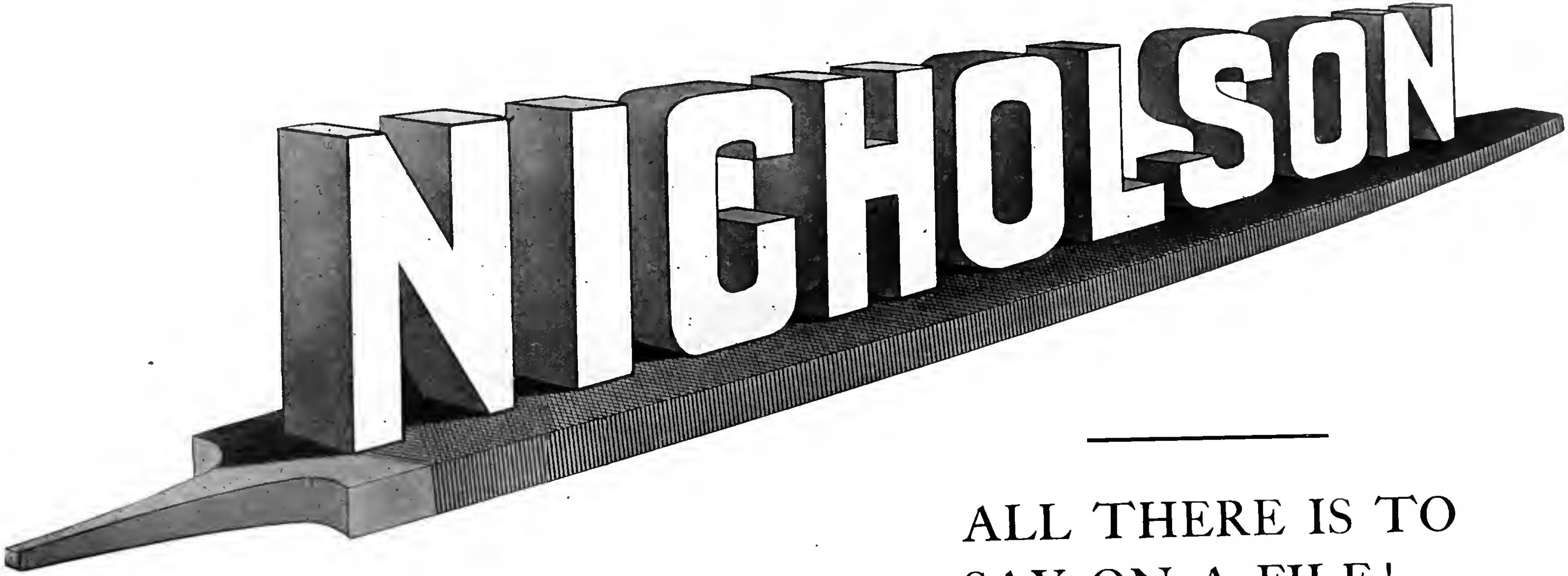
The knowledge that we have gained is used for the benefit of our customers and we are often able to give advice and make suggestions which are helpful to them.

We invite you to take advantage of our experience and have the assurance that such cutters as we will furnish will be properly designed and constructed. They will be of the very highest grade and a source of constant satisfaction.

May we have your inquiries?

Union Twist Drill Co., Athol, Mass.

THE CUTTER MAKERS



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No. 930

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"Flatwist"
High Speed Drill
WITH A
Flat Taper Shank

CLEVELAND QUALITY

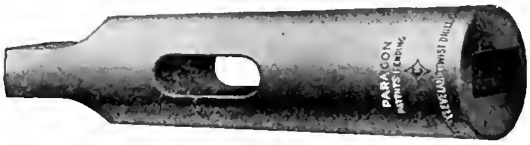
every inch of it.

The Toughest drill ever made of High Speed Steel—
Twisted from the flat bar—
with the simplest, strongest and most logical shank ever designed for a flat or "flatwist" drill—

The Paragon Flat Taper Shank

It's forged and ground to size from the original bar.

THE PARAGON SLEEVE is compact, inexpensive, of regular dimensions, and gives a firm, accurate drive.

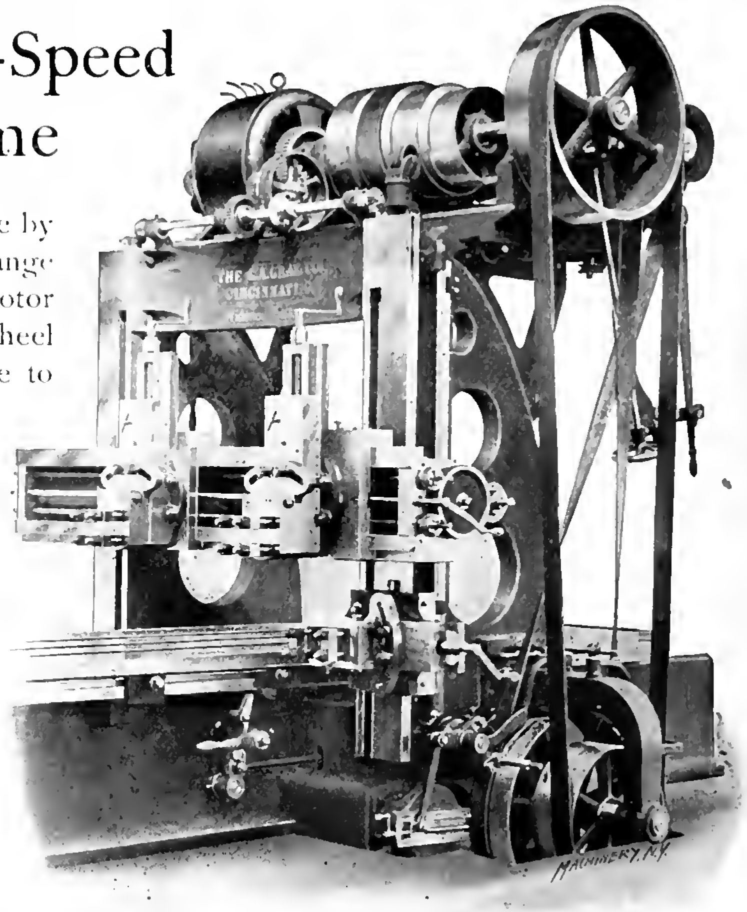


Write for Circular "M" for full particulars.

The CLEVELAND Twist Drill Co.

NEW YORK **CLEVELAND, OHIO** **CHICAGO**

You get a Variable-Speed Planer to Save Time



Then why not save still more time by getting one on which you can change the speeds without stopping the motor and waiting for the heavy fly-wheel and other revolving parts to come to rest?

The Gray variable-speed planer embodies all these special, time-saving features, in addition to the accuracy and smooth-running which has always characterized their single-speed planers.

Send for descriptive circular giving many other points of advantage.

The G. A. Gray Co.
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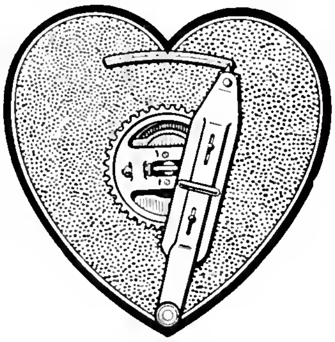


The heart of a shaper

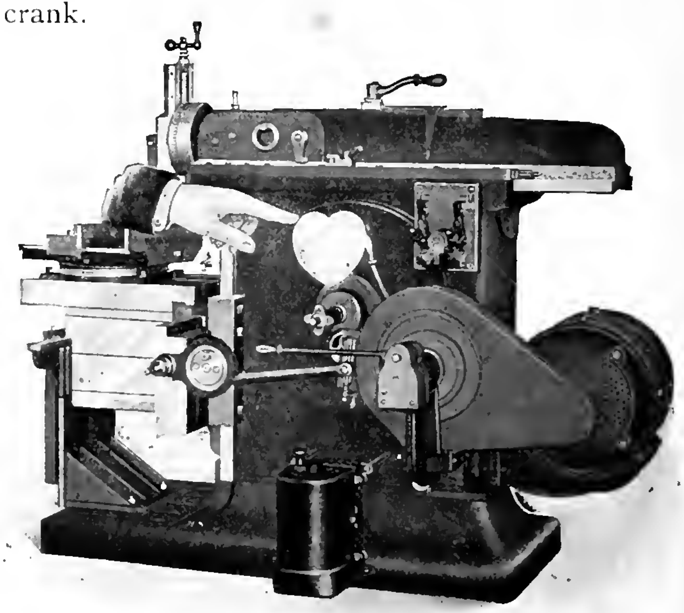
Is Its Crank

If the crank is weak, no matter what the design and strength of the other parts, the shaper is weak. A shaper can be no better than its crank.

25% More Power

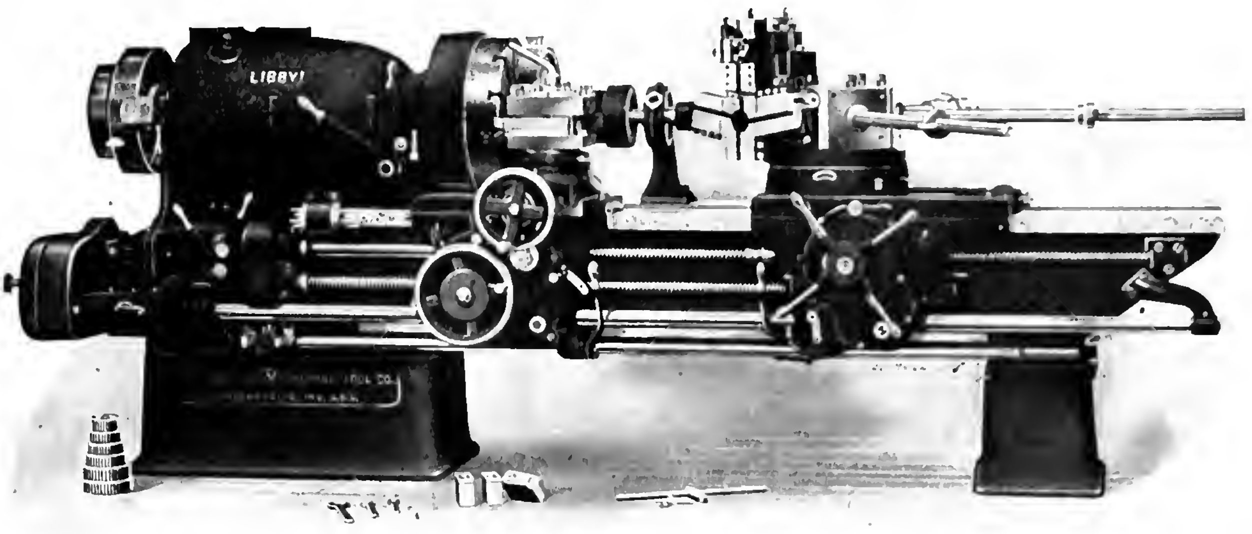
required to do the same work with a plain crank than the Stockbridge Two-Piece-Crank used. Test made at Worcester Polytechnic Institute by H. P. Fairfield. There are reasons for the reputation of the Stockbridge Two-Piece-Crank Motion.

Details of Above Test on Request.



Stockbridge Machine Company
WORCESTER, MASS., U. S. A.
NEW YORK OFFICE:
Niles-Bement-Pond Co. - 111 Broadway

"The Machine Tool Hog"



Put the Heaviest Work and the Hardest up to the Libby Full Swing Side Carriage Turret Lathe

It has the strength and rigidity for heavy cuts and high speed steel; the drive is unusually powerful; there is a wide range of feeds and speeds; every convenience for handling, and with from two to six cutting tools in operation simultaneously there is no need to worry about output.

Other good points are—full swing over carriage, geared head stock, rapid power traverse for both carriages, automatic stop, indicator for position of cutters and the ease with which change from belt to motor drive can be effected. Especially adapted for duplicate work in quantities.

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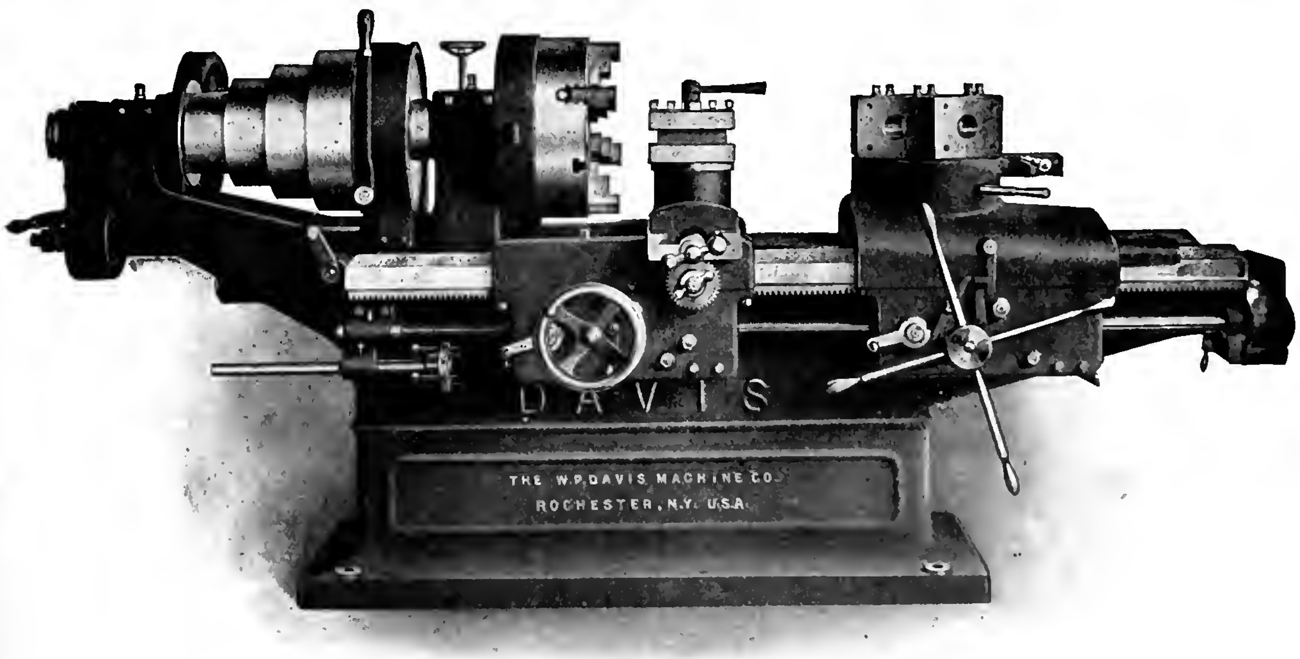
ACCURATE MACHINE TOOLS



New 26-inch Boring, Forming, Turning and Threading Machine. All operations at one Chucking.

Orders can be sent to us direct or through leading machinery dealers in all large cities of the world.
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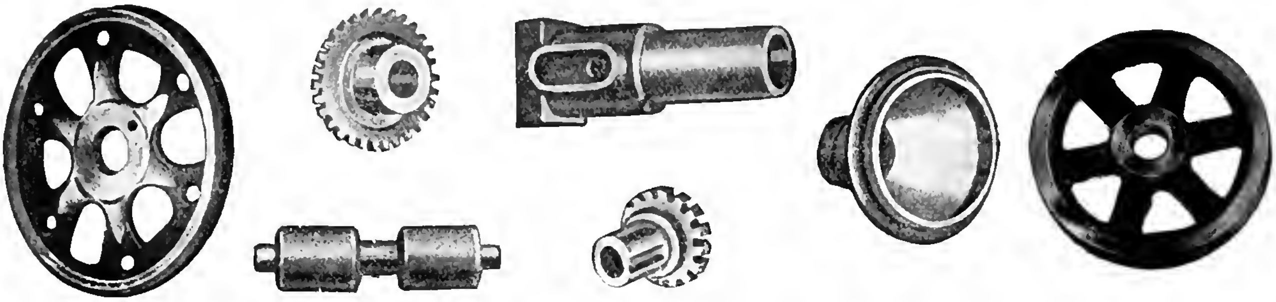
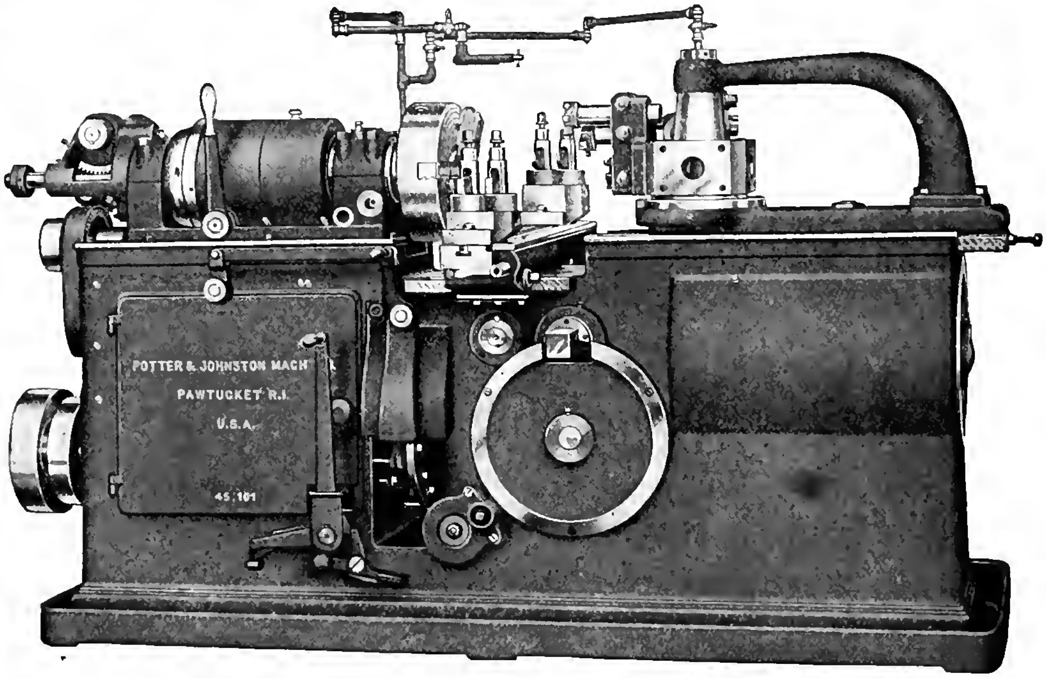
For Handling Duplicate Parts in Great Variety from Castings of Iron, Brass, Steel, also Forgings and Bar Work.

Built in several sizes and combinations, with a range of turning diameters up to 20 inches and 9½ inches long.





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ALL CUTTING OPERATIONS AUTOMATICALLY PERFORMED.
ONE ATTENDANT OPERATES IN GROUPS OF 4 TO 6 MACHINES.

Send us drawings or samples of your duplicate parts for production estimates. Catalog!

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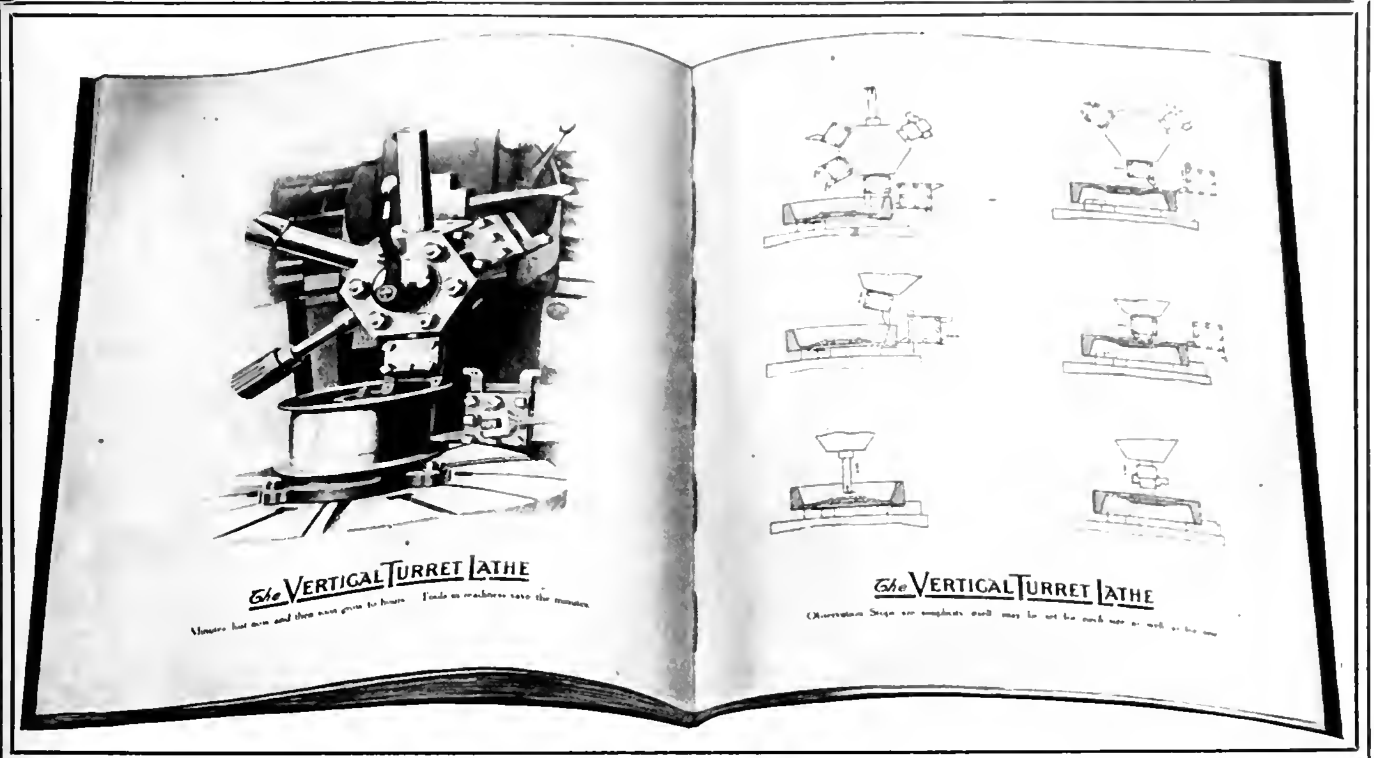

The VERTICAL TURRET LATHE

The VERTICAL TURRET LATHE

IT is filled from cover to cover with photographic suggestions for the reduction of cost on this class of work and will prove of undoubted value to every man interested in obtaining one hundred cents worth of work for every dollar expended for boring, turning, facing, and in fact all manner of work done in the horizontal turret lathe or boring and turning mill.

THE VERTICAL TURRET LATHE
is also fully described.

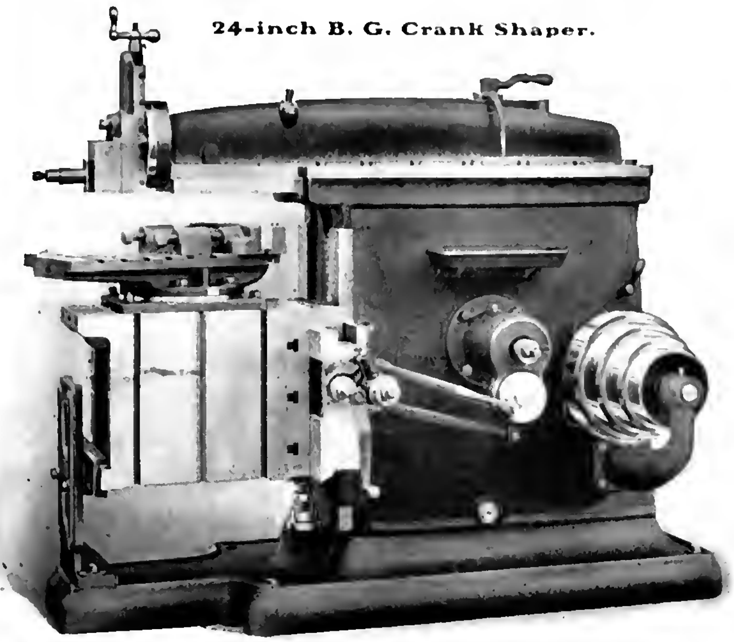
May we send YOU a copy? It's No. V-31.

THE BULLARD MACHINE TOOL CO.

BRIDGEPORT, CONN., U. S. A.

Alphabetical Index of Advertisers

OH! YOU "QUEEN CITY"



24-inch B. G. Crank Shaper.

At Atlantic City we demonstrated our ability to remove twice the metal on our 24-inch shaper, that any other could, and they were as big as 32-inch.

People who did not know our shaper were surprised at its great simplicity and convenience. It is just as superior in point of accuracy and speeds, and a glance will convince any mechanic of its durability.

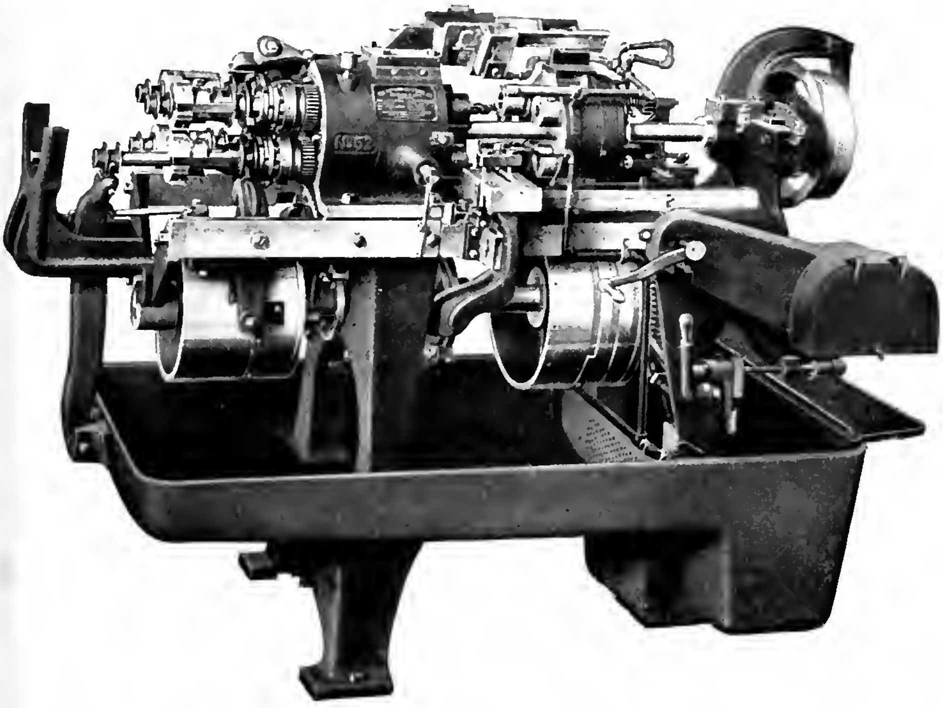
Don't you know it pays to buy the best? Then find out the best by test. Want a "Queen City" to try? It will not cost you one cent of expense, if it is not the best on earth. Yes, 100% ahead of its nearest competitor.

It not only does the actual work faster, but it is easier to set up the job for accurate work, and to get the stroke, feed, speed and positions. Ask about our table support, our feed, etc., and

DON'T BUY A SHAPER IMAGE!

Queen City Machine Tool Co., (Station V.) Cincinnati, O., U. S. A.

AGENCIES IN ALL THE PRINCIPAL CITIES OF THE WORLD



THE Acme's four spindles allow eight or more operations—at once—in the time of one – the longest if performed singly.

¶ The distinctive feature of the "Acme," the stationary Stock Spindle in threading, solves the question of rehandling parts for extra operations. Pieces are in many cases finished as quickly, including the operations of Drilling, Countersinking, Reaming, Milling, Slotting or Slabbing from the side or end, as without them.

¶ Before the recent development in the "ACME," Screw Machines were driven by Multiple Belts, a fruitful source of trouble, expense and delay. Now, one machine, the "ACME," is driven by a single belt—or a constant speed motor—any type—of standard make.

¶ Your Screw Machine operator can make more parts for you on a Single Drive ACME AUTOMATIC. It's built for the operator's convenience.

¶ Breakage of tools is practically impossible. It's fast, safe and economical.

NATIONAL-ACME MFG. CO.

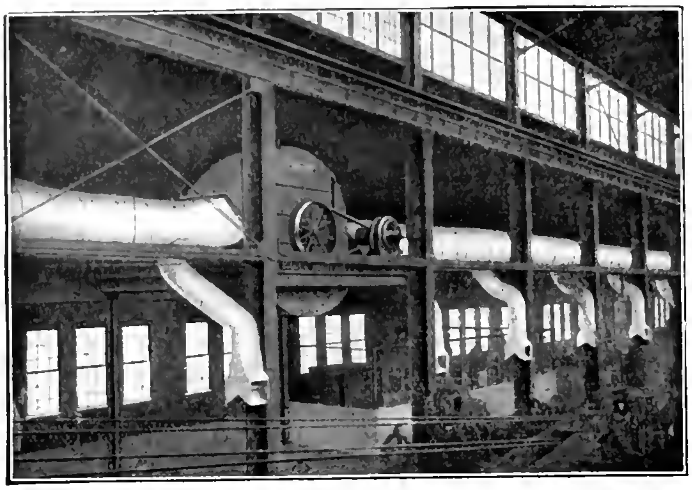
CLEVELAND, OHIO

BRANCH OFFICES: New York Boston Chicago Atlanta

GENERAL FOREIGN REPRESENTATIVES:

Alfred H. Schutte. Schuchardt & Schutte.

NOW IS THE TIME



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TO ARRANGE FOR

NEXT WINTER'S

Heating Apparatus

NO scattered steam piping, and the Sturtevant fan will force the warm air to go where it is wanted.

"The Fan Blower Specialists"

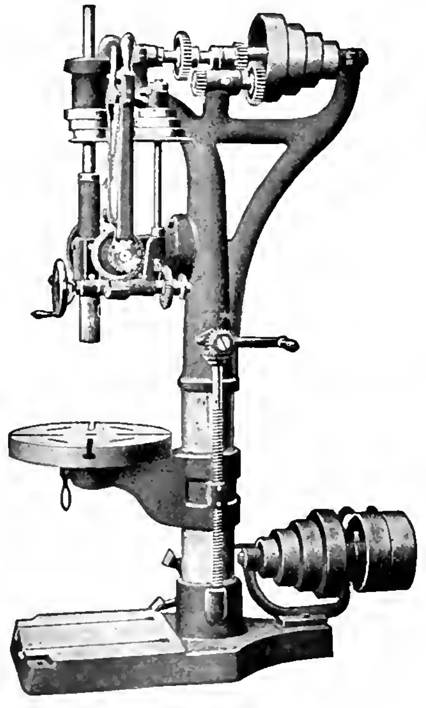
B. F. STURTEVANT CO., Boston, Mass.

General Office and Works, Hyde Park, Mass.

NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters, Rotary Blowers and Exhausters; Steam Engines, Electric Motors and Generating Sets; Pneumatic Separators, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, Steam Turbines, etc.

672



20-INCH UPRIGHT DRILL

Built from new designs, stronger and more compact than formerly and a model of simplicity and convenience in operation. This machine fitted with back gears, power feed and automatic stop, is one of a complete range of sizes, from 15" to 42" swing, adapted for a wide variety of drilling and for long continuous service.

The Kern Drills are modern, efficient and economical.

Ask for Special Circulars.

The Kern Machine Tool Co., Cincinnati, Ohio

AGENTS:—Vandyck-Churchill Co., New York and Philadelphia. Chandler & Farquhar Co., Boston. C. H. Wood Co., Syracuse. Aumen Machinery and Supply Co., Baltimore. The E. L. Essley Machinery Co., Chicago. Fairbanks Co., New Orleans. Crane Co., Birmingham. Henshaw-Bulkley & Co., San Francisco. Hendrie & Bolthoff Mfg. & Supply Co., Denver. Williams & Wilson, Montreal, Canada. A. R. Williams Machinery Co., Toronto, Canada. Alfred Herbert, Ltd., Coventry and Paris. De Fries & Co., Dusseldorf and Milan. G. Koeppen & Co., Moscow. J. Lambercier & Co., Geneva. Nienstaedt & Co., Copenhagen. Henri Nyssens, Antwerp. Van Rietschoten & Houwens, Rotterdam. New York Export & Import Co., Japan, China and the Far East.

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Detroit Hoist & Mch. Co., Detroit, Mich.
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Walton, F. S., Co., Philadelphia, Pa.
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Cling-Surface Co., Buffalo, N. Y.
Belting.
Peerless V-Belt Co., Chicago, Ill.
Shultz Belting Co., St. Louis, Mo.
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Gandy Belting Co., Baltimore, Md.
Belting, Rubber.
New York Belting & Packing Co., New York.
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Williams, White & Co., Moline, Ill.
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Niles-Bement-Pond Co., New York.
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National Tube Co., Pittsburg, Pa.
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Acme Machinery Co., Cleveland, O.
Brown, H. B., Co., East Hampton, Conn.
Detrick & Harvey Mch. Co., Baltimore, Md.
Landis Mch. Co., Waynesboro, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Mchy. Co., Tiffin, O.
Pratt & Whitney Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
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Acme Machinery Co., Cleveland, O.
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Brown, H. B., Co., East Hampton, Conn.
Detrick & Harvey Mch. Co., Baltimore, Md.
Landis Mch. Co., Waynesboro, Pa.
Mummert, Wolf & Dixon Co., Hanover, Pa.
National Mchy. Co., Tiffin, O.
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Standard Engineering Co., Ellwood City, Pa.
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Boring Bars.
Niles-Bement-Pond Co., New York.
Underwood, H. B., & Co., Philadelphia, Pa.
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Beaman & Smith Co., Providence, R. I.
Betts Mch. Co., Wilmington, Del.
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Detrick & Harvey Mch. Co., Baltimore, Md.
Flather, E. J., Mfg. Co., Nashua, N. H.
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Newton Mch. Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Universal Boring Mch. Co., Hudson, Mass.
Williams, White & Co., Moline, Ill.
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Fosdick Mch. Tool Co., Cincinnati, O.
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Lucas Machine Tool Co., Cleveland, O.
Rockford Drilling Mch. Co., Rockford, Ill.
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Baush Mch. Tool Co., Springfield, Mass.
Betts Mch. Co., Wilmington, Del.
Bickford, H., & Co., Lakeport, N. H.
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Colburn Mch. Tool Co., Franklin, Pa.
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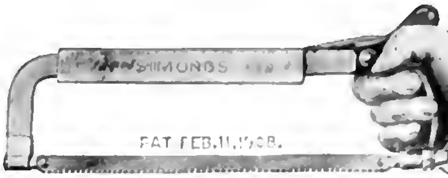
Gisholt Mch. Co., Madison, Wis.
Mitts & Merrill, Saginaw, Mich.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Boring Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, O.
Krieger Tool & Mfg. Co., Grand Rapids, Wis.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.



Make a Cut in your Blade Bills with
Simonds Hack Saw Blades

Made from special steel by a special process, the set of teeth scientifically correct for fast, accurate cutting, our blades will successfully stand all tests for hardness, toughness, and cutting power, and will give absolute satisfaction from every point of view

The new handle fits the hand in a comfortable, natural way and is a big improvement on the old-style frame.

We are prepared to furnish blades on yearly contracts for large users.

Send for circulars.

SIMONDS MANUFACTURING CO.

Fitchburg, Mass. Chicago, Ill. Montreal, Que. New York City
New Orleans, La. San Francisco, Cal. Seattle, Wash. Portland, Ore.
8 White St., Moorefields, London, E. C., Eng.

Landis Bolt Cutters

The most economical tools for their purpose yet offered.

A feature of these machines is the improved Landis Die, fitted with long chasers which can be reground and set forward as required until the metal is entirely used up. No hobbing, retempering or annealing required; lead is positive; clearance correct; same chasers cut right or left hand threads, and the life of the ordinary hobbed die is exceeded twenty times.

More work at less cost. Write for booklet.

LANDIS MACHINE CO., Waynesboro, Pa.

Marshall & Huschart Machinery Co., Sole Agents for Chicago and St. Louis. Schuchardt & Schutte, 34 Victoria St., Westminster, London, Sole Agents for Great Britain, Ireland and British Colonies. Schuchardt & Schutte, 9 Kiangse Road, Shanghai, Sole Agents for China and Japan. Adler & Eisenschitz, Sole Agents for Italy.

Automatic Machine Screw Work of all kinds

Our Capacity, 1/8" to 3 1/4"; from sample or blue print.

Prices right. Workmanship the best. Write today.

STANDARD MACHINE SCREW CO., 2268 Spring Grove Ave., Cincinnati, O.

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HACK SAW BLADES
AND
POWER MACHINES

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DIAMOND SAW & STAMPING WORKS
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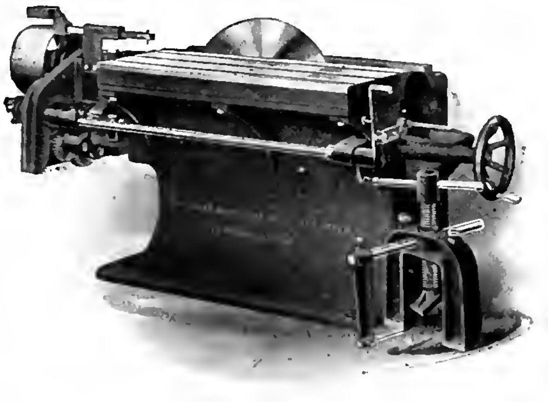
231 Elizabeth Street,
Melbourne, Australia.

2a Calle de Dolores, Num. 10, Mexico City, Mexico

Twenty-inch Cutting-off Saw

WITH POWER SCREW FEED



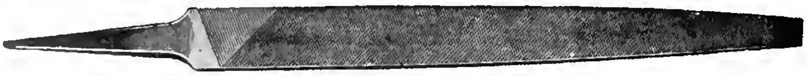
This new saw is equipped with automatic knockout which can be set at any point, unusually large clamping table, and has a steady drive which eliminates backlash and reduces breakage of blades to a minimum. The rigidity with which the saw is held permits cutting solid steel or tubing with the same blade.

Price $160.00—Circulars on request.

THE BURKE MACHINERY COMPANY
1837 Thirty-fifth Street CLEVELAND, OHIO, U.S.A.

NOT IN A TRUST

HAYES FILE CO., - DETROIT, MICHIGAN



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Bronze Bearings.
Lumen Bearing Co., Buffalo, N. Y.
Reeves, P. S., & Son, Philadelphia, Pa.

Bronze Castings, Bushings, etc.
Reeves, P. S., & Son, Philadelphia, Pa.

Bulldozers.
Ajax Mfg. Co., Cleveland, O.
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Williams, White & Co., Moline, Ill.

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Carborundum Wheels.
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Franklin Mfg. Co., Syracuse, N. Y.

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Pratt & Whitney Co., Hartford, Conn.
Springfield Mch. Tool Co., Springfield, O.
Whiton, D. E., Mch. Co., New London, Conn.

Chains.
Baldwin Chain Mfg. Co., Worcester, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Whitney Mfg. Co., Hartford, Conn.

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Link Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Conn.

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Yale & Towne Mfg. Co., New York.

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Cincinnati Chuck Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
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Horton, E., & Son Co., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mch. Co., New Bedford.
National Twist Drill & Tool Co., Detroit, Mich.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Oneida National Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Frankfort, N. Y.
Reed, Francis, Co., Worcester, Mass.
Russell Anti-Friction Drill Chuck Co., Elmira.
Skinner Chuck Co., New Britain, Conn.
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Walker, O. S., & Co., Worcester, Mass.
Westcott Chuck Co., Oneida, N. Y.
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Whiton, D. E., Mch. Co., New London, Conn.

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Bliss, E. W., Co., Brooklyn, N. Y.
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Moore & White Co., Philadelphia, Pa.
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Burr, John T., & Sons, Brooklyn, N. Y.
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Sprague Electric Co., New York.

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L. & D. Co., Boston, Mass.
Norton Grinding Co., Worcester, Mass.
Variable Speed Clutch Co., Milwaukee, Wis.

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Durbrow & Hearne Mfg. Co., New York.
Root, C. J., Co., Bristol, Conn.
Veeder Mfg. Co., Hartford, Conn.

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Maris Bros., Philadelphia, Pa.
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Modern Tool Co., Erie, Pa.

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Winkley Co., Detroit, Mich.

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Pratt & Whitney Co., Hartford, Conn.
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Wilmarth & Morman Co., Grand Rapids, Mich.

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Standard Tool Co., Cleveland, O.

Drills, Twist.
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Mueller Mch. Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Western Mch. Tool Works, Holland, Mich.

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Andrew, M. L. & Co., Cincinnati, O.
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Baker Bros., Toledo, O.
Barr, H. G., Worcester, Mass.
Barnes, W. F. & J., Co., Rockford, Ill.
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Baush Mch. Tool Co., Springfield, Mass.
Betts Mch. Co., Wilmington, Del.
Burke Mchy. Co., Cleveland, O.
Cincinnati Bickford Tool Co., Cincinnati, O.
Cincinnati Mch. Tool Co., Cincinnati, O.
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Kern Mch. Tool Co., Cincinnati, O.
Knecht Bros. Co., Cincinnati, O.
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Mechanics Machine Co., Rockford, Ill.
Mitts & Merrill, Saginaw, Mich.
Mueller Mch. Tool Co., Cincinnati, O.
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Nile-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Quint, A. E., Hartford, Conn.
Reed, Francis Co., Worcester, Mass.
Rockford Drilling Mch. Co., Rockford, Ill.
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Sibley Mch. Tool Co., So. Bend, Ind.
Snyder, J. E., & Son, Worcester, Mass.
Superior Mch. Tool Co., Kokomo, Ind.
Taylor & Fenn Mch. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.

Drilling Machines, Portable, Electrical Driven.
Cincinnati Elec. Tool Co., Cincinnati, O.
Dallett, Thos. H., Co., Philadelphia, Pa.
Hisey-Wolf Mch. Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
Stow Flexible Shaft Co., Philadelphia, Pa.
United States Elec. Tool Co., Cincinnati, O.
Van Dorn Elec. & Mfg. Co., Cleveland, O.

Drying Ovens.
Steiner, E. E., Newark, N. J.

Dynamos.
Crocker-Wheel Co., Ampere, N. J.
Fort Wayne Elec. Works, Fort Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, Ohio.
Sprague Electric Co., New York.
Sturtevant, B. F., Co., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrotypers.
Lovejoy Co., New York.

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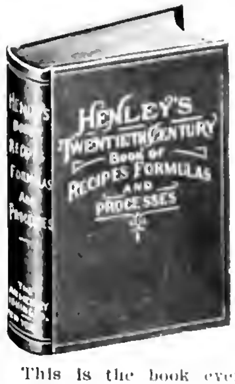

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This is the book everyone should have at his command who seeks practical, accurate knowledge and guidance in his every-day work, as no book has ever been published which so fully meets the multifarious requirements of the factory, the workshop, the laboratory, and the household.

The entire work is a veritable mine of practical information and up-to-date in every respect. A work which will prove of value to the Artisan, Mechanic, Engineer and all engaged in any way in any of the arts. From the contents we append only a few of the subjects treated, lack of space preventing the publishers from giving more.

Adhesives
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Alloys
Alluminum and its treatment
Amalgams
Ammonia
Antiseptics
Belt Pastes
Benzine
Beverages
Boiler Compounds
Brass
Bronzes
Castings
Celluloid
Cements
Ceramics
Cigars
Cleaning Receipts
Condiments
Confectionery
Copper
Cosmetics
Disinfectants
Dyeing
Electroplating
Electrotyping
Enameling
Engraving
Essences and Extracts
Etching
Explosives
Fertilizers
Fire-proofing
Food Adulterations
Freezing
Preventives
Fumigants
Glass
Gold
Hectograph Pads and Ink
Household Formulas
Ink
Iron
Ivory
Jewelers' Formulas
Lacquers
Laundry Preparation
Leather
Lubricants
Metals
Mirrors
Molds
Nickel Testing
Oils
Paints
Paper
Perfumery
Petroleum
Photography
Plaster
Plating
Polishers
Porcelain
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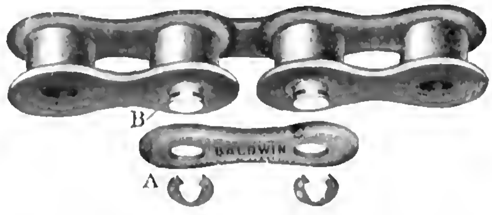

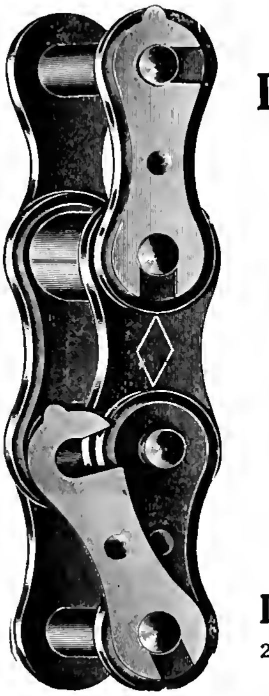

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Emery and Corundum Wheels.
- Abrasive Material Co., Philadelphia, Pa.
- American Emery Wheel Works, Providence, R. I.
- Safety Emery Wheel Co., Springfield, O.
- Sterling Emery Wheel Mfg. Co., Tiffin, O.
- Vitrified Wheel Co., Westfield, Mass.

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- Standurd Tool Co., Cleveland, O.

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- Stow Flexible Shaft Co., Philadelphia, Pa.
- Stow Mfg. Co., Binghamton, N. Y.

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- Burke Mchy. Co., Cleveland, O.
- Sturtevant, B. F., Co., Hyde Park, Mass.

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- Machinery Forging Co., Cleveland, O.
- Phosphor Bronze Smelting Co., Philadelphia, Pa.
- Williams, J. H., & Co., Brooklyn, N. Y.
- Wyman & Gordon, Worcester, Mass.

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- Ajax Mfg. Co., Cleveland, O.
- Bliss, E. W., Co., Brooklyn, N. Y.
- National Mchy. Co., Tiffin, O.
- Scranton & Co., New Haven, Conn.
- Williams, White & Co., Moline, Ill.

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- Westmacott Gas Furnace Co., Providence, R. I.

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- New England Gear Wks., Boston, Mass.
- New Process Raw Hide Co., Syracuse, N. Y.
- Nuttall, R. D., Co., Pittsburg, Pa.
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- Van Dorn & Dutton Co., Cleveland, O.

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Whiton, D. E., New London, Conn.

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Gleason Works, Rochester, N. Y.

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Fellows Gear Shaper Co., Springfield, Vt.

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Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Hisey-Wolf Mch. Co., Cincinnati, O.
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Diamond Mch. Co., Providence, R. I.
Gould & Eberhardt, Newark, N. J.
Graham Mfg. Co., Providence, R. I.
Hisey-Wolf Mch. Co., Cincinnati, O.
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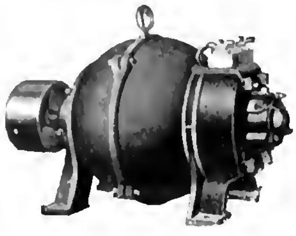

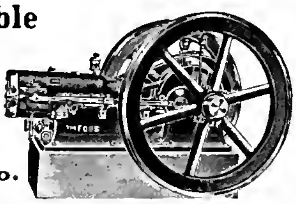

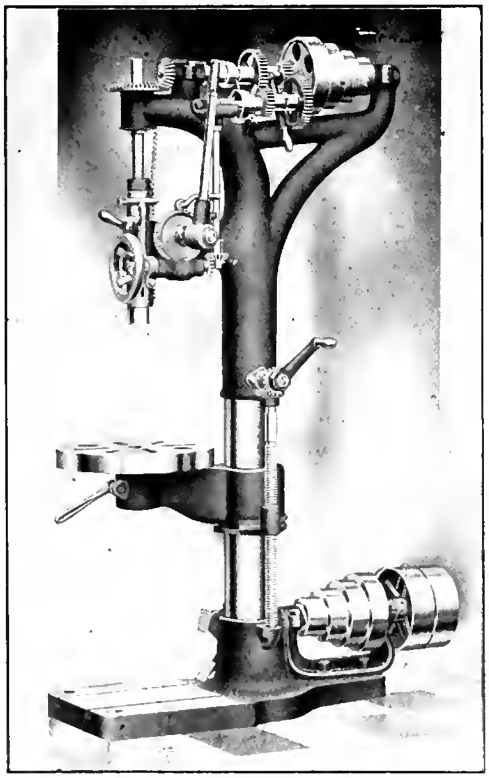

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Watson-Stillman Co., New York.

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Woodman, R., Mfg. & Supply Co., Boston, Mass.

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Dienelt & Eisenhardt, Philadelphia, Pa.
Watson-Stillman Co., New York.

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Baker Bros., Toledo, O.
Burr, John T. & Sons, Brooklyn, N. Y.
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Mitts & Merrill, Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Rockford Drilling Mch. Co., Rockford, Ill.

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Cooper-Hewitt Electric Co., New York.
General Electric Co., Schenectady, N. Y.

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Warner & Swasey Co., Cleveland, O.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.

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Nutting, A. B., & Co., Amesbury, Mass.

Lathes, Pulley.
Cincinnati Pulley Mchy. Co., Cincinnati, O.

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Le Count, William G., Norwalk, Conn.
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Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.
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Lyon Metallic Mfg. Co., Aurora, Ill.

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Besly, C. H., & Co., Chicago, Ill.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Walton, F. S., Co., Philadelphia, Pa.

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Morton Mfg. Co., Muskegon Heights, Mich.
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Standard Gauge Steel Co., Beaver Falls, Pa.

Machine Screws.
Standard Mch. Screw Co., Cincinnati, O.

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McCabe, J. J., New York.
Motch & Merryweather Mchy. Co., Cleveland, O.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.

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Hammacher, Schlemmer & Co., New York.
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Pratt & Whitney Co., Hartford, Conn.
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Slocomb, J. T., Co., Providence, R. I.
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Welles, F. A., Waukesha, Wis.
Wells Bros. Co., Greenfield, Mass.
Wyke, J., & Co., Boston, Mass.

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Cleveland Twist Drill Co., Cleveland, O.
Nicholson, W. H., & Co., Wilkesbarre, Pa.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Western Tool & Mfg. Co., Springfield, O.

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Buffalo Forge Co., Buffalo, N. Y.
Sturtevant, B. F., Co., Hyde Park, Mass.

Metal.
Goldschmidt Thermit Co., New York.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
Reeves, P. S., & Son, Philadelphia, Pa.

Metal, Polish.
Hoffman, George W., Indianapolis, Ind.

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Becker Milling Mch. Co., Hyde Park, Mass.
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Huther Bros. Saw Mfg. Co., Rochester, N. Y.
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Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Starrett, L. S., Co., Athol, Mass.
Tabor Mfg. Co., Philadelphia, Pa.
Union Twist Drill Co., Athol, Mass.

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Becker Milling Mch. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
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Pratt & Whitney Co., Hartford, Conn.
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Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

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Geometric Tool Co., New Haven, Conn.
Rogers, J. M., Works, Gloucester City, N. J.

Molding Machines.
Adams Co., Dubuque, Ia.

Motors (Electric).
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Elec. Works, Fort Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Robbins & Myers Co., Springfield, O.
Sprague Elec. Co., New York.
Sturtevant, B. F., Co., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Name Plates.
Sackmann, W. L., Akron, O.

Nozzles.
McCullough-Dolzell Crucible Co., Pittsburg, Pa.

Nut Tappers.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Oil Cans.
Delphos Mfg. Co., Delphos, O.

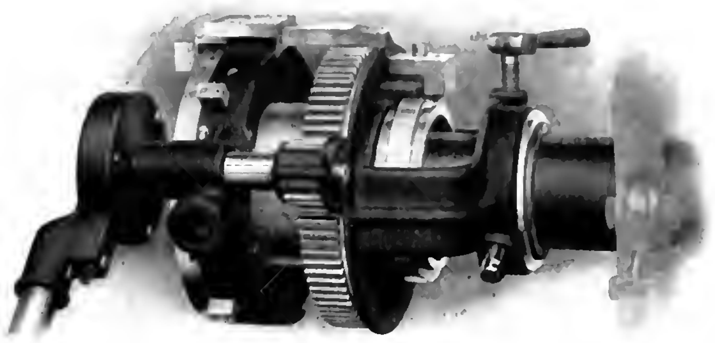
Oil Cups.
Bay State Stamping Co., Worcester, Mass.
Besly, C. H., & Co., Chicago, Ill.
Tucker, W. M. & C. F., Hartford, Conn.
Winkley Co., Detroit, Mich.

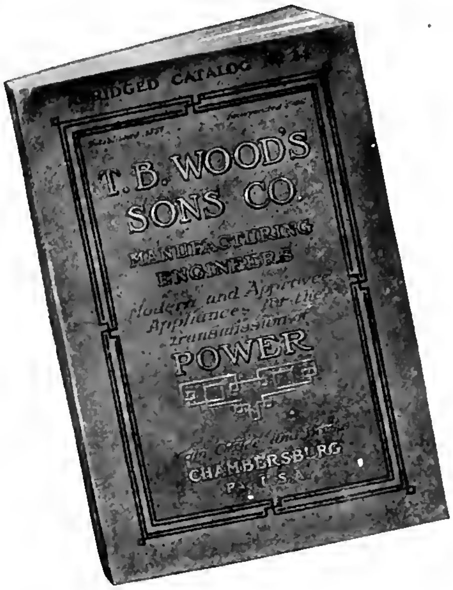
Oilers.
Gem Mfg. Co., Pittsburg, Pa.

Oil Hole Covers.
Bay State Stamping Co., Worcester, Mass.
Tucker, W. M. & C. F., Hartford, Conn.
Winkley Co., Detroit, Mich.

Oilless Bearings.
Arguto Oilless Bearing Co., Philadelphia, Pa.

Oil Stones.
Norton Co., Worcester, Mass.





Classified Index to Advts. (Continued).

Packing.
Houghton, E. F., & Co., Philadelphia, Pa.
New York Belting and Packing Co., New York.

Pattern Letters.
Butler, A. G., New York.

Patents.
Burnham, Royal E., Washington, D. C.
Howson & Howson, Philadelphia, Pa.
Macdonald, Macdonald & Cavanagh, New York.
Parker, C. L., Washington, D. C.
Whittlesey, Geo. P., Washington, D. C.

Pattern Shop Equipment.
Colburn Mch. Tool Co., Franklin, Pa.
Fox Machine Co., Grand Rapids, Mich.

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Pipe-Cutting and Threading Tools.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Hart Mfg. Co., Cleveland, O.
Landis Mch. Co., Waynesboro, Pa.
Loew Mfg. Co., Cleveland, O.
Merrill Mfg. Co., Toledo, O.
Pratt & Whitney Co., Hartford, Conn.
Saunders', D., Sons, Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
Trimont Mfg. Co., Roxbury, Mass.

Pipes and Fittings.
National Tube Co., Pittsburg, Pa.

Planers, Metal.
American Tool Wks. Co., Cincinnati, O.
Betts Mch. Co., Wilmington, Del.
Cincinnati Planer Co., Cincinnati, O.
Cleveland Crane & Engr. Co., Wickliffe, Ohio.
Cleveland Planer Wks., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather, Mark, Planer Co., Nashua, N. H.
Gleason Works, Rochester, N. Y.
Gray, G. A., Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rockford Mch. Tool Co., Rockford, Ill.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.
Wilson, W. A., Mch. Co., Rochester, N. Y.
Woodward & Powell Planer Co., Worcester, Mass.

Portable Tools, Repair, Railroad, etc.
Underwood, H. B., & Co., Philadelphia, Pa.

Pneumatic and Turntable Motors.
Detroit Hoist & Mch. Co., Detroit, Mich.

Pneumatic Tools.
Bliss, E. W., Co., Brooklyn, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Shepard Elec. Crane & Hoist Co., Montour Falls.

Presses.
Billings & Spencer Co., Hartford, Conn.
Bliss, E. W., Co., Brooklyn, N. Y.
Ferracute Mch. Co., Bridgeton, N. J.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrell Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Presses, Power Forcing.
Lucas Machine Tool Co., Cleveland, O.

Pulley Blocks.
Yale & Towne Mfg. Co., New York.

Pulley Castings.
Central Foundry Co., Hamilton, O.

Pulleys.
American Pulley Co., Philadelphia, Pa.
Philips Pressed Steel Co., Philadelphia, Pa.
Poole Eng'rg & Mch. Co., Baltimore, Md.
Saginaw Mfg. Co., Saginaw, Mich.
Sellers, Wm. & Co., Inc., Philadelphia, Pa.
Wood's, T. B., Sons Co., Chambersburg, Pa.

Pumps.
Buffalo Forge Co., Buffalo, N. Y.
Waterbury-Farrell Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Punches and Dies.
Armstrong-Blum Mfg. Co., Chicago, Ill.
Bliss, E. W., Co., Brooklyn, N. Y.
Burke Mchy. Co., Cleveland, O.
Cleveland Crane & Engr. Co., Wickliffe, Ohio.
Globe Mch. & Stamping Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Richards, I. P. Providence, R. I.
Watson-Stillman Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Punching and Shearing Machinery.
Bertsch & Co., Cambridge City, Ind.
Bliss, E. W., Co., Brooklyn, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Cincinnati Punch & Shear Co., Cincinnati, O.
Cleveland Crane & Engr. Co., Wickliffe, Ohio.
Long & Allstatter Co., Hamilton, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Rapping Plates.
Milwaukee Fdry. Supply Co., Milwaukee, Wis.

Reamers.
Cleveland Twist Drill Co., Cleveland, O.
Kelly Tool Co., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Van Dorn Elec. & Mfg. Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Classified Index to Advts. (Continued).

Reamers, Adjustable.
Cleveland Twist Drill Co., Cleveland, O.
Kelly Tool Co., Cleveland, O.
Lapointe Machine Tool Co., Hudson, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.
Schellenbach-Hunt Tool Co., Cincinnati, O.

Reamers, Pneumatic.
Stow Flexible Shaft Co., Philadelphia, Pa.

Rivet and Spike Machinery.
National Mchy. Co., Tiffin, O.

Riveters.
Buffalo Forge Co., Buffalo, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Grant Mfg. & Mch. Co., Bridgeport, Conn.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Shepard Elec. Crane & Hoist Co., Montour Falls.
Waterbury-Farrell Fdry. & Mch. Co., Waterbury.

Roller Bearings.
Bantam Anti-Friction Co., Bantam, Conn.

Rope Dressing and Preservative.
Cling-Surface Co., Buffalo, N. Y.

Saw Blades.
Boker, Hermann & Co., New York.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Hammacher, Schlemmer & Co., New York.
Millers Falls Co., New York.
Simonds Mfg. Co., Fitchburg, Mass.
West Haven Mfg. Co., New Haven, Conn.

Saw Tables.
Crescent Mch. Co., Leetonia, Ohio.

Saws, Power and Hand.
Billings & Spencer Co., Hartford, Conn.
Diamond Saw and Stamping Wks., Buffalo, N. Y.
Espen-Lucas Mch. Wks., Philadelphia, Pa.
Hoefer Mfg. Co., Freeport, Ill.
Millers Falls Co., New York.
Racine Gas Engine Co., Racine, Wis.
Robertson Drill & Tool Co., Buffalo, N. Y.
Story, H. T., Chicago, Ill.
Tabor Mfg. Co., Philadelphia, Pa.
West Haven Mfg. Co., New Haven, Conn.

Saws, Band.
Crescent Mch. Co., Leetonia, O.
Fox Mch. Co., Grand Rapids, Mich.
Huther Bros. Saw Mfg. Co., Rochester, N. Y.
West Haven Mfg. Co., New Haven, Conn.

Schools.
International Corr. School, Scranton, Pa.
Pratt Institute, Brooklyn, N. Y.

Screws and Worms.
Screw Cutting Co. of America, Philadelphia, Pa.

Screw Driver, Automatic.
Reynolds Mchy. Co., Moline, Ill.

Screw Machinery.
Cook, Asa S., Co., Hartford, Conn.

Screw Machines.
Cleveland Auto. Mch. Co., Cleveland, O.
National Acme Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Screw Cutting Co. of America, Philadelphia, Pa.
Smurr & Kamen Mch. Co., Chicago, Ill.
Universal Mch. Screw Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, O.
Wood Turret Mch. Co., Terre Haute, Ind.

Shaft Hangers.
Wood's, T. B., Sons Co., Chambersburg, Pa.

Shapers.
American Tool Wks. Co., Cincinnati, O.
Cincinnati Shaper Co., Cincinnati, O.
Flather & Co., Nashua, N. H.
Flather, Mark, Planer Co., Nashua, N. H.
Fox Mch. Co., Grand Rapids, Mich.
Gould & Eberhardt, Newark, N. J.
Hamilton Mch. Tool Co., Hamilton, O.
Hendey Mch. Co., Torrington, Conn.
Juengst, Geo., & Sons, Croton Falls, N. Y.
Kelly, R. A., Co., Xenia, O.
Lutter & Gies, Milwaukee, Wis.
Morton Mfg. Co., Muskegon Heights, Mich.
Newark Gear Cutting Mch. Co., Newark, N. J.
New Haven Mfg. Co., New Haven, Conn.
Newton Mch. Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Queen City Mch. Tool Co., Cincinnati, O.
Rockford Mch. Tool Co., Rockford, Ill.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Smith & Mills, Cincinnati, O.
Springfield Mch. Tool Co., Springfield, O.
Steptoe, John Shaper Co., Cincinnati, O.
Stockbridge Mch. Co., Worcester, Mass.
Walcott & Wood Mch. Tool Co., Jackson, Mich.

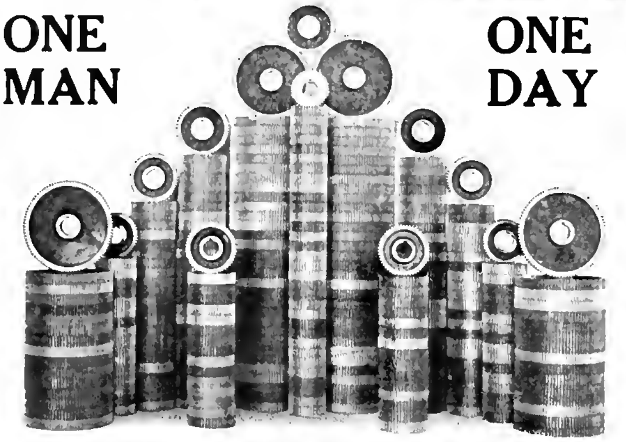
Slotting Machines.
Betts Mch. Co., Wilmington, Del.
Dill, T. C., Mch. Co., Philadelphia, Pa.
Newton Mch. Tool Wks., Inc, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sellers Wm., & Co., Inc., Philadelphia, Pa.

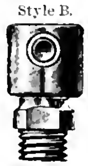
Special Machinery.
Blanchard Mch. Co., Boston, Mass.
Bliss, E. W., Co., Brooklyn, N. Y.
Elgin Tool Works, Elgin, Ill.
Hoefer Mfg. Co., Freeport, Ill.
Newark Gear Cutting Mch. So., Newark, N. J.
Niles-Bement-Pond Co., New York.
Waltham Mch. Wks., Waltham, Mass.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Williams, White & Co., Moline, Ill.
Wilson, W. A., Mch. Co., Rochester, N. Y.

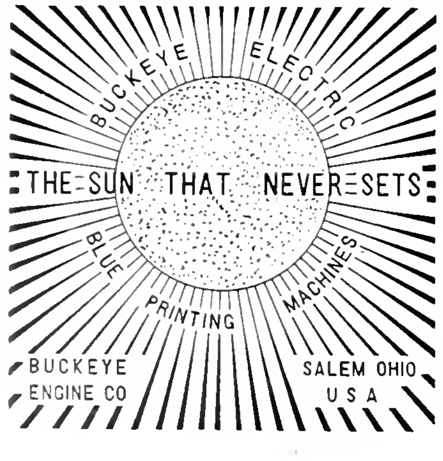
Speed Changing Devices.
[illegible]ns, G. F., Newton Centre, Mass.
[illegible] & White Co., Philadelphia, Pa.
Variable Speed Clutch Co., Milwaukee, Wis.

Stamping Sheet Metal.
Globe Mch. & Stamping Co., Cleveland, O.

Stamps, Letters and Figures.
Schwerdtle Stamp Co., Bridgeport, Conn.







Classified Index to Advts. (Continued).

Steel.
Boker, Hermann, & Co., New York and Chicago.
Cammell, Laird & Co., New York.
Columbia Steel Co., Elyria, O.
Cumberland Steel Co., Cumberland, Md.
Firth-Sterling Steel Co., McKeesport, Pa.
Heller Bros. Co., Newark, N. J.
Jessop, Wm., & Sons, Ltd., New York.
Ward, Edgar T., & Sons, Boston, Mass.

Steel Castings and Forgings.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Jessop, Wm., & Sons, Ltd., New York.

Steel Rules.
Brown & Sharpe Mfg. Co., Providence, R. I.
Lufkin Rule Co., Saginaw, Mich.
Starrett, L. S., Co., Athol, Mass.

Steel Shelving Racks, Barrels, Tables, etc.
Lyon Metallic Mfg. Co., Aurora, Ill.

Sub-Press Dies.
Waltham Mch. Wks., Waltham, Mass.

Swaging Machines.
Excelsior Needle Co., Torrington, Conn.

Taps and Dies.
Bay State Tap & Die Co., Mansfield, Mass.
Besly, C. H., & Co., Chicago, Ill.
Butterfield & Co., Derby Line, Vt.
Card, S. W. Mfg. Co., Mansfield, Mass.
Carpenter, J. M., Tap & Die Co., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Hart Mfg. Co., Cleveland, O.
Jessop, Wm., & Sons, Ltd., New York.
Lapointe Machine Tool Co., Hudson, Mass.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
Reece, E. F., Co., Greenfield, Mass.
Reed Mfg. Co., Erie, Pa.
Smart, A. J., Mfg. Co., Greenfield, Mass.
Standard Tool Co., Cleveland, O.
Toledo Mch. & Tool Co., Toledo, O.
Wells Bros. Co., Greenfield, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Tapping Attachments.
Beaman & Smith Co., Providence, R. I.
Cincinnati Mch. Tool Co., Cincinnati, O.
Modern Tool Co., Erie, Pa.
Rockford Drilling Mch. Co., Rockford, Ill.

Tapping Machines.
Baker Bros, Toledo, O.
Burke Mchy. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Saunders', D., Sons, Yonkers, N. Y.

Thermit.
Goldschmidt Thermit Co., New York.

Thread Cutting Machinery.
Automatic Mch. Co., Bridgeport, Conn.
Bickford & Washburn, Greenfield, Mass.
Billings & Spencer, Hartford, Conn.
Fay Mch. Tool Co., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Brighton, Mass.

Tire Welders and Benders.
Buffalo Forge Co., Buffalo, N. Y.
Williams, White & Co., Moline, Ill.

Tools.
Hammacher, Schlemmer & Co., New York.
Montgomery & Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Walworth Mfg. Co., Boston, Mass.

Tool Cases.
Gerstner, H., & Sons, Dayton, O.

Tool Holders, Lathe and Planer.
Armstrong Bros. Tool Co., Chicago, Ill.
Beaman & Smith Co., Providence, R. I.
Billings & Spencer Co., Hartford, Conn.
Krieger Tool & Mfg. Co., Grand Rapids, Mich.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Tool Racks.
Lyon Metallic Mfg. Co., Aurora, Ill.
New Britain Mch. Co., New Britain, Conn.

Tracks, Trolley and Overhead.
Yale & Towne Mfg. Co., New York.

Transformers.
Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Elec. Works, Fort Wayne, Ind.
General Elec. Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Transmission Machinery.
Link-Belt Co., Philadelphia, Pa.
Peerless V-Belt Co., Chicago, Ill.
Sellers, Wm., Co., Inc., Philadelphia, Pa.
Wood's, T. B., Sons Co., Chambersburg, Pa.

Trimmers, Wood.
Fox Mch. Co., Grand Rapids, Mich.

Trolleys.
Yale & Towne Mfg. Co., New York.

Tube Expanders.
Watson-Stillman Co., New York.

Tubing, Seamless Steel.
Cumberland Steel Co., Cumberland, Md.
National Tube Co., Pittsburg, Pa.
Standard Welding Co., Cleveland, O.

Tumbling Barrels.
Globe Mch. & Stamping Co., Cleveland, O.

Turret Machinery.
Bullard Mch. Tool Co., Bridgeport, Conn.
Fay & Scott, Dexter, Me.
Flather, E. J., Mfg. Co., Nashua, N. H.
Gisholt Mch. Co., Madison, Wis.
Hendey Mch. Co., Torrington, Conn.
International Mch. Tool Co., Indianapolis, Ind.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Smurr & Kamen Mch. Co., Chicago, Ill.
Steinle Turret Mch. Co., Madison, Wis.
Warner & Swasey Co., Cleveland, O.
Windsor Mch. Co., Windsor, Vt.

Classified Index to Advts. (Continued).

Universal Joints.
Baush Mch. Tool Co., Springfield, Mass.
Boston Gear Wks., Norfolk Downs, Mass.

Valves.
National Tube Co., Pittsburg, Pa.

Vises.
Armstrong Mfg. Co., Bridgeport, Conn.
Graham Mfg. Co., Providence, R. I.
Merrill Bros., Brooklyn, N. Y.
Plunket, J. E. Chicago, Ill.
Prentiss Vise Co., New York.
Reed Mfg. Co., Erie, Pa.
Skinner Chuck Co., New Britain, Conn.
Williams, J. H., & Co., Brooklyn, N. Y.
Wyman & Gordon, Worcester, Mass.

Welding.
Goldschmidt Thermit Co., New York.
Standard Welding Co., Cleveland, O.

Wire Nail and Washer Mchy.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Wood Working Machinery.
Crescent Mch. Co., Leetonia, O.
Fox Mch. Co., Grand Rapids, Mich.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Wrenches.
Armstrong Mfg. Co., Bridgeport, Conn.
Bemis & Call, H. & T., Co., Springfield, Mass.
Billings & Spencer Co., Hartford, Conn.
Carpenter, J. M., Tap & Die Co., Pawtucket, R. I.
Coes Wrench Co., Worcester, Mass.
Greene, Tweed & Co., New York.
Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Williams, J. H., & Co., Brooklyn, N. Y.

For Alphabetical Index see page 36

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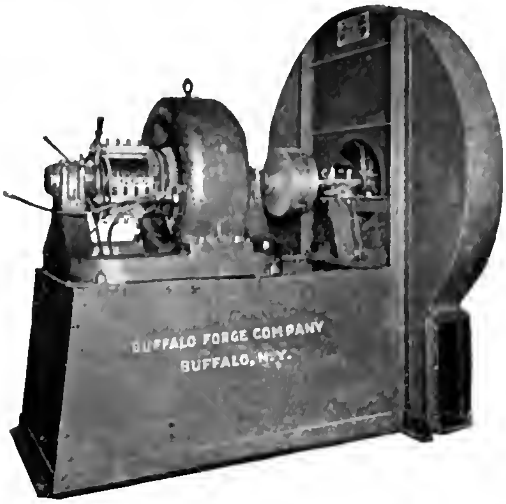

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1—No. 30 " " " "
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1 Small Turret Lathe.
1—18"x8' Porter Lathe.
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2 Gas Furnaces and Blower.
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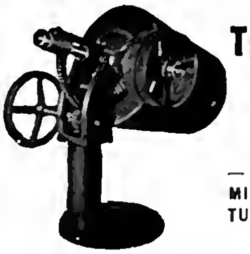

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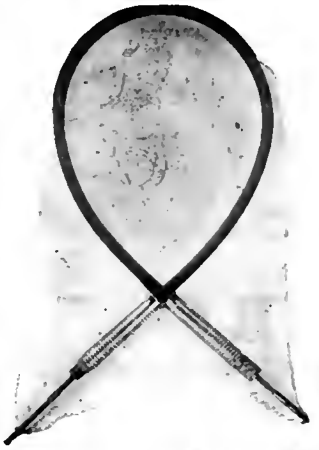

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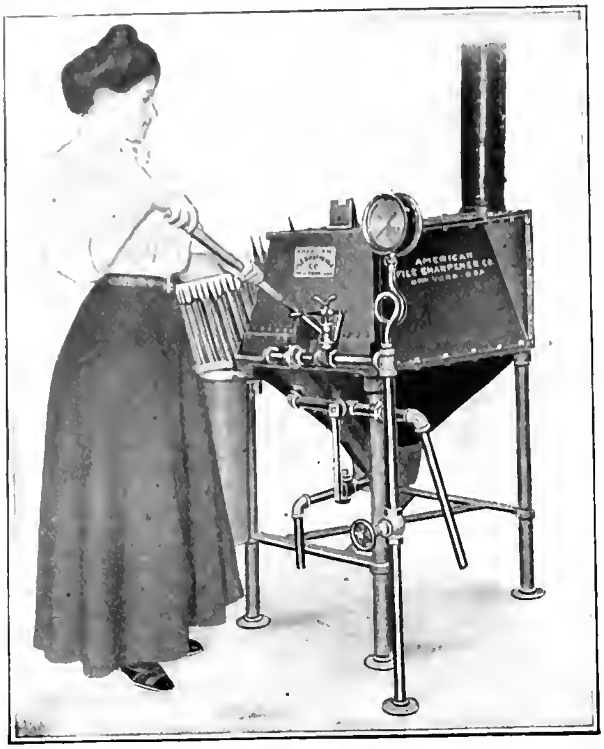

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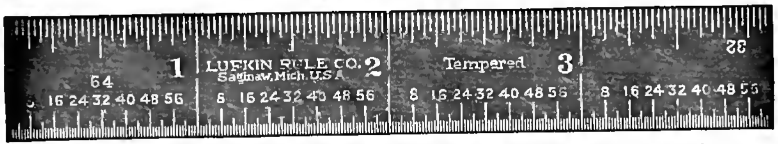

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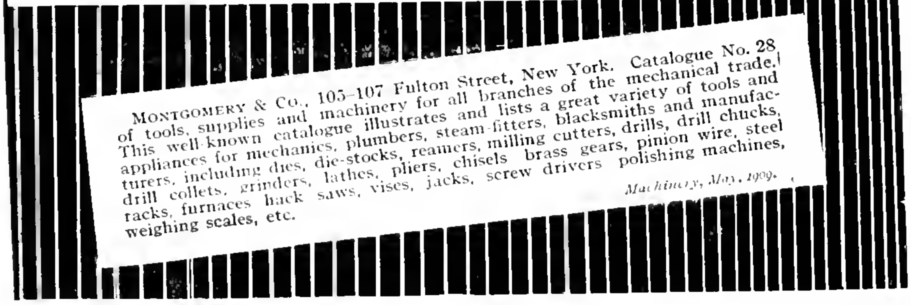

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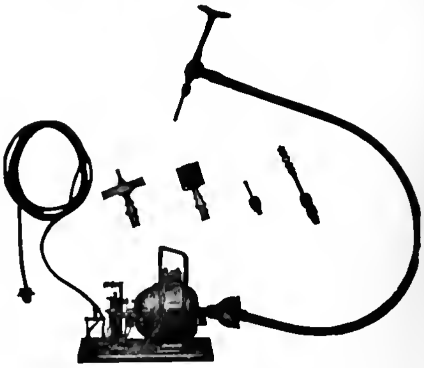


Old fashioned methods won't "go" in the up-to-date shop—why waste time on hand work that a

Stow Flexible Shaft

and Ready Electric Motor

will do more accurately and in a fifth of the time. One outfit serves for drilling, reaming, grinding, etc. Perfectly portable—just take it to the work.

Full particulars on request.

**Stow Flexible Shaft Co.
26th and Callowhill Sts.
PHILADELPHIA, PA., U. S. A.**

Gorton Engraving Machines

For engraving metal plates, dies, patterns, etc.—relief or sunken—in quick time and at small cost. *Write for details.*

Geo. Gorton Machine Co., Racine, Wis.

"MILWAUKEE"

The most powerful 16-inch engine lathe on the market.

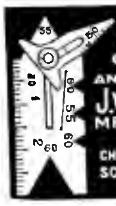
Ask for details.

**MILWAUKEE MACHINE TOOL CO.
MILWAUKEE, WIS.**

Screw Machines

Ask for circulars showing improved features.

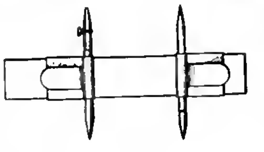
**SMURR & KAMEN MACHINE COMPANY
97 S. Clinton Street, Chicago, Ill.**



PATENT UNIVERSAL
SCREW-CUTTING
CENTRE, DEPTH, ANGLE,
AND **TWIST DRILL GAGE**
J. WYKE & CO. E. Boston Mass. U.S.A.
MFR'S FINE MACHINISTS TOOLS.
FOREIGN AGTS.
CHAS. CHURCHILL & CO. CROSS ST. LONDON ENGLAND
SCHUCHARDT & SCHÜTTE, SPANDAUER STRASSE
BERLIN, GERMANY.

Not too expensive to buy. Good enough to use is this

Beam Compass.



Every engineer, machinist, draftsman or home study student needs one. Ready for instant use.

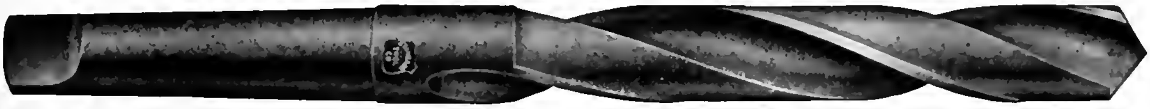
Complete with pen, pencil, needle points and 12-in. Beam, postpaid for $1.00.

P. S. ANROS CO., Lock Box 81A, North Tonawanda, N. Y.

THE STANDARD TOOL CO'S

Twist STANDARD TOOL CO. Drills

Carbon or High Speed

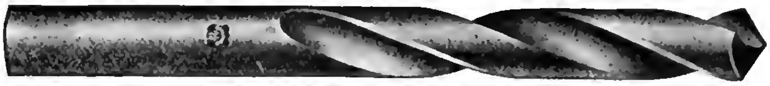


For All Kinds of Drilling

We can vary the construction or temper to meet any special condition. Years of experience in the manufacture of Twist Drills for every conceivable purpose, a factory and equipment that cannot be excelled, places us in a position to supply just what you need.

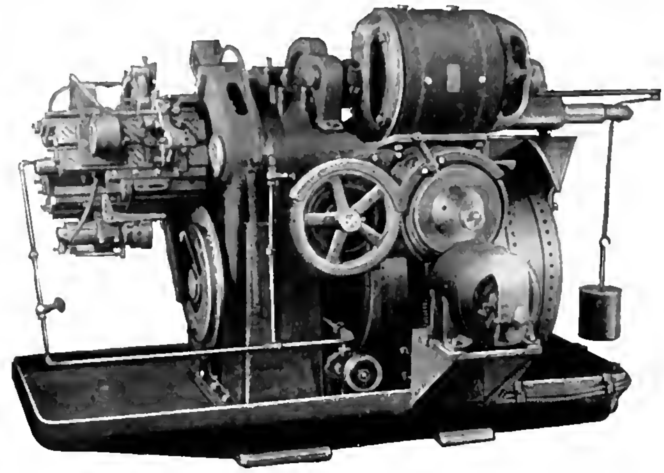
Give us the particulars regarding any of your work that is out of the ordinary and we will do the rest.

We solicit a trial order.



OFFICES AND FACTORY:
Cleveland, O., U. S. A.
C. W. Burton, Griffiths & Co., London. Burton Fils, Paris. F. W. Horne, Yokohama, Japan.

EASTERN SALESROOM:
94 Reade St., New York
J. Lambercier & Cie., Geneva. Wilh. Sonesson & Co., Malmo, Sweden. Honore Demoor & Cie., Bruxelles.



Front view of a Gridley Automatic Turret Lathe operated by two direct current Type CR General Electric Motors.

What Wages do you Pay your Machinery?

In paying your men you try to estimate their wages according to their producing power. You are careful to see that they do not idle away their time—that they are productive every minute of the working day.

Are you as careful to see that your machinery is working up to its highest efficiency?

Are "high salaried" machine tools wasting time because the power that moves them is not adequate?

Are your "low salaried" shafting, belts and pulleys wasting the power that should give impulse to the machinery?

In a word, are your machines giving you the returns you are paying for?

If driven by G. E. Motors they are.

Thousands of manufacturers who have thrown out other systems of motive power and replaced them with G. E. motors, will testify to the high earning power of these motors.

General Electric Motors have found extensive use in driving a great variety of Lathes, Drills, Grinders, Punches, Shears, Boring Mills, as well as many smaller tools.

There is no operation too small, no task too heavy or complicated to be satisfactorily and economically performed by a General Electric Motor.

The General Electric Company has a motor for every service, a controller for every motor, and engineers to combine them properly for any work.

Some of the Advantages of General Electric Motors for Machine Tools.

Economy of Power. In any belt-driven shop the line shafting, belts, pulleys, counter and jack shafts absorb from thirty to sixty per cent. of the total energy supplied by the prime mover. Where tools are driven by G. E. individual motors, practically none of the power is diverted from its useful purpose and the work done is almost exactly equivalent to the power used. Gangs of shafts, pulleys and belts are not adding an extra burden when the machinery is running, nor are they putting in time when the machinery is idle. If a rush job requires the use of only one or two machines, it can be put through without excessive factory costs.

Increased Production. In many cases the output of a factory has been *doubled* by the adoption of G. E. Electric Motors, *without the addition of a single tool,* through the use of individual and group drive as specific cases required. This increase in production is due to the advantages of speed control, ease of handling work and better arrangement of machines.

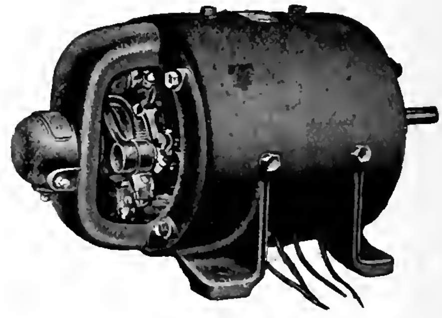
Ease of Control. Machines requiring it can be equipped with G. E. motors having a speed variation, making it possible to secure the highest efficiency and maintain constant cutting speeds for any and all classes of work. The Controller used on these motors is small and can be placed where most convenient to the operator.

Convenience of Handling. Where overhead cranes and trolley hoists are desired, G. E. individual motors make space available that in a belt-driven shop would be occupied by shafts and pulleys. Even where hoists are not required, the elimination of belts, shafting and pulleys contributes to cleanliness, light, safety and convenience in moving work.

Better Arrangement. With G. E. Electric Motors several tools used for a sequence of operations may be placed in the most advantageous positions for forwarding the work, which is not possible when the line shafting is the determining factor of location. This independence also permits the addition of motor-driven machines in belt-driven shops where little space is apparently available.

Ever ready Quality. G. E. Electric Motors are always ready. They will work where it is hot or cold, where cleanliness is essential or where dust and inflammable material fill the air.

Decreased Cost. G. E. Electric Motors eliminate the cost of expensive belt renewals, oiling and care of shafting and hangers, and the close attention which belt transmission makes necessary.



Type CR Form B Motor.

General Electric Company

New York Office
30 Church Street

PRINCIPAL OFFICE
Schenectady, N. Y.

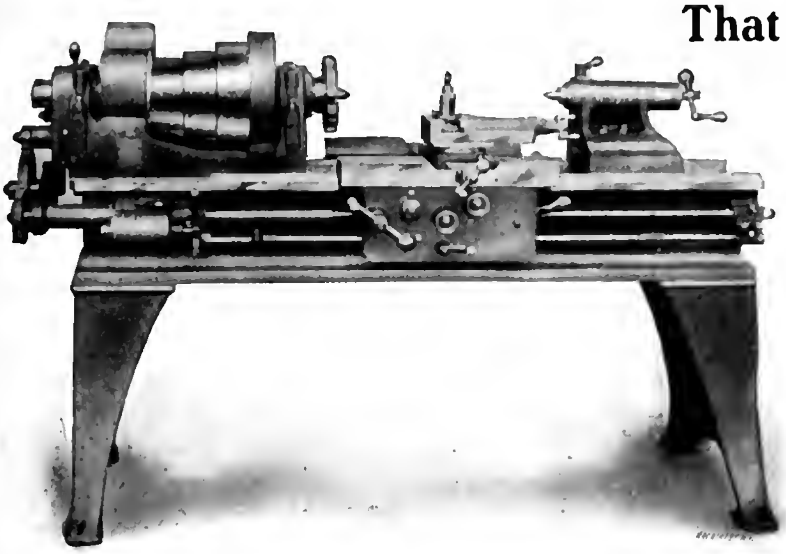
Sales Offices in
all large cities

2191

A Group of Springfield Tools

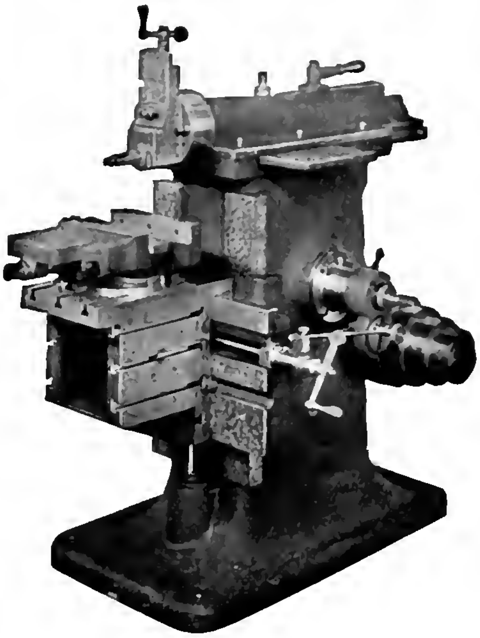
That have won their Spurs

Like all Springfield machines they are strong, simple in design and operation, and guaranteed to give the most efficient service.



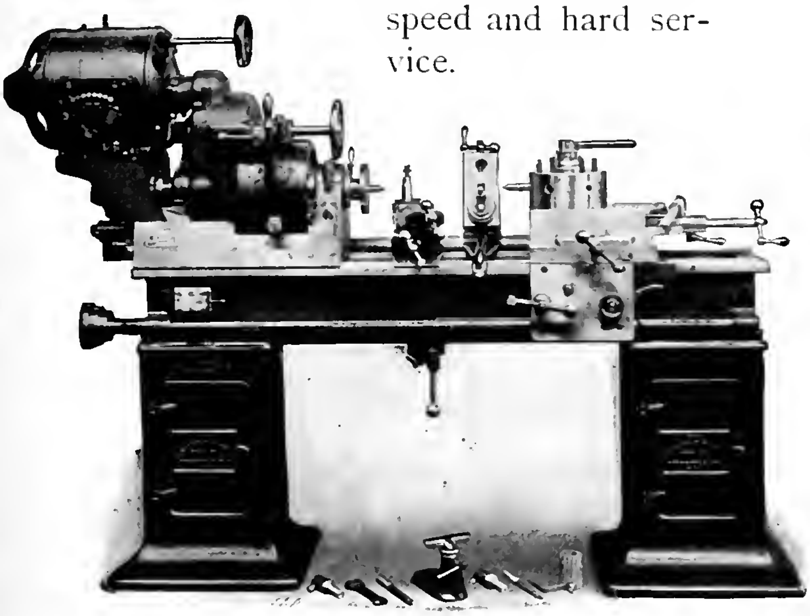
New Style Standard Engine Lathe

Three step cone, back gears, new feed changing mechanism. Adapted for high speed and hard service.



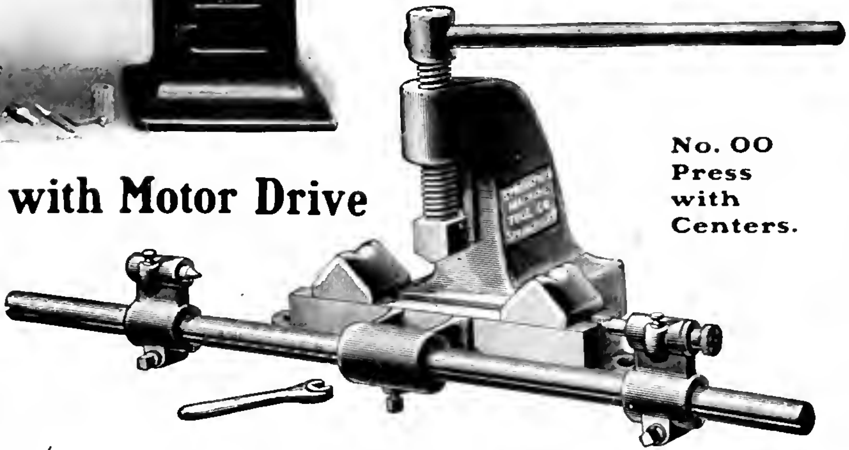
16-inch
Geared Crank Shaper

Heavy construction. Large bearing surfaces, heavy, self-aligning cross rail.



Brass Finishing Lathe with Motor Drive

Redesigned and improved in every part. Unequaled for rapid and accurate production.



No. 00 Press with Centers.

Bench Straightening Press.

Special Circulars mailed on request.

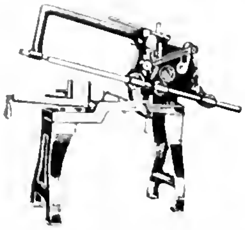
THE SPRINGFIELD MACHINE TOOL COMPANY

631 Southern Avenue, SPRINGFIELD, OHIO, U. S. A.

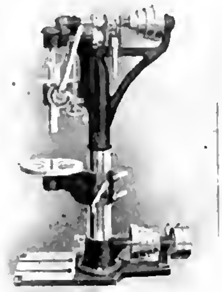
Agents for Chicago, McDowell, Stocker & Co., E. L. Essley Mchy. Co. Agents for Italy, Stussi & Zweifel, Milan. Agents for Germany, L. Loewe & Co., Berlin.

Our Royal Power Saws and Modern Drills

are improved right up to-date. No Machine Shop complete without them. Saws made in eight sizes. Drills 21-inch with Universal or solid tables.



Write for Circulars.



THE ROBERTSON DRILL & TOOL COMPANY
BUFFALO, N. Y., U, S. A.

REAMERS

The KELLY Adjustable

MADE IN

ONE STYLE ONLY

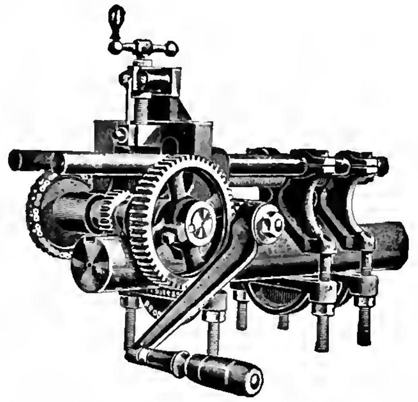
Finish, Ream or Rough-bore ANYTHING from a

ONE-INCH to a SIXTY-INCH CYLINDER

Type B for the Turret. Type C for Cylinders.

THE KELLY TOOL CO., Cleveland, U.S.A.

$40. F. O. B. New York.



This No. 1 Portable Shaft Keyseater

is indispensable to the repair shop. It will mill keyseats in the middle or on the ends of shafting from 1¼" to 5" in diameter without removing from the hangers. It can be slipped over heavy shafting or spindles when desired; can be operated in the most awkward places, and will mill a keyseat 12' long without resetting.

Other advantages are its rapid operation, accuracy of work produced and the fact that it cuts without jar or chatter of any kind.

We shall be glad to send full details on request.

JOHN T. BURR & SONS, 429 Kent Ave., Brooklyn, N. Y.

Selig, Sonnenthal & Co., London.

Sawyer Tool Mfg. Co.

FITCHBURG, MASS.

Machinists' Fine Tools.
Steel Rules a Specialty.

DRILL CHUCKS.

For sale by
De Fries & Co.,
Dusseldorf, Germany.
Charles Churchill & Co., Ltd.
London, Eng.

Trump Bros. Machine Company,
MANUFACTURERS
Wilmington, Del., U. S. A.

BRISTOL COUNTERS

The Counters that Count—and Count Right.

Simple, few parts, no spring. Adaptable for any machine, cannot be tampered with, and provide an infallible record of the day's output, which is automatically registered. Strong, convenient and compact. Ask for Catalogue No. 27.

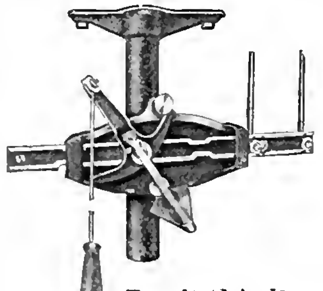
THE C. J. ROOT COMPANY, Bristol, Conn.

The "PULLET"

BELT-SHIFTER

To start "PULLET" To stop "PULLET"

The "Pullet" is quick as a wink, locks automatically, handle can be located directly over the work. Simple, durable, adjustable, reversible, dependable. Cut out the woodpile of "shipper" levers and install "Pullet" shifters or countershafts. Acquire the pull habit.



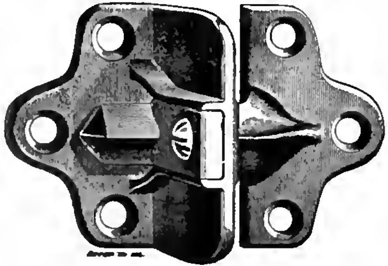
Don't think-- just pull!

The L. & D. Co., Boston

DISK GRINDERS

If in the market, our circular and prices WILL interest you.

Hoysradt & Case, Kingston, N.Y.



Frazer's Adjustable Malleable Iron Flask Pin

saves time, expense, and makes true castings. Quickly applied and easily adjusted.
Send for prices on our line of Pattern Makers' Specialties.

Milwaukee Foundry Supply Company
Milwaukee, Wis.

The Western (Triple Geared) Radial Drill

With the Low Hung Drive

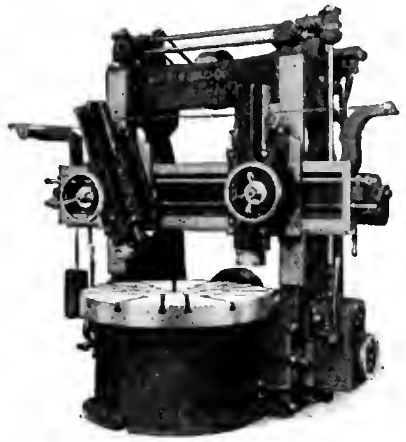
An improved design has just been completed. Write for particulars.

WESTERN MACHINE TOOL WORKS
Holland, Michigan

RADIAL DRILLS and ENGINE LATHES

THE JOHN B. MORRIS FOUNDRY CO., CINCINNATI, OHIO., U. S. A.

COLBURN
BORING MILLS

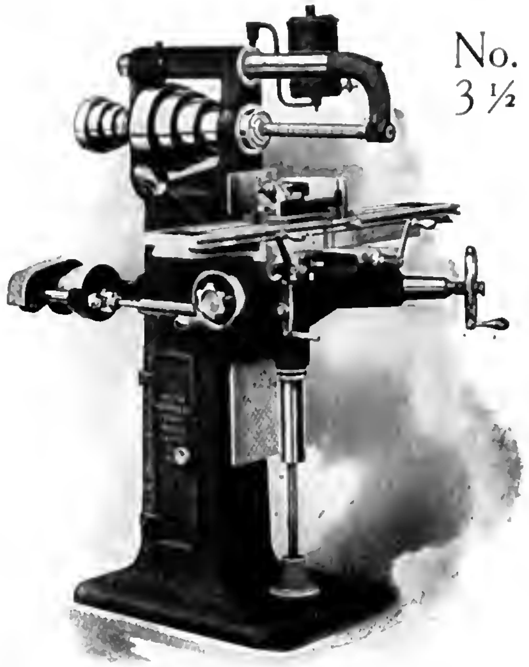


MECHANICAL BELT SHIFTERS on Colburn Mills save a lot of cuss words, likewise sore hands and enable the cone pulley belt to be shifted to any step with practically no more effort than is required in operating the controller for a variable speed motor.

Quick and frequent speed changes, when necessary, can and will be made by the operator of a mill equipped with our device.

Colburn Machine Tool Company
FRANKLIN, PA.

FOREIGN AGENTS: Ludw. Loewe & Co., Berlin and London



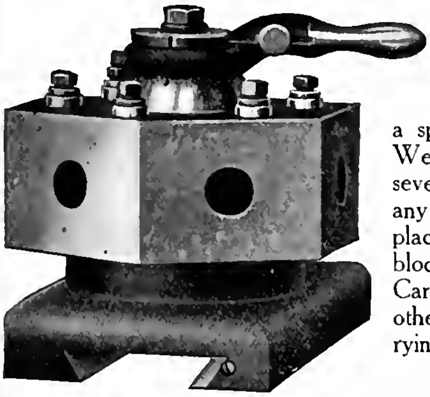
No. 3½

THE FOX LIGHT MILLERS

"came into their own" as soon as manufacturers discovered how distinctly good they were. The No. 3½ is a medium light Miller of unusual stiffness and power, with capacity for a very wide range of work, and will be found especially valuable for the tool-room or wherever small work is handled. Hand and power feed and all the "Fox" improvements. *Specify Catalogue 47.*

FOX MACHINE CO., 815-825 N. FRONT ST. GRAND RAPIDS, MICH.

Hexagon Carriage Turret



A device which soon pays its initial cost. Carriage turrets are a specialty with us. We make them in several styles to fit on any make lathe in place of the tool block. ROUND Carriage Turrets and other styles for carrying various tools.

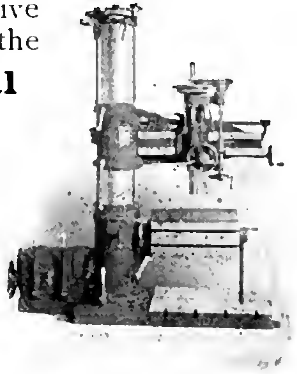
Circular?

FAY & SCOTT, DEXTER, MAINE

The combination Positive and Friction Feed of the

Mueller Radial Drill

is something that all drill users should investigate. It is especially valuable when using high speed tools.



When are you going to send for the circular?

THE MUELLER MACHINE TOOL CO., - Cincinnati, Ohio

NATIONAL
IN NAME
IN USE
IN SATISFACTION

MILLING CUTTERS

made any style or kind, of High-speed or Carbon steel. Outwear and outwork all other makes.

Clean, fast, accurate cutting; many other good business reasons why you should specify them.

Furnished "in a hurry," if you say so.

THE NATIONAL TOOL COMPANY
CLEVELAND, OHIO

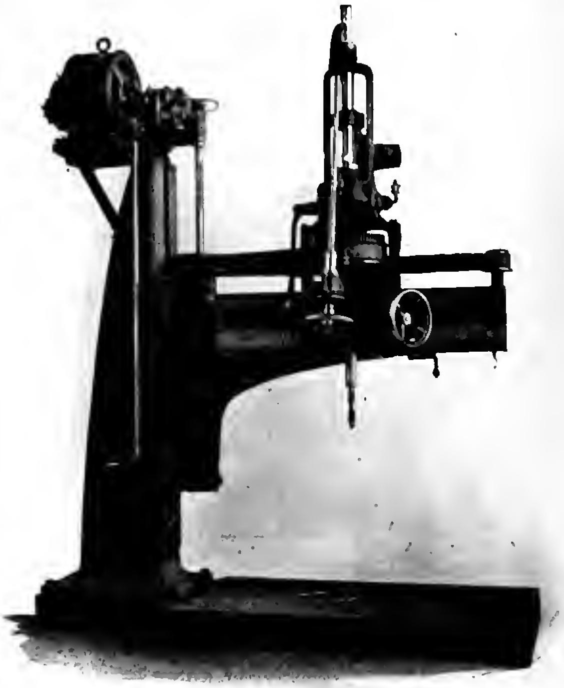
Pond Heavy Radial Drills

Regularly built in four sizes—five, six, seven and eight foot arms. Direct connected motor drive, five step cone or single pulley through speed box.

A very stiff and powerful machine for all kinds of heavy accurate work.

Easily handled—all levers and handles convenient to operator.

Write for catalog "Radial Drills."



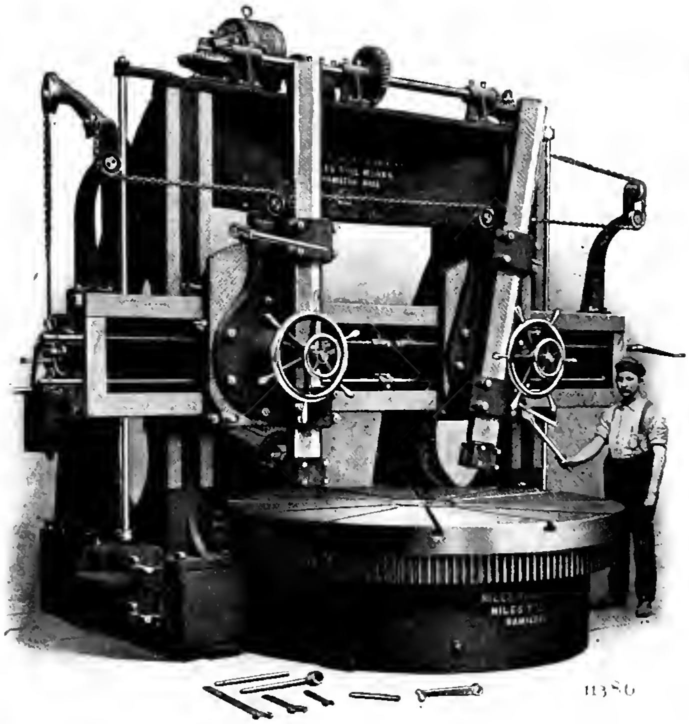
1398

6-ft. Pond Radial Drill.

NILES MILLS

Built in twenty-five sizes from 30-in. to 30-ft. swing. Driven through speed box by direct connected motor or single pulley. Belt driven machines may be readily changed to motor drive at any time.

Write for catalog "Niles Boring Mills."



11386

10-ft. Niles Boring and Turning Mill.

Bement Steam Hammers

250 to 40,000 lbs. falling weight. Variety of types including Single and Double Frame, Single and Double Open Frame, Steam and Board Drop, and Steel Tilting, covering all the requirements of modern forge practice.

Write for catalog "Bement Hammers."

1612

2000-lb. Bement Double Frame Steam Hammer.

Write for Catalog **NILES ELECTRIC CRANES**

NILES-BEMENT-POND COMPANY

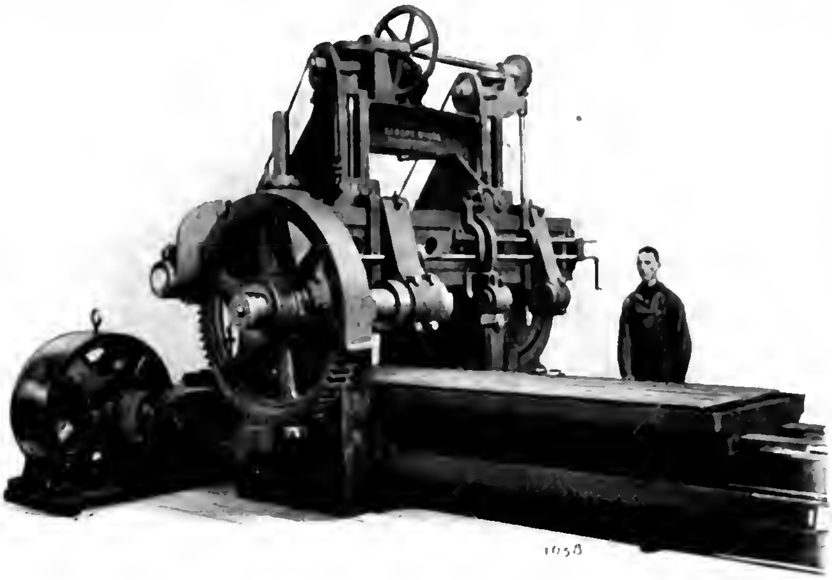
OFFICES—Boston, Oliver Bldg. Chicago, Commercial National Bank Bldg. Pittsburgh, Frick Bldg. St. Louis, 516 No. Third St. Philadelphia, 21st and Callowhill Sts. Birmingham, Ala., Brown-Marx Bldg. Agents for Canada, The Canadian Fairbanks Co., Ltd., Montreal, St. John, Toronto, Calgary,

Continuous Heavy Cuts

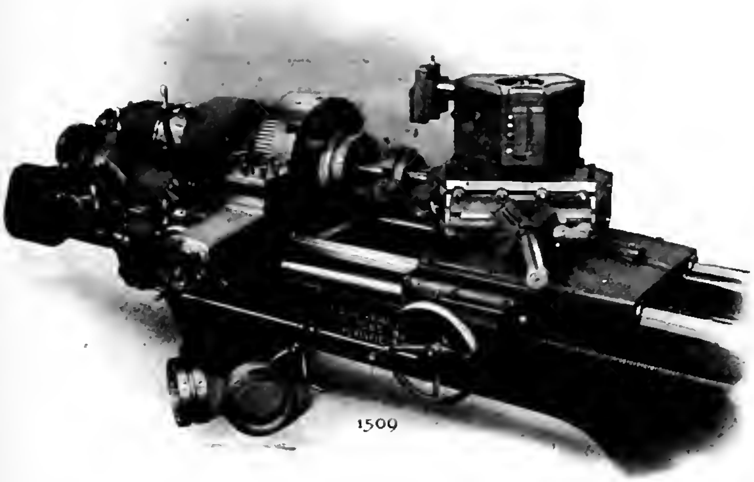
Bement Milling Machines are built in a variety of types and sizes, both vertical and horizontal.

They will use the latest improved Milling Cutters, with blades of high power steel, to their limit of endurance.

Write for catalog "Heavy Milling Machines."



48-inch Heavy Rod Milling Machine.



28-inch Pond Rigid Turret Lathe, also made in 21-inch.

Duplicate Chuck Work

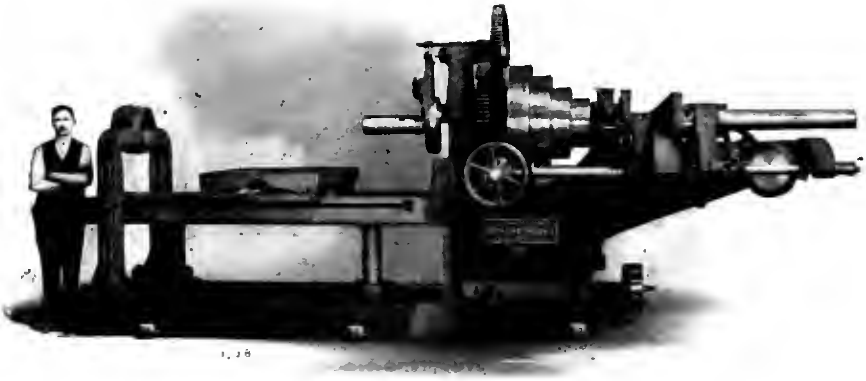
Pond Rigid Turret Lathe will show 50 to 150 per cent. increase in production on such work as gear blanks, fly wheels, gas engine cylinders, etc.

Tools are of wide adjustment and are rigidly attached to the wide faces of the turret which indexes and clamps automatically and is operated by power.

Write for Catalog "The Pond Rigid Turret Lathe."

Horizontal Boring and Drilling Machines

Built in several sizes for work on irregular pieces which are difficult to hold, such as automobile parts, cylinders, etc., etc. Several holes may be drilled and bored at one setting of the work.



80-inch Horizontal Boring and Drilling Machine.

Write for catalog "Horizontal Boring and Drilling Machines.

AND HOISTS 3-4 to 200 tons capacity

Trinity Building, 111 Broadway, New York

Winnipeg and Vancouver. Agents for California, Nevada and Arizona, Harron, Rickard & McCone, 461 Market St. San Francisco, and 164-168 N. Los Angeles St., Los Angeles, Cal. Italy, Ing. Ercole Vaghi, Milan. Germany, F. G. Kretschmer & Co., Frankfurt, a. M. Japan, F. W. Horne, 70-C Yokohama.

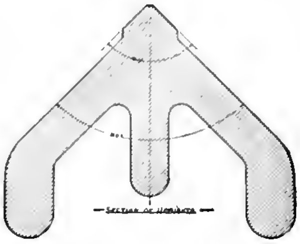
THE NEW

DROP HAMMER

The B. & S. Model "C"

¶ It has undergone the severest tests in our own drop shop and we unhesitatingly recommend it for yours.

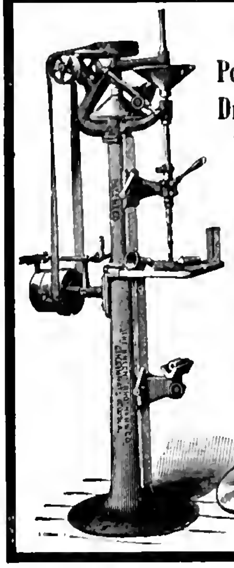
¶ An improved board clamp is located at the extreme top of the machine, where it is impossible for oil to get between the clamps and board. The front and rear friction rolls with their eccentrics are interchangeable, and are so adjusted that a true alignment between the lifting board and rolls is always preserved. The special bronze bearings are easily removed and replaced. All adjustments are made from the floor. Other important improvements



(Section of Upright.)

Full details and prices gladly sent on request.

THE BILLINGS & SPENCER CO.
HARTFORD, CONN.
London, 8 Long Lane, Aldersgate Street.



When Speed and Power are Right the Drills Don't Break.

The saving in drills alone, therefore, will more than pay for the installation of the

KNECHT-FRICTION SENSITIVE DRILL,

and the many other advantages will be clear gain. Don't you think it would pay you to investigate? Our book is ready.

THE KNECHT PLANER CO., 819 Wade St., CINCINNATI, O.

Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris. R. S. Stokvis & Zonen, Agents for Holland and the Dutch East Indies.

PARAGON SLEEVES

THEY'RE BUILT TO FURNISH A SIMPLE, STRONG, ACCURATE DRIVE FOR "FLATWIST" DRILLS

See Page 31 **The Cleveland Twist Drill Co.** See Page 31

COES WRENCHES

Steel Always Reliable

WRITE

COES WRENCH CO., Worcester, Mass.
Or, J. H. Graham & Co., J. C. McCarty & Co., New York.

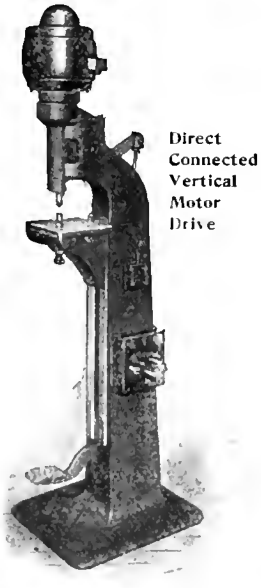
Automatic and Special Machinery

of all kinds designed and built. Inventions perfected. Builders of Variable Speed Iron Planers. Correspondence Solicited.

ENGINEERS AND MACHINISTS.
The W. A. Wilson Machine Co.
ROCHESTER, NEW YORK.

Millions of Rivets--but not a Single Flaw

One of our customers writes: *** "For the peining of rivets where it is absolutely essential that they shall not be up-set even to the slightest degree, I do not know of any machine that does the work as satisfactorily as the Grant. I think we have not had a single case of tight rivet in all the millions we have made with your machine."

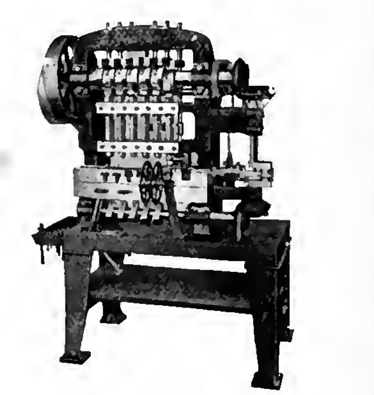


Direct Connected Vertical Motor Drive

THE GRANT RIVET SPINNING MACHINE

spins a perfect head on any rivet in one second, is noiseless, produces work that is uniform, accurate and dependable, and has capacity up to 3/8" rivets.

The Grant Mfg. and Machine Company
80 Silliman Avenue, BRIDGEPORT, CONN.



MULTIPLE PLUNGER PRESSES
CUT AND CARRY PRESSES
SINGLE, DOUBLE AND TRIPLE ACTION PRESSES

Presses of almost every description for working sheet metal.

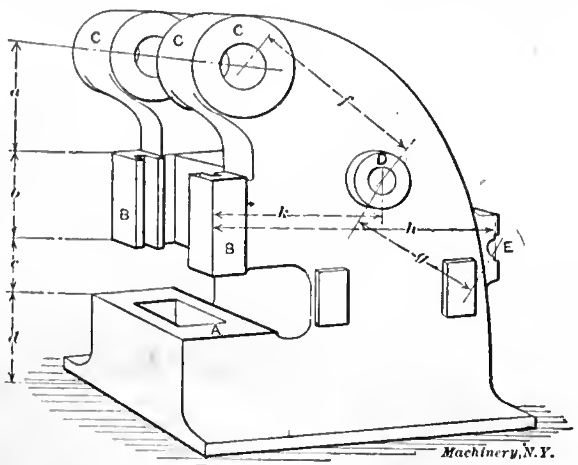
The Waterbury Farrel Foundry & Machine Company
WATERBURY, CONN., U. S. A.
Western Office: Cleveland, Ohio, 1012 Williamson Bldg.

Supplement to MACHINERY, August, 1909

Operations for the Article in this number entitled "Machine Shop Practice—Laying out Work—I"

SHOP OPERATION SHEET NO. 106.

Oscar E. Perrigo. MACHINERY, August, 1909



Machinery, N.Y.

To Inspect and Measure a Punch-press Casting.

NOTE.—The object of this inspection is to ascertain if the casting is sound, and if it will probably finish up to the dimensions given on the drawing.

1. Examine the casting inside and outside for evidences of shrinkage cracks, blow holes and "spongy spots." With a hammer "sound" all suspicious spots for internal blow holes and shrinkage cavities.

2. With a square resting on the die-block base *A*, and the blade upward against the guides *B*, determine by measurement if the latter are central, and the proper distance apart, to finish to the required dimensions. With the square on top of the guides *B*, determine whether the bosses *C* are central, and the proper distance apart, allowing, as before, for finishing. Measure the distance between the outside of each boss to see whether the difference between this and the finish dimension is enough to allow for finishing.

3. Note if the cored holes at *C*, *D*, and the half hole at *E* are small enough to allow for finishing.

4. Fit pieces of brass across the holes in the bosses *C*, *D*, and the bearing *E*; and lay off centers on them.

5. Note if the vertical distances *a*, *b*, *c* and *d* are proper; that is, see if dimensions *b* and *d* equal the finish dimensions plus two finishes; *c* the finish dimension minus two finishes, and *a* the finish dimension minus one finish.

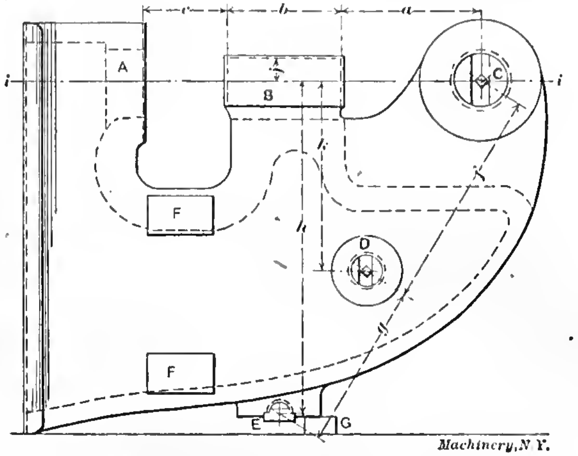
6. Note if a vertical line which is central with the guides *B* is also central with the bosses *C*.

7. Measure the center distances *f* and *g*, to see if they are correct; also the dimensions *k* and *h*, which should equal the finish dimension plus one finish.

NOTE.—When a single casting, of the kind shown, is to be machined, the preliminary inspection to determine the correctness of the casting is advisable, but when this is ascertained, if there were a number of similar castings to be finished, such detailed inspection would not be necessary.

SHOP OPERATION SHEET NO. 107.

Oscar E. Perrigo. MACHINERY, August, 1909.



Machinery, N.Y.

To Lay Out the Side of a Punch-press Casting for Machining.

1. Plane the bottom of the casting, setting it so that the base flange will be of uniform thickness. The amount of metal removed should be just enough to true the base. Care should be taken to see that the base will finish approximately at right angles with the center line *v—v* shown in Operation Sheet No. 108.

2. Chalk all surfaces on the rough casting where scriber lines are to be drawn.

NOTE.—The amount of stock to be taken off in roughing and finishing should be as nearly equal on all surfaces as possible.

3. Place the casting on a surface plate or planer table, in the position shown in the illustration. Set the finished base square with the surface plate supporting the casting by blocks, as at *G*.

4. With a surface gage test the centers *C* of the large bosses, on each side of the work; the casting should be adjusted until these centers are the same distance from the surface plate. Then with the pointer of the gage set to coincide with *C*, scribe center lines *i—i*; also scribe the center line *p—p*. (See Shop Operation Sheet No. 108.)

5. Scribe lines above the center line equal to dimension *j*. Lower the gage pointer a distance *k*, and scribe center lines for bearings *D*. Set the pointer to dimension *h* and scribe center lines for bearings *E*.

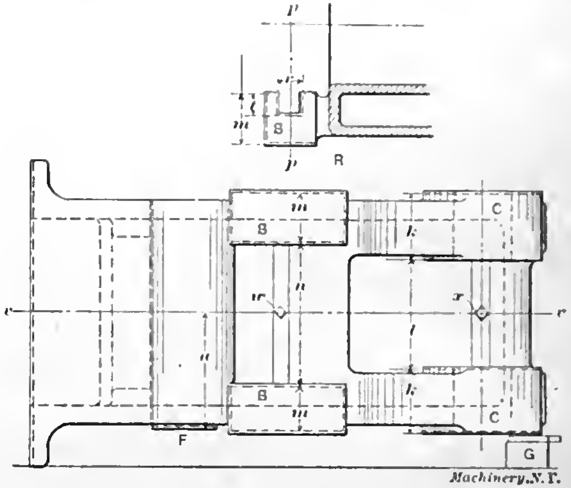
6. Set a pair of beam trammels to dimension *f* and, with point *C* as a center, locate centers of bearings *D*. Set the trammels to dimension *g* and locate centers of bearings *E*.

7. Place the casting in an upright position on its finished base. Set the pointer of the surface gage a distance *a* below center *C*, and scribe the finish lines for the tops of guides *B*. Lower the pointer distances *b* and *c*, successively, and scribe the remaining lines.

8. With a pair of dividers scribe circles equal to the size of the bearings *C*, *D* and *E*, on each side of the casting.

SHOP OPERATION SHEET NO. 108.

Oscar E. Perrigo. MACHINERY, August, 1909



Machinery, N.Y.

To Lay Out the Front of a Punch-press Casting for Machining.

1. Place the casting on the surface plate in the position shown in the illustration. Fit a wooden centering piece between the guides *B* and locate a point *w* central with the outside surfaces of the guides. Fit a second centering piece between the bosses *C*. Insert blocking and a wedge at *G*, and by means of the wedge, adjust the work until the finished base is perfectly square with the surface plate.

2. With a square ascertain if the center line *p—p*, which was previously scribed across the tops of the guides *B*, is at right angles with the surface plate. If it is necessary to adjust the casting, this may be done by inserting a thin steel wedge beneath the base flange.

3. Lay off on the front of the guides finish-lines to the required dimensions *n* and *m*, *m* working from the central point *w*. Transfer these lines to the top surfaces of the guides as illustrated at *R*, where a plain view of one of the guides is shown; this should be done with a surface gage.

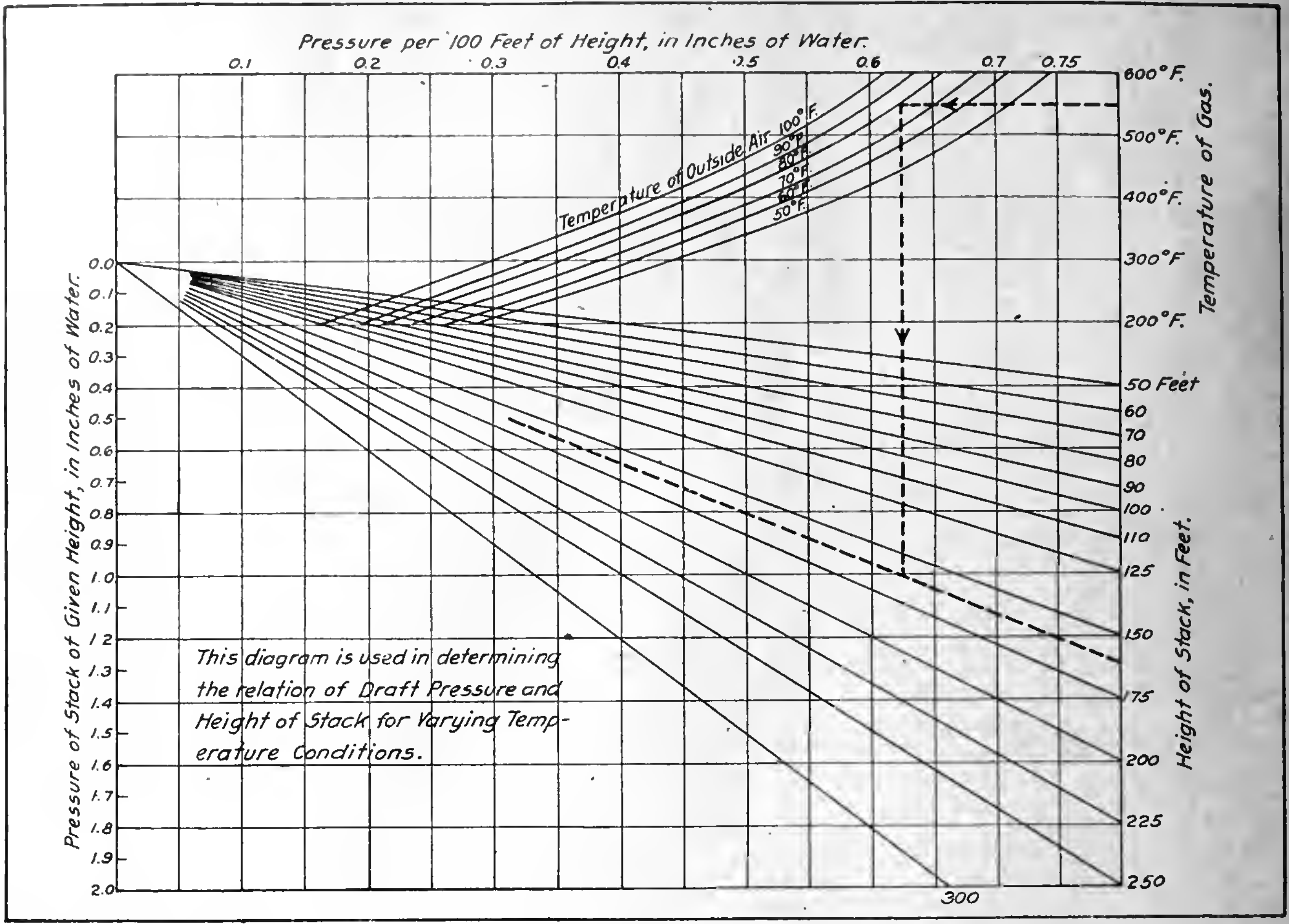
4. The lines indicated by dimensions *t* and *r* are next laid out, the latter being parallel with the center line *p—p* and central with it.

5. The center *w* is now transferred to the center piece between bosses *C*, and lines to the dimensions *l* and *k*, *k*, laid off on the bosses central with the center *x*.

6. Lay off the dimension *u* for planing the pads *F*.

NOTE.—Upon first going over these lines it may frequently be found that at some point there is not stock enough to "clean up." Then the lines, involving several dimensions perhaps, must be changed to equalize the amount to finish off. It would be well before planing the base of this particular casting to locate the centers *w* and *x* and a line *i—i* (see preceding sheet), and then set the work so that the finished base would be at right angles with the center lines *v—v* and *i—i*.

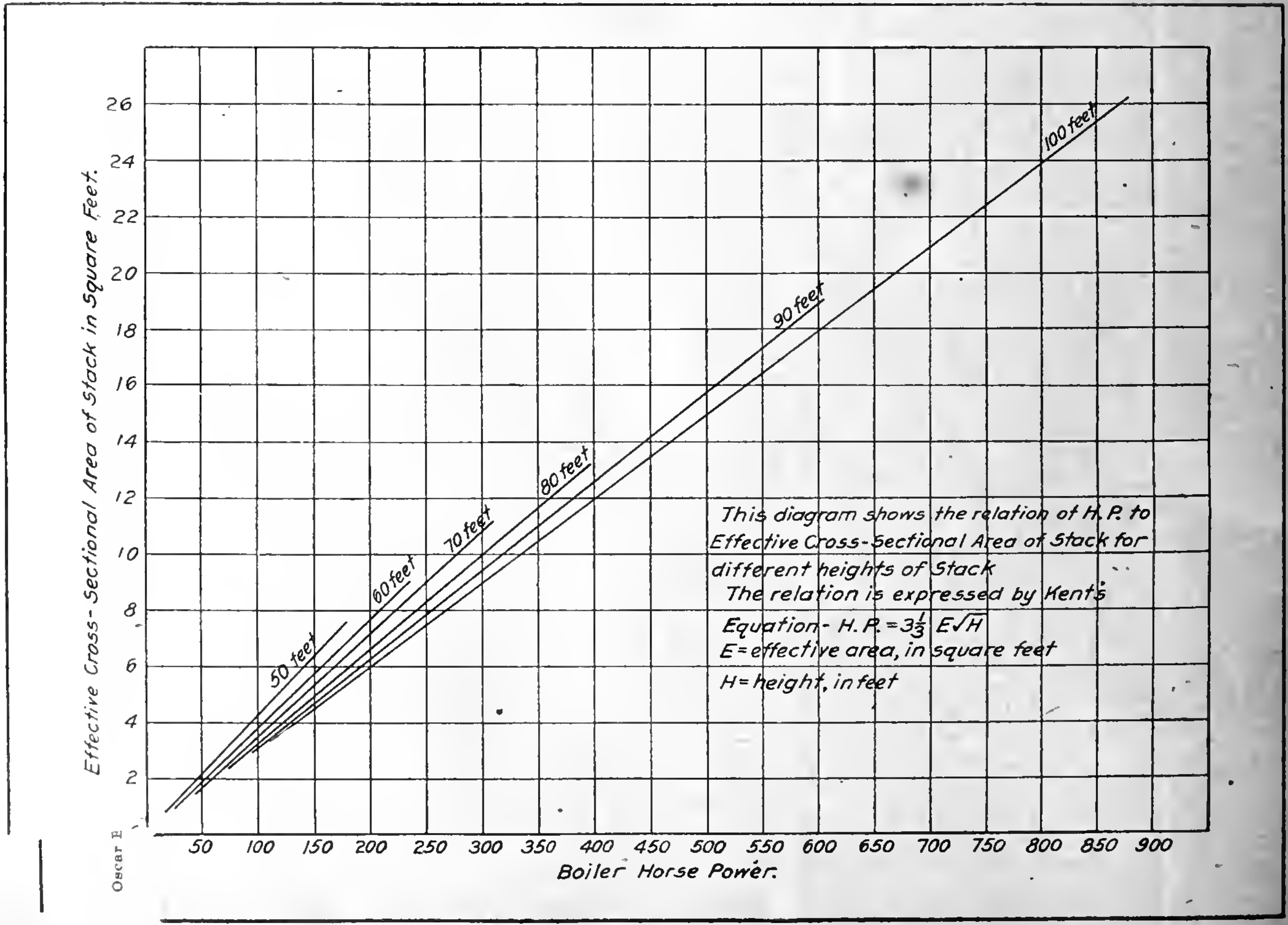
I.—DRAFT PRESSURE OF STACKS FOR TEMPERATURES AND HEIGHTS



This diagram is used in determining the relation of Draft Pressure and Height of Stack for Varying Temperature Conditions.

Contributed by A. J. Haire, Jr.

II.—HORSEPOWER AND AREA OF STACKS



This diagram shows the relation of H. P. to Effective Cross-Sectional Area of Stack for different heights of Stack

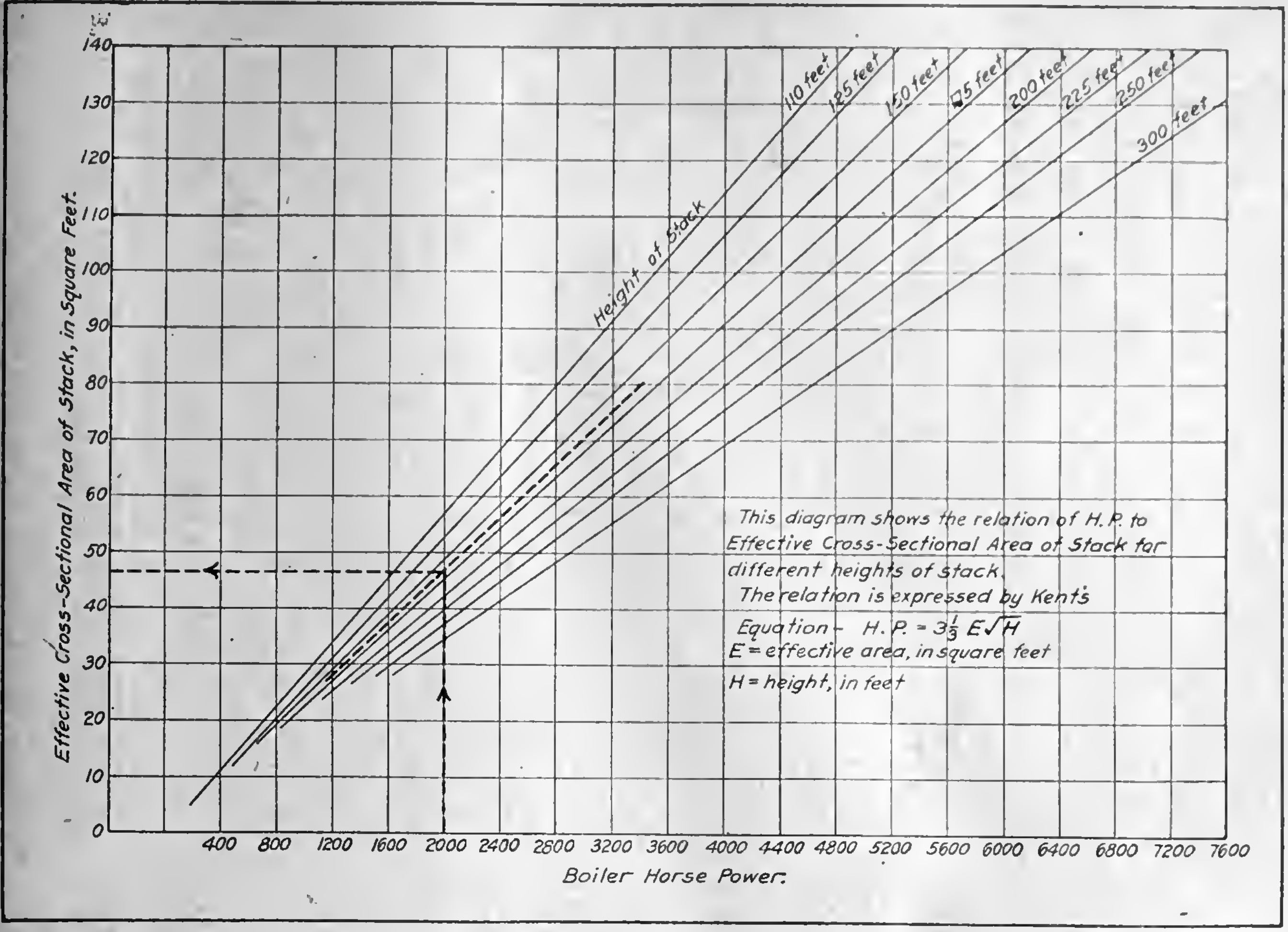
The relation is expressed by Kent's Equation - $H.P. = 3\frac{1}{3}\, E\sqrt{H}$

E = effective area, in square feet

H = height, in feet

A. J. Haire, Jr.

III.—HORSEPOWER AND AREA OF STACKS



This diagram shows the relation of H.P. to Effective Cross-Sectional Area of Stack for different heights of stack.

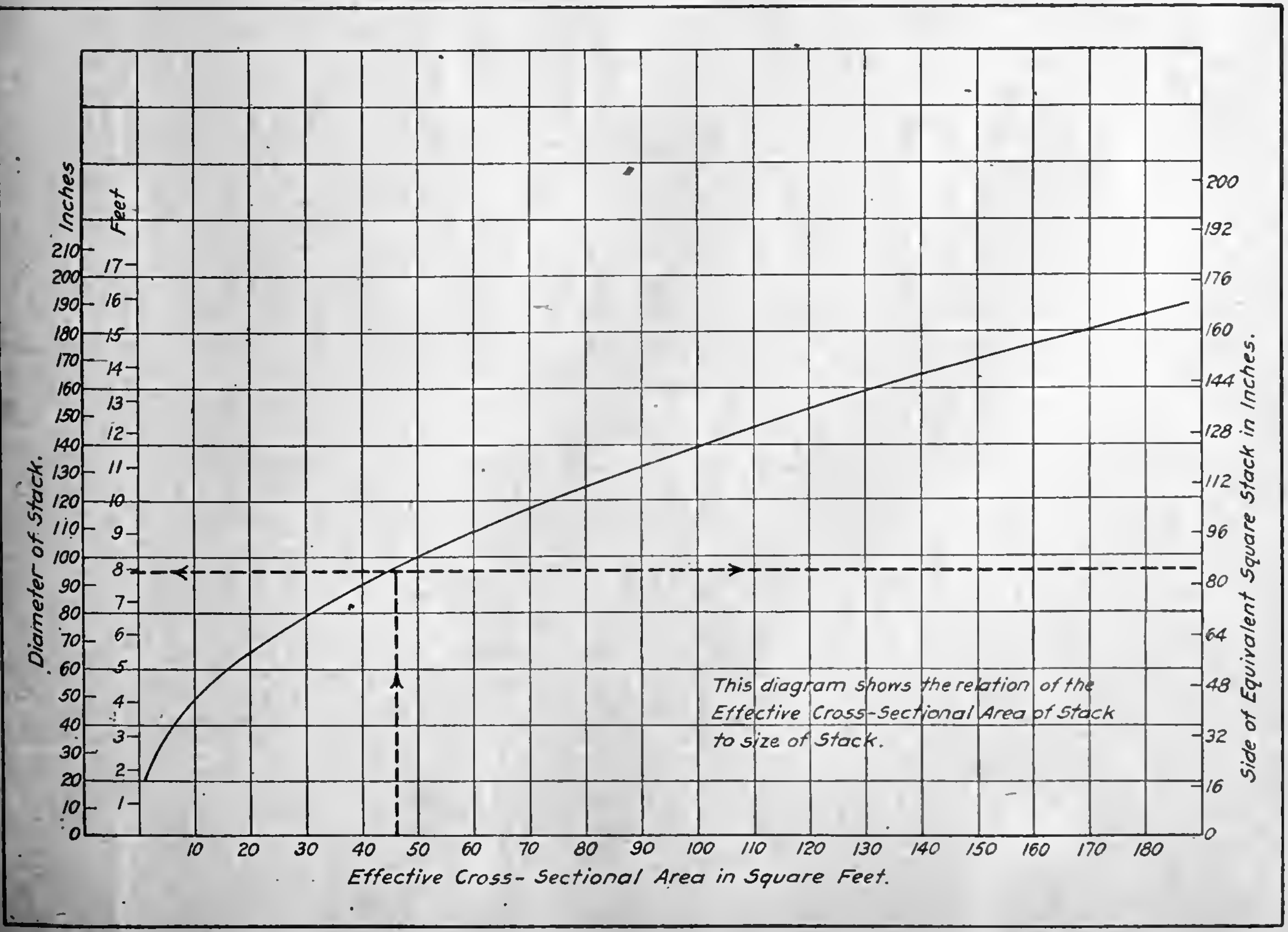
The relation is expressed by Kent's Equation – $H.P. = 3\frac{1}{3} E\sqrt{H}$

E = effective area, in square feet

H = height, in feet

Contributed by A. J. Haire, Jr.

IV.—EFFECTIVE AREA AND SIZE OF STACKS



This diagram shows the relation of the Effective Cross-Sectional Area of Stack to size of Stack.

Contributed by A. J. Haire, Jr.

MACHINERY

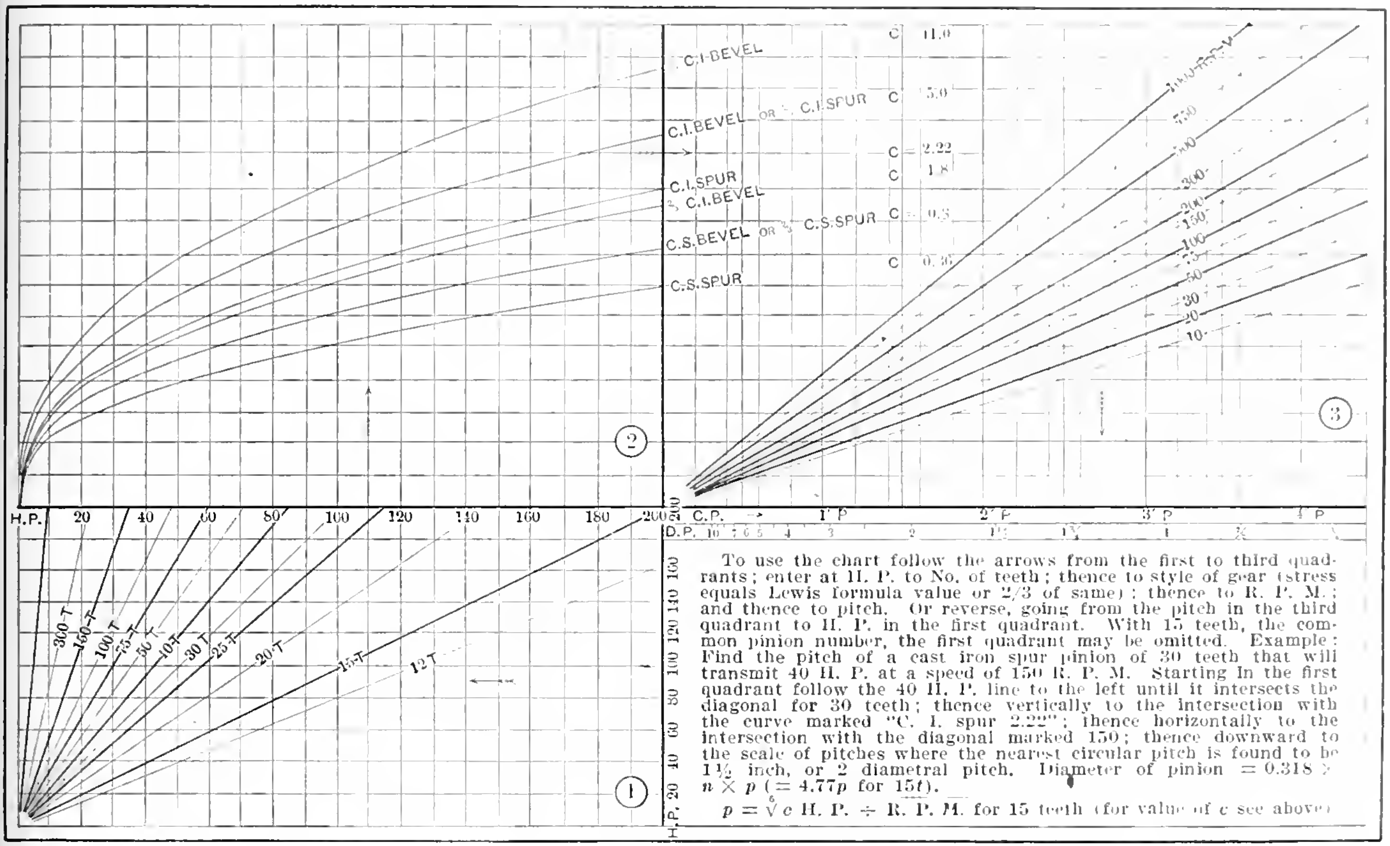
August, 1909

SIMPLIFIED GEAR FORMULAS*

HORSE-POWER, PITCH, DIAMETER, WEIGHT AND PRICE

C. R. WHITTIER†

It is generally conceded that the Lewis formula for the strength of gear teeth, with its accompanying tables, is the most accurate in form, as the maximum strength of each tooth is determined from its shape. It may be safely used for determining the strength of gears made by modern methods, but its tabulated form makes it difficult to use from the standpoint of the designers. It is well adapted to determine the strength of any given gear or pinion. But the reverse process—that of finding a gear suitable to meet the condition of a given horse-power and revolutions per minute is not so simple; the trial-and-error method being a lengthy one at the best. The following deductions give close and rapid approximations for preliminary work.



To use the chart follow the arrows from the first to third quadrants; enter at H. P. to No. of teeth; thence to style of gear (stress equals Lewis formula value or 2/3 of same); thence to R. P. M.; and thence to pitch. Or reverse, going from the pitch in the third quadrant to H. P. in the first quadrant. With 15 teeth, the common pinion number, the first quadrant may be omitted. Example: Find the pitch of a cast iron spur pinion of 30 teeth that will transmit 40 H. P. at a speed of 150 R. P. M. Starting in the first quadrant follow the 40 H. P. line to the left until it intersects the diagonal for 30 teeth; thence vertically to the intersection with the curve marked "C. I. spur 2.22"; thence horizontally to the intersection with the diagonal marked 150; thence downward to the scale of pitches where the nearest circular pitch is found to be 1½ inch, or 2 diametral pitch. Diameter of pinion $= 0.318 \times n \times p$ ($= 4.77p$ for $15t$).

$p = \sqrt[6]{c \text{ H. P.} \div \text{R. P. M.}}$ for 15 teeth (for value of c see above)

Machinery, N.Y.

Three Quadrant Gear Chart for Solution of Spur and Bevel Gear Problems, based on Lewis Formula M = s p f y; for 15-degree Involute and Cycloidal Teeth

As both the gear and its pinion are usually made of the same material, either cast iron or cast steel, the strength of the pair is determined by the strength of its weakest member, which is the pinion when made of the same metal as the gear. For economical reasons the pinion is usually limited to about 15 teeth, so we may take that number as a convenient base. Circular pitch is used in the calculations, but the circular pitch can finally be transformed to diametral pitch if this is desired.

In a train of gears, the maximum reduction on any pair is usually taken at 4 or 5 to 1, so the number of reductions and ratios may be quickly deduced. Then the problem is usually presented as follows:

Given the H. P. and R. P. M. to find the Working Stress, Pitch, Face and Diameter

Given the horsepower and revolutions per minute of the pinion, what will be the allowable working stress, pitch, face, factor of strength and diameter?

The majority of trade gear lists give the horsepower of gears at 100 r. p. m. with an allowable stress for cast iron of 3,000 pounds per square inch. But it is more difficult to transform this horsepower to suit the other conditions, than to proceed independently.

The values of s, the safe working stress, which Mr. Lewis adopted tentatively, as they gave satisfactory results in practice, were as follows:

Let v = speed of teeth in feet per minute and s = safe working stress, then

For v =	100 (or less)	200	300	600	900	1,200	1,800	2,400
For cast iron:								
s =	8,000	6,000	4,800	4,000	3,000	2,400	2,000	1,700
For cast steel:								
s =	20,000	15,000	12,000	10,000	7,500	6,000	5,000	4,300

When these values are plotted, it will be seen that the curves, though slightly irregular, closely approximate curves of the hyperbolic form. The equations of the curves which most nearly agree with the Lewis values, are found to be the following:

$$\text{For cast iron, } s = \frac{88{,}000}{\sqrt{v}}.$$

$$\text{For cast steel, } s = \frac{220{,}000}{\sqrt{v}}.$$

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* For additional information on this subject, see "The Variation of the Strength of Gear Teeth With the Velocity," January, 1908, and articles there referred to, and Data Sheet supplement, January, 1908.

† Address: 204 West 111th St., New York.

These formulas give the following comparative values:

When v =	100	200	300	600	900	1,200	1,800	2,100
For cast iron								
s =	8,800	6,250	5,000	3,600	2,930	2,540	2,080	1,790
For cast steel,								
s =	22,000	15,625	12,500	9,000	7,325	6,350	5,200	4,475

The agreement with the Lewis assumed values is remarkably close. The new values will probably come much nearer the true ones, as they are in much better line. They are also much more dependable, as the stress suitable for any speed can be easily found from the formula to the fraction of a pound if desired, on a true curve; whereas, the use of the tabular values results in the substitution of values which descend by variable steps of from 2,000 to 300 pounds at a jump, or if ordinary interpolation is used the result is still inaccurate, as the interpolation necessarily follows a straight line between the two nearest values, and is thus too high. The new curve values also come nearer to the comparative Harkness values as given by Kent.

The face of gears, f, is another variable quantity; but in the manufacturer's standard lists of to-day the face is usually about 3 times the pitch, and this may be adopted as close enough for preliminary work. It will be found that the majority of stock gears have either 15-degree involute or cycloidal teeth, so these styles will be used in these calculations. The factor of strength, y, in the Lewis tables for a 15-tooth pinion of these types is 0.075. We have, therefore, the following data for a 15-tooth cast iron spur pinion:

Let s = safe working stress, in pounds;
p = circular pitch, in inches;
f = face, in inches;
y = factor of strength;
v = speed of pitch line, in feet per minute.

The Lewis general formula reduces to

$$\text{H. P.} = \frac{spfyv}{33{,}000}.$$

From our average determination above, we have:

$$s = \frac{88{,}000}{\sqrt{v}},$$

$$f = 3\,p.$$

$$y = 0.075.$$

Substituting these values in the general formula and reducing, we have for a 15-tooth cast iron spur pinion:

$$\text{H. P.} = 0.6\,p^2\sqrt{v} \quad \dots\dots (1)$$

By a similar process, we find for a 15-tooth cast steel spur pinion:

$$\text{H. P.} = 1.5\,p^2\sqrt{v} \quad \dots\dots (2)$$

For a bevel pinion, let
d = small diameter of bevel.
D = large diameter of bevel.

$$\text{Then H. P.} = \frac{spfyv}{33{,}000} \times \frac{d}{D}.$$

As $\frac{d}{D}$ usually equals $\frac{2}{3}$, we can say:

$$\text{H. P.} = \frac{spfyv}{33{,}000} \times \frac{2}{3}.$$

and for a 15-tooth cast iron bevel pinion,

$$\text{H. P.} = 0.4\,p^2\sqrt{v} \quad \dots\dots (3)$$

For a 15-tooth cast steel bevel pinion,

$$\text{H. P.} = p^2\sqrt{v} \quad \dots\dots (4)$$

We now wish to find v in terms of revolutions per minute. For a 15-tooth pinion, approximately:

$$v = \frac{15 \times \text{r.p.m.} \times p}{12} = 1.25\ \text{r.p.m.} \times p.$$

Substituting this value in (1) we have:

$$\text{H. P.} = 0.6\,p^2\sqrt{1.25\ \text{r.p.m.} \times p}.$$

$$\text{Squaring,}\quad \text{H. P.}^2 = 0.36\,p^4\,(1.25\ \text{r.p.m.} \times p).$$

Reducing, and solving for p, we have for cast iron spur pinion:

$$p = \sqrt[5]{\frac{2.22\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \dots\dots (5)$$

A similar substitution and reduction in formulas Nos. (2) (3) and (4) gives the following:

$$\text{For c. s. spur, } p = \sqrt[5]{\frac{0.36\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \dots\dots (6)$$

$$\text{For c. i. bevel, } p = \sqrt[5]{\frac{5.0\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \dots\dots (7)$$

$$\text{For c. s. bevel, } p = \sqrt{\frac{0.8\ \text{H. P.}^4}{\text{r.p.m.}}} \quad \dots\dots (8)$$

For rapidly varying loads, or where there is much starting and stopping, it is well to reduce the safe stress to two-thirds that allowed by the above formulas. We then have:

$$\text{For c. i. spur, H. P.} = 0.4\,p^2\sqrt{v};\ p = \sqrt[5]{\frac{5\ \text{H. P.}^2}{\text{r.p.m.}}} \quad (9)$$

$$\text{For c. s. spur, H. P.} = p^2\sqrt{v};\ p = \sqrt[5]{\frac{0.8\ \text{H. P.}^2}{\text{r.p.m.}}} \quad \dots\dots (10)$$

$$\text{For c. i. bevel, H. P.} = 0.27\,p^2\sqrt{v};\ p = \sqrt[5]{\frac{11.0\ \text{H. P.}^2}{\text{r.p.m.}}} \quad (11)$$

$$\text{For c. s. bevel, H. P.} = 0.67\,p^2\sqrt{v};\ p = \sqrt[5]{\frac{1.8\ \text{H. P.}^2}{\text{r.p.m.}}} \quad (12)$$

The fifth root can be easily determined by logarithms on the slide rule, or from the usual tables, but the values for the common cases are given in the following:

Corrections for Tooth Numbers

It now remains to determine the correction for different numbers of teeth.

As the teeth of pinions generally range from 12 to 30, we need not go outside these limits. Let n = number of teeth. Plotting the Lewis values for y for this case, and determining the nearest curve, we find that the straight line formula:

$y = \frac{2n + 45}{1{,}000}$ expresses this curve very closely, as will be seen by the following comparative table:

No. of Teeth, n	y by Formula	y from Lewis's Tables	No. of Teeth, n	y by Formula	y from Lewis's Tables
12	0.069	0.067	19	0.083	0.087
13	0.071	0.070	20	0.085	0.090
14	0.073	0.072	21	0.087	0.092
15	0.075	0.075	23	0.091	0.094
16	0.077	0.077	25	0.095	0.097
17	0.079	0.080	27	0.099	0.100
18	0.081	0.083	30	0.105	0.102

Therefore, for other teeth, we can multiply the horsepower given in the above formulas by $\frac{2n + 45}{75}$, or more briefly, by $0.027\,n + 0.6$.

Correction for Increased Velocity

We must also correct for the increased velocity of this larger pinion, *i. e.*, multiply the result by $\sqrt{\frac{n}{15}}$ or $0.26\sqrt{n}$.

The continued product of these last two multipliers might be used, but this does not simplify the calculation. These corrections need seldom be applied for preliminary work.

To Find the Pinion Diameter

Lastly, to find the diameter of the pinion, approximately:

$$\text{diameter} = \frac{n \times p}{\pi}, \text{ or}$$

$$\text{diameter} = 0.318\,n\,p,$$

or for a 15-tooth pinion,

$$\text{diameter} = 4.77\,p \quad \dots\dots (13)$$

If diametral pitch is desired, it is sufficiently close to say:

$$\text{diametral pitch} = \frac{3}{p} \quad \dots\dots (14)$$

The following formulas, therefore, Nos. (5) to (14) (as deduced above), give closely enough for all preliminary determinations, the size of pinion required of 15 teeth.

$$\begin{array}{rcc} & \text{Stress = Lewis' Tables} & \text{Stress = Lewis Tables} \\ \text{c. i. spur, } p = & \sqrt[5]{\dfrac{2.22\text{ H. P.}^2}{\text{r.p.m.}}} & \sqrt[5]{\dfrac{5.0\text{ H. P.}^2}{\text{r.p.m.}}} \\ \text{c. s. spur, } p = & \sqrt[5]{\dfrac{0.36\text{ H. P.}^2}{\text{r.p.m.}}} & \sqrt[5]{\dfrac{0.8\text{ H. P.}^2}{\text{r.p.m.}}} \\ \text{c. i. bevel, } p = & \sqrt[5]{\dfrac{5.0\text{ H. P.}^2}{\text{r.p.m.}}} & \sqrt[5]{\dfrac{11.0\text{ H. P.}^2}{\text{r.p.m.}}} \\ \text{c. s. bevel, } p = & \sqrt[5]{\dfrac{0.8\text{ H. P.}^2}{\text{r.p.m.}}} & \sqrt[5]{\dfrac{1.8\text{ H. P.}^2}{\text{r.p.m.}}} \end{array}$$

$$\text{diameter} = 4.77\, p.$$

$$\text{diametral pitch} = \frac{3}{p}.$$

Practically, stock gears are made up to 3 inches circular pitch by ¼-inch steps, and a pitch of less than 1 inch is seldom used.

The following table will therefore determine the roots for the nearest common pitch.

No. or Root	Fifth Power	No. or Root	Fifth Power	No. or Root	Fifth Power
¾	0.24	2	32	3½	525
1	1	2¼	58	4	1,024
1¼	3	2½	98	4½	1,845
1½	8	2¾	158	5	3,125
1¾	16	3	243	5½	5,033
				6	7,776

In case the revolutions per minute of the pinion are less than 80, which is exceptionally slow, care must be taken in applying the formula, or the allowable stress may be exceeded. With a 15-tooth pinion:

80 r.p.m. = 100 feet per minute for 1-inch p.
40 r.p.m. = 100 feet per minute for 2-inch p.
27 r.p.m. = 100 feet per minute for 3-inch p.
20 r.p.m. = 100 feet per minute for 4-inch p.

Chart for Rapid Solution of Gear Problems

I have prepared a simple three quadrant chart for the rapid solution of these problems by mere inspection, good for any number of teeth, and for all the different styles, materials, and stresses of gears given by the above formulas, but for occasional preliminary determination, the formulas are sufficient, as their solution is simple. For working drawings, if the proportions vary from those assumed above, the dimensions should be checked by the more extended data in Kent's handbook, or by the use of a special chart.

It will, of course, be understood that the teeth considered in these formulas are those of the usual standard dimensions, in which the height of tooth equals seven-tenths of the pitch. What are known as "short tooth gears," in which the height of tooth equals half the pitch, are undoubtedly stronger, but their smaller working face is supposed to cause more rapid wear, and their use is not common. Although machine-molded cast gears run quietly at low speeds, they should not be used for rim speeds much over 1,000 feet per minute. For speeds of from 1,000 to 3,000 feet per minute cut gears should be substituted.

For a quick approximation of the diameter of the pinion shaft in inches:

$$\text{Shaft diameter} = p + 1.$$

The weight of pinions and gears varies with different makers. Pinions of from 12 to 30 teeth are usually made slightly wider than gears, even if they are not shrouded; and the smaller sizes have solid webs in place of arms. It is found that a formula of the form

$$\text{Weight in pounds} = \text{coefficient} \times p^2 f n,$$

will usually fit the weights.

For many tables, the coefficients of the following values will serve:

$$\text{Weight of pinion} = 0.35\, p^2 n f,$$
$$\text{Weight of gear} = 0.45\, p^2 n f,$$

or where $f = 3p$,

$$\text{Weight of pinion} = p^3 n,$$
$$\text{Weight of gear} = 1.35\, p^3 n,$$

or when diameter and p are known, as $n = \dfrac{\pi d}{p}$,

$$\text{Weight of pinion} = 3.1\, d\, p^4$$
$$\text{Weight of gear} = 4.2\, d\, p^4.$$

The price of gears varies largely with different manufacturers. The price of cast tooth spur gears can be usually expressed by a formula of the following form.

$$\text{Price} = (\text{coeff.} \times p\, n) + (\text{coeff.} \times p)$$

Cut tooth gears usually cost about 20 per cent more than cast tooth; and cast steel gears from 50 to 75 per cent more than cast iron gears of the same size.

* * *

TOOL-MAKERS' FILES—HOW TO ORDER

Almost every tool-maker knows from experience that an order calling for an assortment of files which merely states the length, shape and cut will rarely bring him the files he wants, unless he specifies the brand or maker's name. There are differences in makes of files which often make it impossible to use the files secured on the order, although they may be nominally what are called for. The following information regarding tool-makers' files received from the American Swiss File & Tool Co., 24 John St., New York, therefore will doubtless be appreciated by many tool-makers and others who have been troubled by inability to get exactly the files they desire.

The most marked difference in files has heretofore been found between those of domestic manufacture and imported Swiss files, appropriately called by their makers, "files of precision." But as these files of precision are now successfully produced in the United States, the terms "domestic" and "imported" have largely lost their significance as designating two distinct classes of files.

The ordinary domestic files range in length from 3 to 25 inches, and are made in five cuts, which are designated as "rough," "bastard," "second-cut," "smooth," and "super-smooth," while tool-makers' files are made in sizes from 2 to 12 inches in length and in eleven cuts, the cuts not being named but numbered. The first five numbers correspond approximately in fineness (the number of teeth to the inch) to the domestic files as follows: No. 000 same as "rough"; No. 00 same as "bastard"; No. 0 same as "second-cut"; No. 1 same as "smooth"; No. 2 same as "super-smooth." All tool-makers' file cuts above No. 2 to No. 8 have no equivalent in ordinary files.

The exact number of teeth per inch varies in both classes of files and with the different makes of the same class, but not sufficiently to make the difference noticeable until the file is used. To avoid mistakes in ordering files of precision, the order should invariably specify tool-makers' files.

* * *

In a short article in *Technik und Wirtschaft* for May, 1909, Mr. H. Noelke of Tokio, Japan, reviews the Japanese machine trade during 1908. The value of the imports of machines and tools, in round figures, from the leading industrial countries were as follows: From Great Britain, $10,500,000; from the United States, $4,600,000; from Germany, $2,250,000. Locomotives were imported from Great Britain valued at $500,000, and from the United States valued at $1,200,000. The value of the total imports of various classes of machine tools were as follows: Planers, $180,000; shapers, $18,000; slotters, $33,000; milling machines, $250,000; lathes, $475,000; automatic screw machines, $135,000; drill presses and boring mills, $425,000. The total value of the imports of machine tools amounted to about the same as the imports in 1907.

* * *

Nickel-chrome rails are, at the present time, attracting the attention of a number of the railroad companies, and the Bethlehem Steel Co. has furnished several lots of these rails to the Lehigh Valley, the Lackawanna, and other companies. While definite information concerning the experience with these rails has not been made public, it is understood that they apparently give at least three times the service of the ordinary Bessemer rail now sold at $28 a ton. As the nickel-chrome rail is sold at $51 per ton, a distinct saving is apparent wherever the traffic is heavy. The nickel and chrome produce a rail of great toughness and coarse grain, and the high carbon content which it is possible to use in connection with these two elements make the rail very hard.

Fig. 1. Getting a Heavy Frame ready for Welding

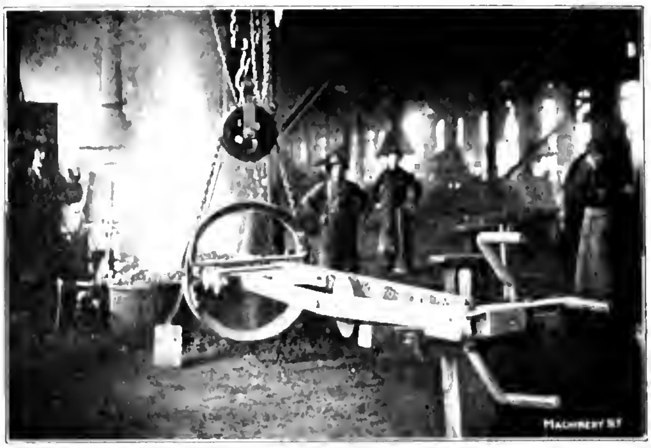

Fig. 2. The Apparatus used to handle Locomotive Frames in the Blacksmith Shop

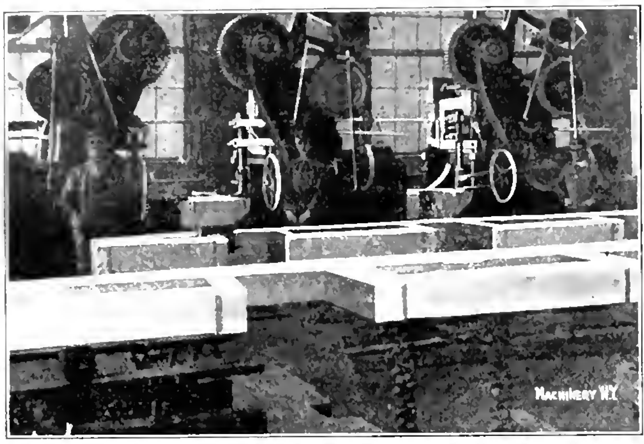

Fig. 3. Three-head Slotter which machines from Two to Four Locomotive Frames simultaneously

Fig. 4. Planing Locomotive Frames on a 74-inch by 38-foot Niles-Bement-Pond Planer

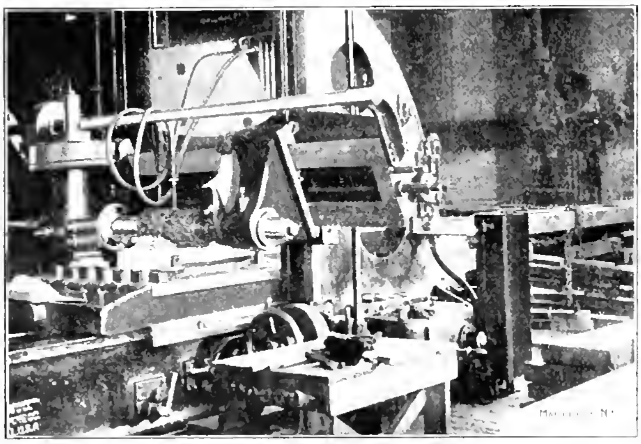

Fig. 5. Milling a $\frac{1}{2}$ by $38\frac{1}{2}$-inch Offset on the Front End of a Frame

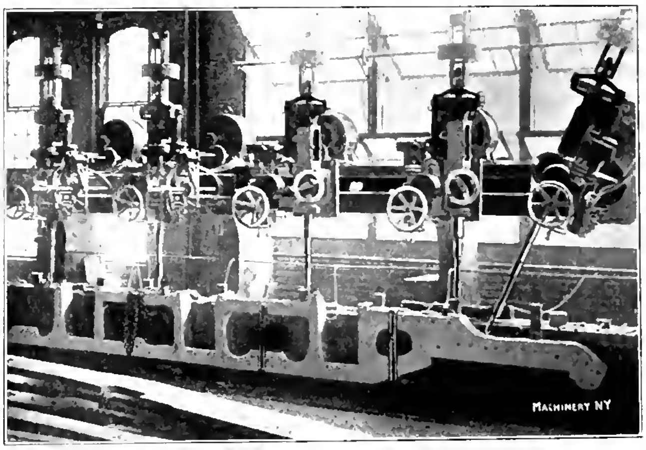

Fig. 6. Five-spindle Drill at work on a Locomotive Frame

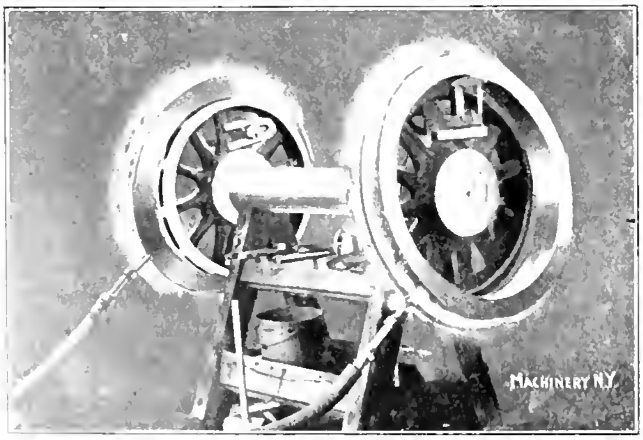

Fig. 7. Heating Two Tires simultaneously with a Gas Heater

Fig. 8. Boring Locomotive Tires which are held by Hook-bolts

LOCOMOTIVE REPAIR SHOP PRACTICE—1

THE C. M. & ST. P. R.R. SHOPS AT MILWAUKEE*

ETHAN VIALL†

It is always interesting to note the various ways in which the same class of material is handled in different shops. For instance, one shop may do a majority of the work on lathes, while another a few blocks or a few miles away, will machine exactly the same parts in less time on drill-presses, or perhaps the first shop may mill everything while the second uses planers or shapers for the same operations. Of course this difference is sometimes a case of necessity rather than choice, as a shop is often originally planned and equipped for an entirely different class of work than that for which it is finally used, but even where shops have been fitted up expressly for certain similar lines of work, the divergence in method or tool is often very marked. Railroad shops, as a rule, are of a class that must make the best of existing conditions, new shop equipment not being easily available, for in many cases the shops are the first and longest to suffer from hard times or the economical methods of a saving regime. It is possible that this is the reason that practice in railroad shops varies as widely as it does. However, a few of the railroad companies are managed by men broad enough to see that the mechanical department is not the only place in which to try to effect a saving, and that it must have suitable machines and tools with which to turn out work quickly and in a first-class manner; consequently liberal allowances are often made for machine tool equipment.

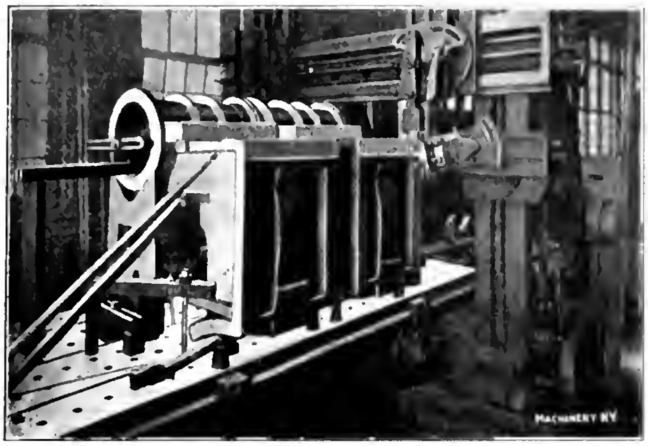
Fig. 9. Planing the Inner Faces of Two Locomotive Cylinders

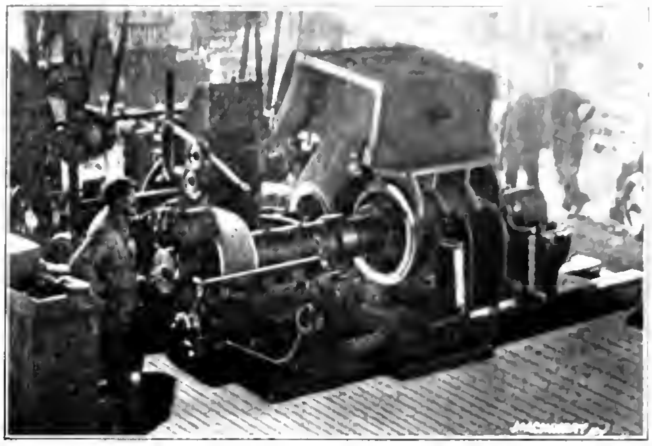
Fig. 10. Machining both Bores of a Compound Cylinder simultaneously

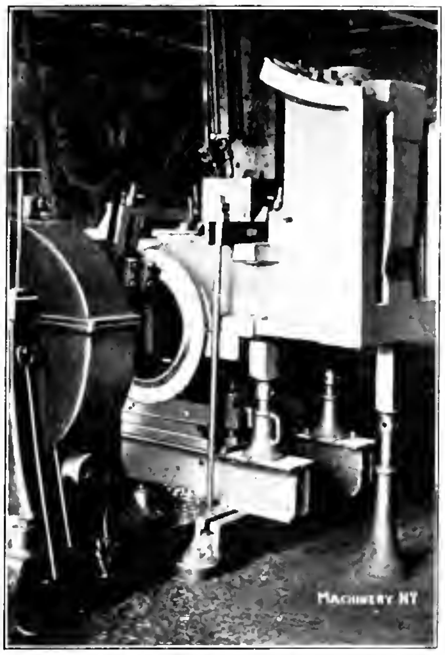
Fig. 11. Boring and Facing both Ends of a Cylinder

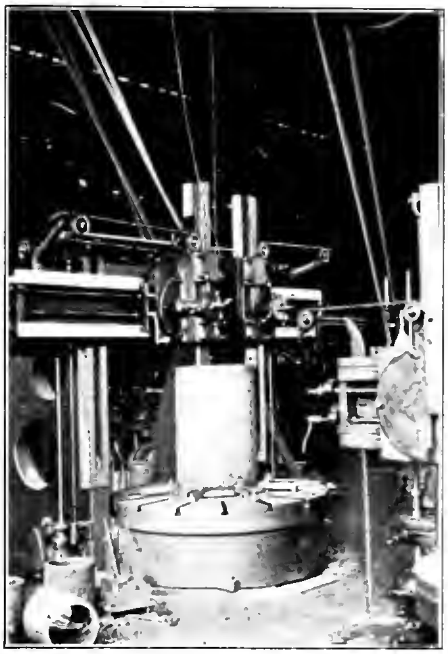
Fig. 12. Boring and turning a Cylinder Bushing

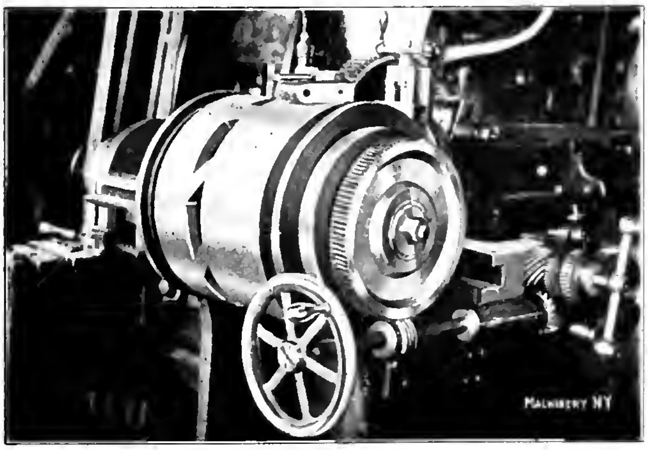
Fig. 13. Planing Valve Ports on a Shaper by using a Special Rotary Feed Attachment

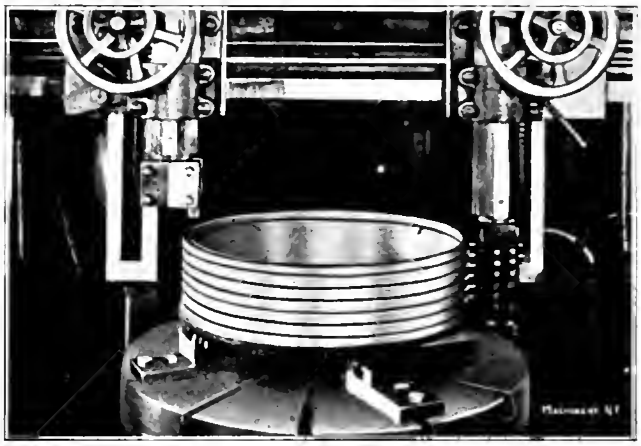
Fig. 14. Cutting off Packing Rings with a Gang Tool which severs the Rings successively from the Top

Generally speaking, the work handled in a railroad shop is of a heavy nature, and the more practical way is to use this weight to help hold the work in position while it is being machined rather than to carry the weight suspended by heavy jigs or fixtures. It is this idea that has apparently been kept in mind in equipping the Chicago, Milwaukee & St. Paul Railroad shops at Milwaukee, Wis., and by so doing many operations have been simplified and expensive jigs

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* For additional information concerning the arrangement and equipment of these shops see the articles: The Shops of the Chicago, Milwaukee & St. Paul Railway, which appeared in the January, February and March, 1904, numbers of RAILWAY MACHINERY.

† Associate Editor of MACHINERY.

or fixtures dispensed with or replaced by very simple ones. In these shops a large part of the work which other shops do on lathes is done on boring mills, where the pieces can rest solidly on the horizontal face-plates instead of being suspended by jigs or straps, and in consequence the time taken to place a piece in position is reduced to a minimum. Slotters are also favorites for many jobs usually done in other shops on shapers or planers, and slotters of all makes, shapes and sizes are in evidence all through the plant.

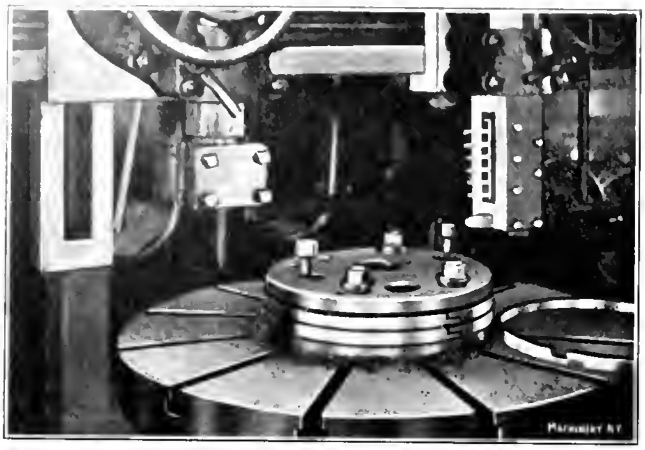

Fig. 15. Fixtures in which the Split Packing Rings are held when taking the Finishing Cut

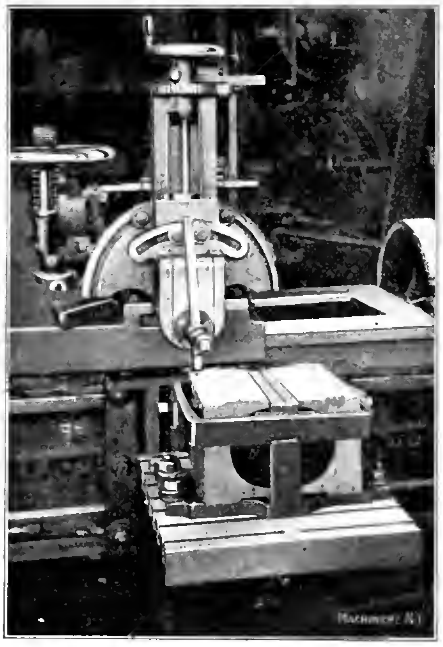

Fig. 16. Machining the Sides of Truck Cellars with Traveling Head Shaper

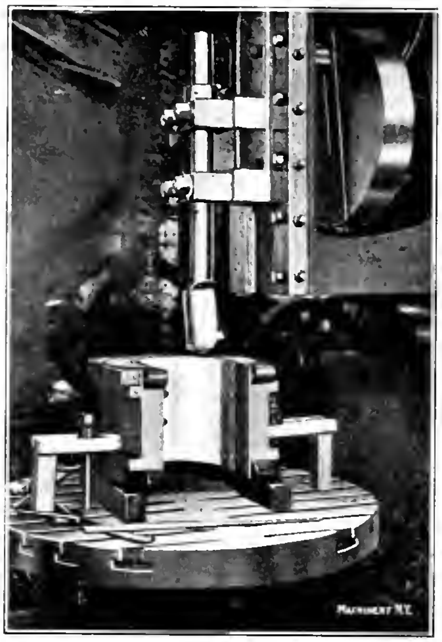

Fig. 17. Slotting the Driving-boxes for the Brasses

Fig. 18. Turning the Box Brasses on a Boring Mill

The superintendent of motive power at the Milwaukee shops is Mr. A. E. Manchester; the master mechanic Mr. C. F. Winn, and the machine foreman in the locomotive department Mr. E. Moran, and it is to these three men that I am especially indebted for the information contained in this article. I am also under obligation to F. C. Kneller, floor foreman, C. L. Fuller, assistant to Mr. Moran, and a number of others who will be named in connection with their several departments

Handling and Machining Frames

The principal repair work of the system is done in these shops. The locomotive frames handled vary from light to the extremely heavy ones, and Fig. 1 shows one of the largest side frames being made ready for welding in the blacksmith shop, which is in charge of A. Bennett. The method by which these frames are handled, is more clearly shown in the picture of the small one, Fig. 2. In this engraving, the way the hoist chain is applied, and the channel-rimmed wheel which is clamped around the middle of the frame, which facilitates turning the latter, and the handles clamped on the end, are clearly shown. A round weight is also shown fastened inside of the frame to balance it properly and make the handling as easy as possible. By using this apparatus the heaviest locomotive frame is handled and placed in any position as easily as if it only weighed one or two hundred pounds.

Leaving the blacksmith shop for the present, we will take up some of the operations through which the new frames pass. Fig. 3 shows a three-head Bement slotter at work on a pair of frames for one of the large types of locomotives. This slotter will machine two of the heaviest or four of the light frames at once. The slotter heads with their respective feeding mechanisms are entirely separate from each other and require an operator for each one.

Fig. 4 shows a 74-inch by 38-foot Niles-Bement-Pond planer planing the sides of two heavy frames, while Fig. 5 shows an Ingersoll miller cutting an offset of ½ inch × 38½ inches on the front end of an extra heavy frame in order to get the front deck properly in place on the engine.

Fig. 6 is a five-spindle Bement frame drill at work on a frame.

Removing and Boring Tires

The method of heating locomotive tires for removal or replacing, is about the same as that used in other large shops except that two heaters are used at once, as shown by Fig. 7, gas and compressed air being used for fuel. Tires are held on a boring mill while being bored out, in practically the same way as they are at the Northwestern shop, as was shown in the May issue, except that the centering jaws used here are specially made and the clamping hooks are tightened by nuts, as in Fig. 8, instead of by taper pins. Either way is quick, however, and effectually prevents springing or slipping of the tire under a heavy cut.

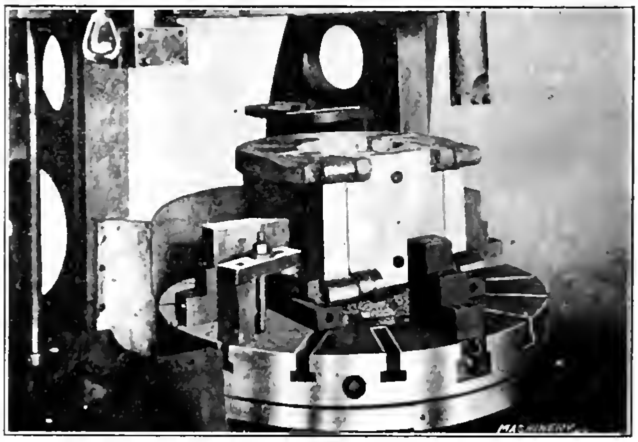

Fig. 19. Boring the Driving-box Brasses

Machining Cylinders

In Fig. 9 is shown a Pond machine planing the back walls of two cylinders at one time, and Fig. 11 shows a machine for boring out and facing off both ends of a cylinder at once, while in Fig. 10 is shown a machine which will bore out both cylinders of a compound at once, though the illustration shows a job where only one boring-bar is being used. Both the inside and outside of cylinder bushings are turned at once on a boring mill, as shown in Fig. 12. This is unusual, as most shops do this on lathes in two separate operations, or, if it is done on a boring mill, only one tool is used at a time in many shops.

Fig. 20. Cutter Heads used for Blocking out Holes in Solid Connecting-rod Ends

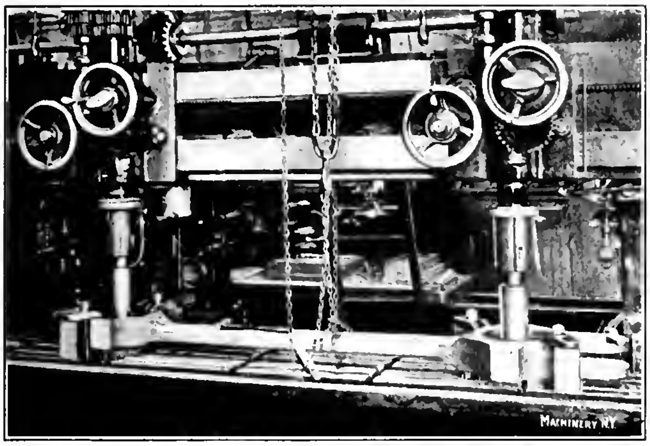

Fig. 21. Finishing the Holes in a Connecting-rod in a Two-spindle Drill Press

Working out Valve Bushing Ports

In order to machine out the cored port-openings in valve-bushings, a rotary attachment has been fitted to a shaper, as shown in Fig. 13. The valve bushing is held between two flanged disks, one of which is fastened to the spindle of the worm gear which runs in a bearing bracket bolted to the shaper column, while the other disk is clamped to the work by a bolt running through the middle. The outer end of this bolt is steadied by a center and bracket. The cutting is done by an extension tool held in the clapper block shown lying on top of the bushing. This clapper block is simply a plain block with a hole in it for the tool in place of the usual tool-post, and the tool is clamped in place by the long set-screw shown. The feeding mechanism of the rotary attachment, is too plainly shown to need explanation and this, together with the traveling shaper head, gives whatever motion is needed and by using suitably shaped tools the openings are cleaned out in good time without leaving the fillet which is the result of ordinary methods.

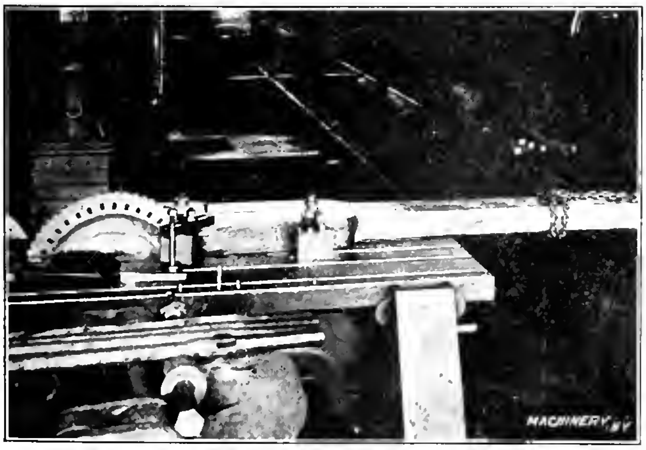

Fig. 22. Sawing out the Metal in the End of a Main-rod with a Higley Cold Saw

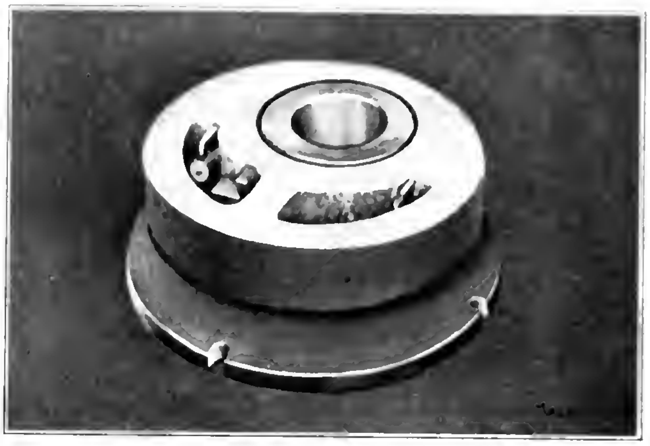

Fig. 23. Fixture for Holding Eccentrics on the Boring Mill while turning the Outside

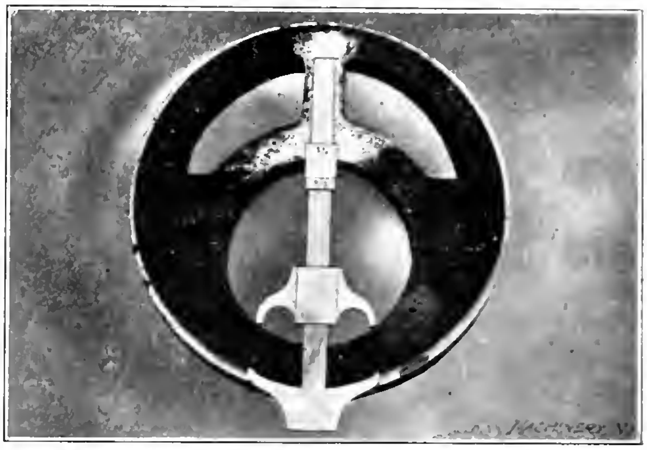

Fig. 24. Tool for Laying Out Eccentric Keyways

Turning, Boring and Cutting Packing Rings

Packing rings are bored and turned in a boring mill in the same way as cylinder bushings. They are then cut off with a gang tool, the cutters of which are so set that the top ring is cut off a little ahead of the one below it, as shown in Fig. 14. The method used to hold the packing ring casting to the table is rather unusual. Four "legs" are cast on the bottom of the casting and special jaws or "sockets," into which these legs fit, are used on the face-plate. These sockets are held by

Fig. 25. Rounding the Ends of an Eccentric-rod Jaw on a Vertical Miller

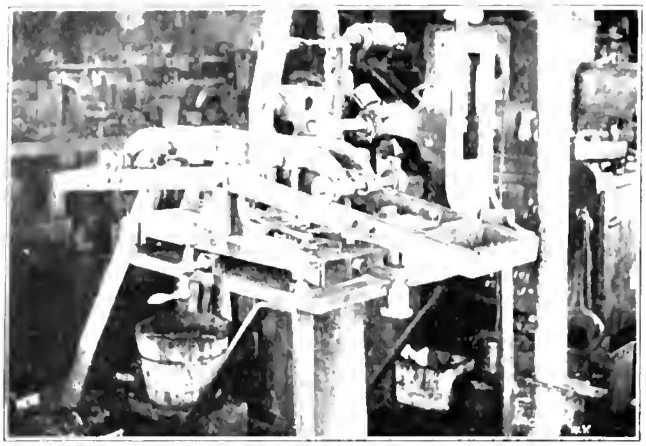
Fig. 26. Grinding Link-blocks on the Machine shown in Fig. 30

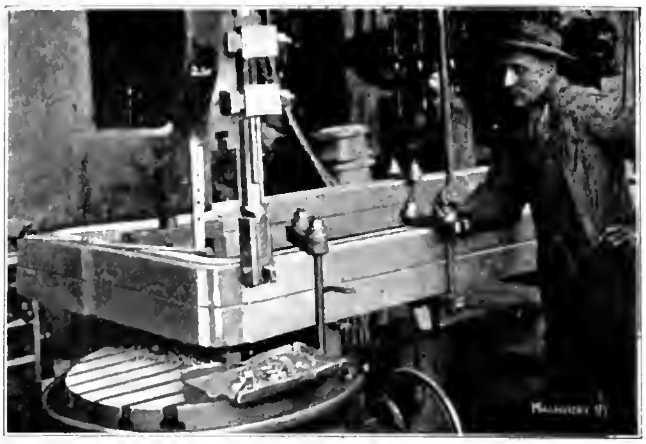

Fig. 27. Slotting Mud-rings

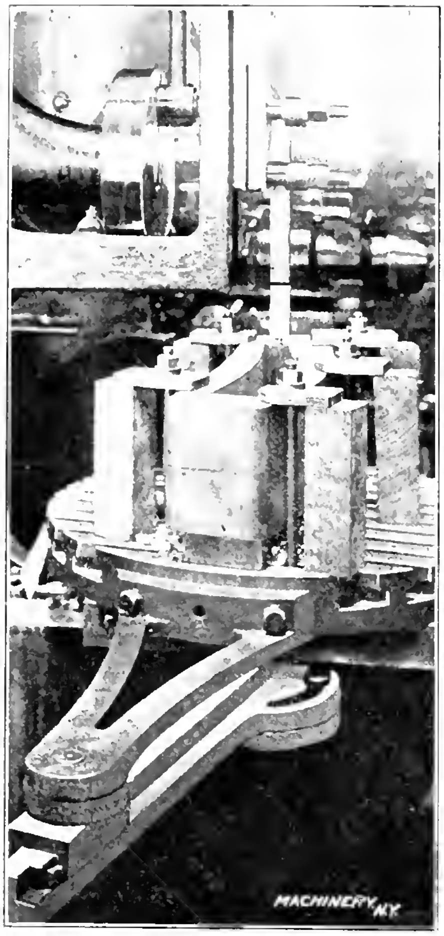

Fig. 28. Slotting Links by the use of an Attachment which gives the desired Radius

set-screws from the side and centered by set-screws from the inside. The plan of using legs on the casting, has many advantages over the usual flange or flaring lugs, as it is utterly impossible for the casting to twist, and only a minute or so is needed to center and clamp it solidly in place, with no tendency to spring it out of round. After being cut off, the rings are milled for a lap joint, and then finished two at a time, in the jig shown in Fig. 15.

Fig. 29. Another View of the Slotter equipped for Slotting Links

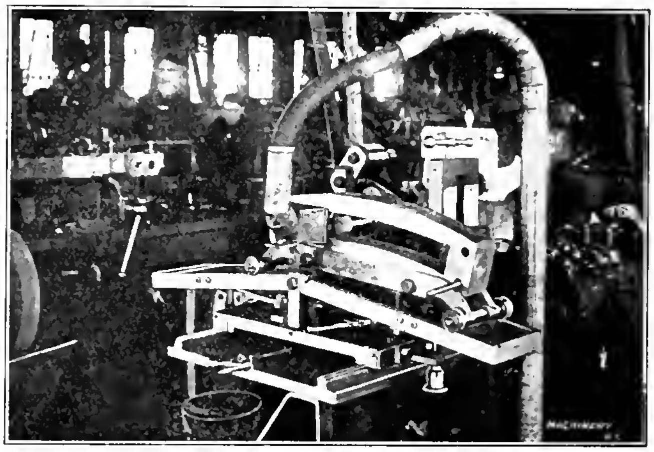

Fig. 30. Grinding the Links on a Special Grinder

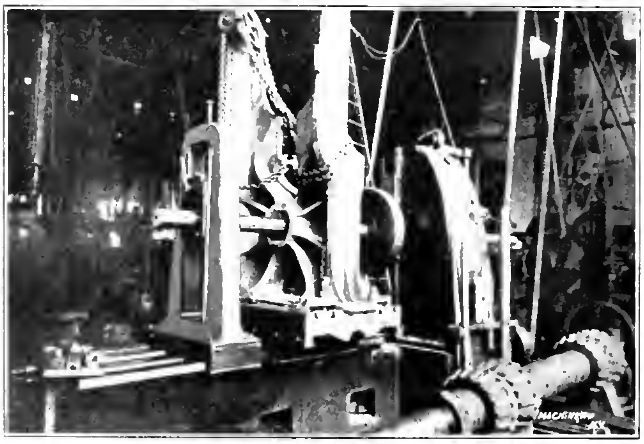

Fig. 31. Boring the King-pin Hole in the Front Deck Casting

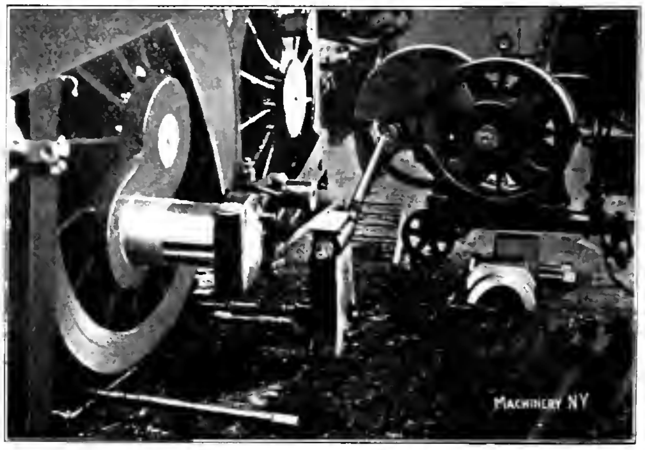

Fig. 32. Valve-setting Machine, which is driven by an Electric Motor

Driving Boxes

Driving-boxes are machined out inside for the brasses one at a time, on a slotter using a single cutting tool and a rotary table feed as shown in Fig. 17, and the brasses are held in a fixture on a boring mill (Fig. 18) while the outside is turned. The straight edges are then surfaced off, the brass forced into the box and the inside bored out, the end turned and the inside edge rounded, as shown in Fig. 19.

In order to reach the sides of the driving-box between the

flanges, extension chuck jaws have been made that fit over the top of the regular jaws of the boring mill.

Fig. 16 shows the fixture used to hold the truck cellars while machining the sides in a shaper.

Boring Side-rods

Side-rods have a hole drilled in each end, where the center of the bearing is to be, for the pilots of the cutter-heads shown in Fig. 20. The bulk of the metal is cut out in round blocks, and the holes finished with single-cutter boring tools in a two-spindle drill press as in Fig. 21. Driving rods have a row of holes drilled across the end of the intended fork, and the metal is then roughed out in two cuts on a Higley cold saw as in Fig. 22.

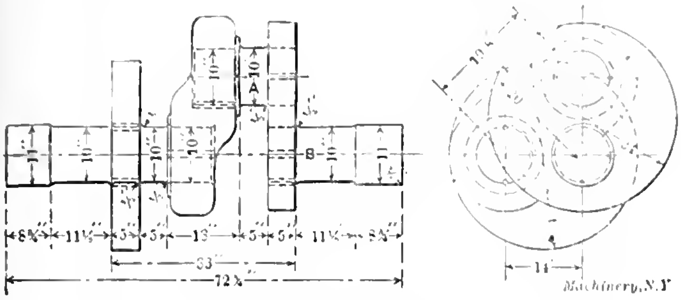

Fig. 33. Crank-axle, the Pins of which are turned by the Tool shown in Fig. 34

Eccentrics and Eccentric Rods

A fixture for holding eccentrics on a boring mill while turning the outside is shown in Fig. 23, and in Fig. 24 is a tool made expressly for laying out the keyways in eccentrics. This tool is made for laying off either 1⅛ or 1¼ inch keyways by simply reversing the small slide on the bar. A shoulder on the under side of the slide, allows it to be placed just right for the depth of the keyway wanted. By using this tool the keyways are laid off absolutely straight and directly in line with the thickest part of the eccentric. The ends of eccentric-rod jaws are rounded on a Bement-Miles vertical mill with rotary table feed, as shown in Fig. 25.

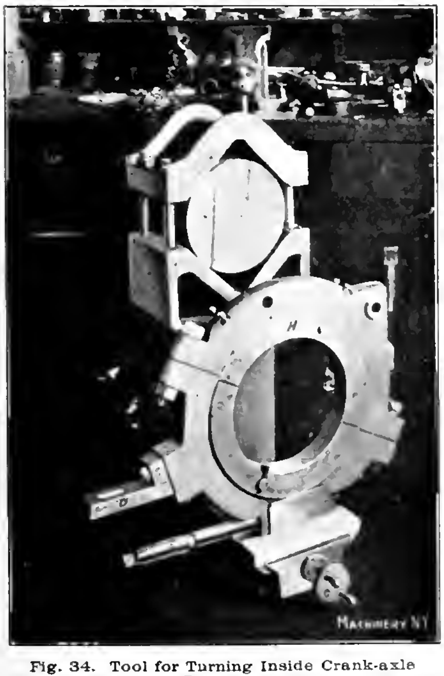

Fig. 34. Tool for Turning Inside Crank-axle Bearings

Fig. 35. Machine in which the Crosshead Pins are turned

Fig. 36. View showing the Mechanism of the Crosshead Pin Turning Machine

Machining Link Slots

Some of the most interesting operations of the shop are those through which the links are put while the arc-like slot is being machined, as the machines and attachments are unusual. The slot in the link is roughed out to the proper radius on a Sellers slotter, using the cross-slide feed of the table and a special attachment shown in Figs. 28 and 29. This attachment consists of an arm solidly bolted to the circular table, to the end of which is fastened a pivoted slide running on a guide which is bolted to the knee of the slotter. The guide is so made as to be easily adjusted, to a limited extent, to different angles with the cross-slide ways, and in this way the work is caused to describe a different arc past the cutting tool if desired. While the cross feed is in use the circular table is, of course, left unlocked and free to revolve on its center as far as the attachment will turn it during the cutting operation.

Fig. 37. Special Chuck used for Planing Shoes and Wedges

Two link-slots are roughed out at once on the slotter, after which the links are placed one at a time on a special grinder, Fig. 30, and finished inside. The carrier of this grinder, to which the link is clamped, is a small four-wheeled truck running upon a double-inclined track, one incline of which is adjustable up or down to change the arc of travel described by the link. The whole attachment of track and carrier is mounted on the grinder table so that it can be fed to or from the wheel by turning the ball-crank on the feed screw. The grinding wheel has vertical adjustment, and an air pipe keeps the work free from dust and metal as the link is pushed back and forth by hand.

Fig. 26 shows the same machine arranged for grinding a link block to the proper curve. By fastening the block to an auxiliary bracket which is attached to the link carriage, as shown, both the top and bottom can be ground at one setting so as to exactly fit the slot.

The method of machining mud-rings two at a time on a slotter, is shown in Fig. 27. Fig. 31 shows the hole in the front deck over the pony truck being bored out. The form of shoe and wedge chucks used to hold the shoes or wedges when planing them on a small Gray planer is shown in Fig. 37. The set-screws in the lugs on the end of the chuck in the fore-ground, plainly show how the chuck is tilted to get the right bevel on the wedge.

Novel Tool for Turning an Inside Crank-axle Bearing

A rather unique fixture used to turn the crank axle bearing (A, Fig 33) is shown in Fig. 34. The crank-axle is held between centers in a lathe for convenience in handling and the fixture is clamped onto it, the bearing *B* of the crank-axle being where the wooden block is shown in the engraving, the ring *H*, carrying the cutting tool, being around the part *A*. The part *D* is placed on top of the tool carriage of the lathe to steady the fixture and keep it from turning. An electric motor is coupled to the shaft *E*, the inner end of which is a worm, meshing with teeth cut in ring *H*. The tool is fed along the cut by the hand wheel *G*. Formerly an air motor was used to drive the cutting mechanism, but it was found to run too jerkily to cut right so an electric motor was substituted with good results.

Turning Crosshead Pins

Crosshead pins are turned in the machine shown in Fig. 35, the parts of which are shown in Fig. 36. This tool is somewhat similar in principle to the one just described in Fig. 34, but a pinion and gear teeth are used to drive the cutter instead of a worm and worm gear, hand feed being used in both cases. The crosshead is adjusted for height on the machine, by means of the wedges *A-A*.

The usual locomotive valve-setting device has been supplemented in these shops by a Westinghouse 7½ H. P. reversible electric motor, mounted on a hand truck and made to drive the rollers which turn the locomotive wheels, by means of gears and a universal jointed shaft, as shown in Fig. 32.

* * *

BEARING METALS[*]

JOSEPH H. HART[†]

By conservative estimate the value of the bearing metal in actual use in the United States exceeds $50,000,000, of which fully one-half is used on the locomotives and rolling stock of the railroads of this country. In view of the increase in the amount of machinery and rolling stock steadily going on, and the constant wearing out and replacement of bearings, the value and importance of this product cannot be over-estimated. The life of a machine is largely dependent upon its bearings, and in view of this, the fact that knowledge in regard to bearing metals and alloys is not more general, is remarkable. Again, the nature of the production of these alloys is such that while in some cases they have been patented and are manufactured under trade names, in many others they are made up of scrap, with widely varying proportions of the different metals incorporated in their structure; on this account, probably no phase of engineering progress in machinery construction and operation is the subject of more difficulty and dissatisfaction.

The fact that bearing metals have to be taken largely on faith or else tested by more or less complicated processes for their chemical constituents, and the further fact that trade conditions in this field are such that the properties of metals are apt to vary greatly in different shipments is a matter of grave import to the average machinery manufacturer and operator. Only the largest consumers can afford to make the necessary tests and investigations of a given consignment in order to test its quality, and, in addition, a definite amount of special knowledge is requisite for this purpose, in view of the often wide variations in properties of the alloy, with a comparatively small variation in the proportion of its constituents. Under these circumstances the average small machine shop and consumer in this field accepts bearings on faith alone and is dependent largely upon the commercial reputation of the firm furnishing the material. That this should not be so is a foregone conclusion, but in view of this condition of affairs the rapid progress of the firm whose standing can be relied upon in this field is readily explained.

Bearings are usually composed of alloys of copper, lead, tin, antimony and zinc, and are known as babbitt metal (after the name of the discoverer of this material), white metal, brass, phosphorous bronze, and various other trade names. Quite a number of these are patented, such as "plastic bronze," etc., but many are sold merely under trade name, and in some instances are of uncertain composition.

The principal qualities which a good bearing metal should have are good anti-frictional properties, so as to withstand heavy loads at high speed, without heating, and second, sufficient compressive strength so as to neither be squeezed out of place under high pressure, nor crack or break when subjected to sudden shocks. In addition to these, many other properties must be considered in a choice of bearing metals depending upon the special purpose for which the material is to be utilized. Temperature variation is often an important factor, especially in refrigerating plants, and the coefficient of expansion should be considered to prevent undue binding, with consequent destruction of the bearing and the possible variation in other properties, such as brittleness, ductility, etc., under various temperature conditions. In addition, many bearings must operate under conditions where they are subject to chemical action, whether that of brine or ammonia in refrigerating plants, or acids, alkalies, etc., in chemical establishments, and in dynamo and motor construction and operation, the electrical conductivity must be considered as well. This statement applies equally to all bearings incorporated in electrical machinery, where these must serve as electrical conductors such as the bearings for the wheels in trolley cars, etc.

The chief properties to date which have been developed to a greater extent than others in machine design are, that of friction elimination and resistance to compressive loads. Theoretically all metals have the same friction, according to Thurston, and the value of the soft white alloys for bearings lies chiefly in their ready reduction to a smooth surface after any local impairment of the surface, such as would result from the introduction of foreign metal between the moving surface and the bearing. Under these circumstances the soft alloys flow or squeeze from the pressure into the irregularity, forming a larger area for the distribution of the pressure, thus diminishing its amount per unit of area. Further, the larger area over which the pressure is extended the less becomes the liability to over-heating and consequent binding. Under these circumstances the frictional properties of a bearing are in inverse ratio to their compressive resistance, and invariably the best bearing alloys, from a high speed viewpoint, are unsatisfactory for utilization in heavy machinery. The recent introduction of an iron or steel grid to form the base of the main bearing, and to be filled with much softer bearing metals than could ordinarily be installed, or in some cases even graphite, is a step in the right direction and presents possibilities of great importance in this field of machine development.

Lead flows more easily than any of the common metals under pressure, and hence it has the greatest anti-frictional properties. Of course, a number of metals exceed lead in this property, but their cost or some other factor render them unavailable. Lead is the cheapest of the metals, except iron, and in comparison to the other metals used in the formation of bearing alloys their relative prices are somewhat in the following order per one hundred pounds: Lead, $4; zinc, $5; antimony, $9; copper, $13; and tin, $30 or more. It can thus be seen that the more lead that is used in a given bearing, the softer it is, the less friction it possesses, and the cheaper it can be furnished. It is, however, too soft to be used alone, as it cannot be retained in the recesses of the bearing even when used simply as a liner and run into a shell of brass, bronze or gun-metal or some other alloy. Various other metals have been alloyed with it, such as tin, antimony, copper, zinc, iron and a number of non-metallic compounds, such as sodium, phosphorus, carbon, etc., and the effect of the different ingredients is to-day fairly well understood.

If antimony is added to the lead it increases its hardness and brittleness, and if tin is added as well it makes a tougher alloy than lead or antimony alone. Nearly all of the various babbitt metals on the market are alloys of lead, tin and antimony in various proportions, with or without other ingre-

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[*] For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: The Study of Alloys Suitable for Bearing Purposes, October, 1903, engineering edition; Oil Grooves and Bearings, May, 1905; The Design of Bearings, December, 1906, January and February, 1907, engineering edition; Hot Bearings, Their Causes and the Means of Avoiding Them, November, 1907. See also MACHINERY's Reference Series No. 11, *Bearings*.

[†] Address: University of Pennsylvania, Philadelphia, Pa.

dients added. In such babbitts, the wear increases with the antimony as a general thing, and the price with the tin. The higher antimony babbitts are used in heavy machinery, as they are harder, while those low in antimony are used in high speed machinery. The steady increase in speed at which various operating units are maintained is responsible for a wide deficiency in this field in the duty performed by the bearing metal. The chief difficulty to-day in the operation of the modern turbine is undoubtedly the maintenance of satisfactory bearing surfaces. Soft babbitts have never sufficient strength to sustain the weight and shock of heavy machinery bearings and can only be used as liners. The tendency to increase in speed as well as weight or size of machinery is limited to-day simply by the satisfactory operation of the bearing metal itself.

Undoubtedly, in investigations in this field, sufficient attention has not been paid to the effect of temperature on the bearing properties of the alloys used for these bearings. More rigid investigation in this field and limitations in regard to the temperatures permissible, with means for maintaining these within fairly close limits, will undoubtedly result in a great increase in the possibility of improvements in speed and weight of various types of machinery. More or less extensive experiments along these lines are being conducted in regard to the bearings used in turbine construction, since the speed here has rendered the problem an acute one and is necessary for efficient operation of the turbine itself.

COMPOSITION OF BEARING METALS

Alloys.	Lead.	Tin.	Antimony.	Copper.	Zinc.	Other Constituents.
Babbitt 1	80.00	20.0				
Babbitt 2	72.0	21.0	7.0			
Babbitt 3.	70.0	10.0	20.0			
Babbitt 4	80.5	11.5	7.5	0.5		
Babbitt 5	0.5	68.0		1.0	31.5	
Babbitt 6		20.0			80.0	
Babbitt 7		86.0	10.0	4.0		
White metal	82.0		12.0	6.0		
White Brass		64 0		2.00	34.0	
Magnolia metal	80.00	4.75	15.0	trace		$Bi = 0\ 25$
Car brass lining	80.5	11.5	7.5	0.5		
Ajax plastic bronze.	30.0	5.0		65.0		
Ajax metal	11.5	11.5		77.0		
P. R. R. car brass, B.	15.0	8.0		77.0		$P = 0.80$
S bearing metal	9 5	10.0		79.7		
Delta metal	5.1	2.4		92.4		$Fe = 0.1$
Camelia metal	14.8	4.3		70.2	10.2	$Fe = 0.5$
Tempered lead	98.5	0.08		0.11		$Na = 1.30$

Bi = bismuth; P = phosphorus; Fe = iron; Na = sodium.

The accompanying table will doubtless prove interesting as showing the various constituents of the more or less common bearing metals now on the market. The original babbitt-metals were very expensive materials, on account of the proportions of the more expensive metals found in them, and have been much modified in actual practice. A wide deviation in the composition of babbitt is readily shown in the first part of the table. The first babbitt is a fairly good alloy for high speed machinery but is not very hard. Its melting point is about 500 degrees F.; in fact, the properties of all alloys or bearing metals can be very widely deduced from their melting point. The second babbitt is somewhat harder and melts at a higher point. Both of these are used largely for lining purposes. The fourth babbitt is used very widely for heavy machinery. All of the babbitts mentioned have been fairly successful.

Babbitt 6 has good wearing properties but cannot be used for high speeds. Most of the other metals included in the table where copper is not used in excess can be regarded as in the same class as babbitts. The "white" class has a fairly good electrical conductivity, much greater than that of ordinary babbitt, and is used in the bearings of generators, motors, electric cars, etc. A rather interesting thing about the alloys containing sodium is based upon the fact that sodium by oxidation produces a material which will saponify with the oil used in the bearing and produce soap, thus assisting lubrication. The extent and amount of such action is scarcely as yet understood, and practically no experiments have been made with this investigation in view. Possibilities along this line, however, are great, not only for this particular alloy but for many others not as yet considered.

The other alloys included in the table consist to a very great extent of copper, tin, and lead, and usually have a thin liner of lead or some soft babbitt, and hence wear much better than an entire bearing of the soft babbitt. The tendency to wear decreases with increase of lead and increase of tin. Increase of lead, of course, diminishes the frictional effect of the alloy and hence its heating properties. A certain amount of other metal, however is necessary to keep the lead from separating from the copper. A study of the table itself, with a knowledge of the various properties of the metals themselves, will show conclusively the bearing properties of the different alloys. Pure copper is so tenacious that it is practically impossible to work it with any tools whatever without preliminary treatment and this same property extends into and influences its bearing properties.

The structure and treatment has more to do with the production of suitable bearing alloy than is generally considered. The tensile strength of solder and, in fact, all alloys, decreases very greatly with the pressure or tension at the time of solidification and in general the cooling process, and the influence on tempering affect the structure and consequently compressional resistance to a much greater extent than is generally considered. The same properties which influence the hardening and tempering of steel by heat, extend to a greater or less degree to all metals and are much more pronounced in alloys than in the simple elements.

Sufficient has been said to show the importance of the bearing metals in machine design to-day, and to give a brief outline of the situation in regard to the character and type of the metals available, with a few of the properties of the same. The possible combinations of alloys for this purpose are very great. Comparatively little progress has been made along investigations covering all possible alloys of different materials in different proportions. The recent introduction and placing on the market of a large number of metals, such as calcium, etc., very common in nature, and ultimately bound to be furnished at a very low rate, and many of them possessing very suitable properties for bearing alloys, is undoubtedly bound to influence the situation; and various engineering devices, such as the steel grid, recently developed, will undoubtedly receive attention in the immediate future with consequent increase in efficiency in this field. The development is but at its inception along this line, and standardization of the alloys at hand should be at once insisted upon and maintained by the various machine manufacturers. This latter is the chief difficulty to-day in commercial development. The scientific end will largely take care of itself. The effect of different metals upon alloys by their presence in various proportions can be foretold to-day largely from theoretical considerations; but that the commercial situation to-day, however, is unsatisfactory, is a foregone conclusion.

* * *

A British firm has recently completed what is believed to be the largest crane in the world. The total height of the crane is 166 feet; it is of the revolving cantilever type and will lift 160 tons at a 95-foot radius. The crane is driven by five large electric motors, the machinery being placed on the rear end of the cantilever and thus acting as a counter-balance of the load. At the tests the crane showed itself capable of lifting and moving loads up to 240 tons. The crane itself weighs about 950 tons.

* * *

A company which is to purchase the exclusive rights for the Wright aeroplane for the German Empire and its colonies, as well as for Sweden, Norway, Denmark and Turkey has been formed at Berlin with a capital of $125,000. The arrangement with the Wright brothers will extend over a period of fifteen years, during which time the company is to be entitled to all improvements made by the inventors during this time. The Wright brothers have also made arrangements with the Italian government, and in England they are building a number of machines for private sale. It is stated that not less than forty Wright aeroplanes are at the present time under construction in France.

INFLUENCE OF THE SCLEROSCOPE IN METALLURGY AND MANUFACTURING*

A. F. SHORE†

The scleroscope is an instrument in a measure dependent on sensitive touch; or, in other words, it feels the substance much the same as the human fingers. When we touch two or more objects as, for instance, an orange and an apple, we know that the orange is softer because it yields under pressure more than the apple. We are powerless to measure the hardness of any object that is harder than the finger tips, and there is no way of telling how hard it may be by finger pressure alone.

The sensitive touch of the scleroscope is produced by a tiny hammer dropping from a height of about ten inches onto the metal, hardened steel, etc., which it penetrates slightly. The hammer moves freely, yet snugly, within a glass tube and weighs about 40 grains. Its striking point consists of an inserted diamond of rare cleavage formation, annealed sufficiently to withstand shocks. This jeweled point is slightly convex and has an area of about 0.001 to 0.025 square inch. When the plunger strikes the metal to be tested, it reacts or rebounds. The height of this rebound is read against a graduated scale, and an accurate determination of the quantitative hardness of the piece under test is thus obtained.

The static testing of soft metal, using a steel ball which is forced into it with a known pressure so as to cause an indentation which can be measured with the microscope, is on a par with the testing of a peach or apple with the unaided nerve cells of the fingers; it fails in dealing with hardened steel, as it is like touching brass and steel to determine the difference in hardness. We could detect no yielding tendencies in either, and they would, therefore, seem to be of equal hardness. By tapping the two with the ball end of a hammer, however, we could tell which of the two is the harder, in that one would yield more and thus absorb more of the energy of the hammer blows; in other words, the harder the metal, the less yield, the less work done, and the higher the rebound of the hammer. On this principle the scleroscope is based. Some have said, for this reason, that the instrument is really a measure of elasticity. This, however, is not true. The elasticity of the metal or material is utilized as a motive force to work the sensitive indicator as will be demonstrated in the following.

Hardness vs. Elasticity

When the hammer of the scleroscope is allowed to drop with no other force than its own weight, and the point is so flat that absolutely no impression is made on the surface of very hard steel, then the rebound will be about 90 per cent of the fall. This phenomenon is known as the elasticity of solid bodies. Now, since hardness is resistance to penetration, in its clearest definition, it stands to reason that the point of the hammer must be somewhat reduced and rounded. Therefore the relation between the weight of the hammer and its point should be such that when it drops on hardened steel, a permanent impression must always be made, so that if we had not the rebound to go by, the microscope would still show the values. What is the result now? When the area of the hammer is thus reduced enough to make a permanent impression, a certain amount of the energy stored in the hammer is utilized in doing work. This overcomes the tendency of the metal to resist penetration, depending on how hard it is, or the resistance it offers, and naturally it must rebound considerably less. The hammer always delivers a blow of exactly the same force. If now we get a rebound of 75 per cent on very hard steel, we know that 15 per cent of the hammer's energy was spent in its efforts to overcome the resistance of the steel before it had a chance to react and repel the missile.

The Instrument

Instead of dividing the whole length of the fall of the indicator into a scale consisting of 100 divisions, the figure 100 is carried down to a point representing about 68 per cent of the total height of the scale as shown in Fig. 1. This was not an arbitrary provision, but was adopted after consultation with the leading metallurgists, one of whom was Dr. Paul Herault, of aluminum and electric steel making fame, of France. These authorities agreed that in the scleroscope, hardened steel of average hardness should be taken as the standard with which all other less hard metals should be compared: 100 is the average hardness of hardened steel; 90 is a low value, while 110 is a very high value. This scale therefore makes it an easy matter to compare the various metals which have to be cut or worked with steel, as we shall see further on.

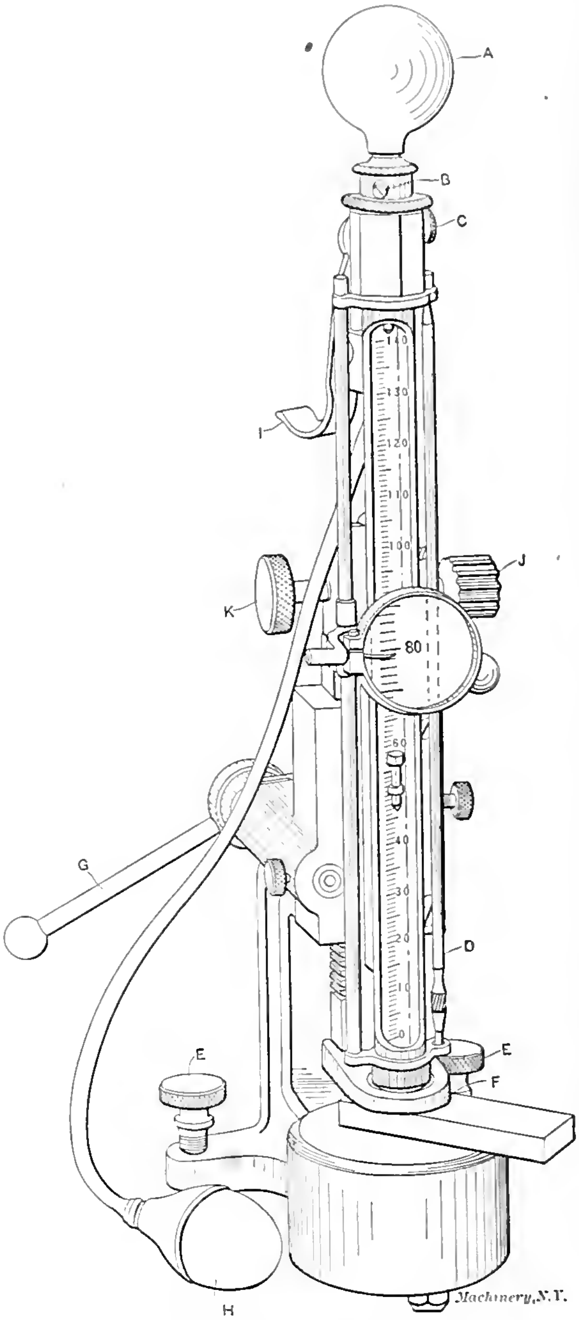

Fig. 1. Detail View of the Scleroscope—an Instrument for Testing the Hardness of Metals

The operation of the instrument is very simple. When the hammer is to be raised to the top, the bulb *A*, Fig. 1, is pressed and then released suddenly. This sucks up the jeweled plunger hammer referred to, so that it may be caught by a hook which is suspended exactly central in the glass tube and engages with an internal groove on the top of the hammer. Adjusting screws *B* for the hook and its spring are contained in the removable knurled cap. *C* is a cylinder and piston for releasing the hook and hammer by bulb *H*, whenever a test is to be made. *I* is a valve and hook which is pressed and thus opened at the same time to avoid a vacuum when the hammer drops. *J* is a pinion knob for moving the instrument up and down independently of the heavy rack and clamp *F* actuated by the lever *G*. At *E* are shown leveling screws and at *D*

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[*] For additional information on the testing of metals, see "The Brinell Method of Testing the Hardness of Metals" (engineering edition), September, 1908, and "A New Mechanical Test for Hardness" (engineering edition), October, 1908.

[†] Address: Shore Instrument & Mfg. Co., 557 W. 22d St., New York.

a plumb rod. When flats and sheets and small pieces are to be tested, the scleroscope, self-contained with its clamp and anvil, is employed. When the ends of drills, rods and many other tools are to be tested, they are clamped in a bench vise, as in Fig. 2, and a swinging arm is employed. In this case, the instrument is removed from its post on the clamp frame by knurled set-screw *K*, and is attached in the same way to the post on the swinging arm. A kind of female dove-tailed finger ring, adapted to be clamped on the dove-tailed rack bar of the instrument, is provided for use in free hand testing and very large floor work, on parts of machinery being assembled, or on the stock rack, etc. It will thus be seen that the apparatus is universal in its application.

Philosophy of the New Method

When the hammer falls through a height of ten inches onto hardened steel, it will deliver a striking energy equal to about 20,000 times its own weight, acting through a very short space, of course. With a hammer weighing about 40 grains, and an indentation of, say, 0.002 inch depth, a working pressure of about 100 pounds is obtained. This force acting on a convex point about 1/64 inch diameter, is concentrated. The pressure thus available is about 500,000 pounds per square inch, which is ample to exceed the elastic limit of the hardest and strongest steel in existence.

A remarkable feature of this instrument is that it is self-compensating with regard to the energy of the hammer blows on the softer metals. This is due to the yielding of the material and the comparatively slow stoppage of the hammer. In lead, for example, a deep impression is made. This requires a great amount of energy, which is nearly all spent in doing work, and there is very little rebound afterward—about 3 degrees as against 110 for the hardest steel. The constant pressure developed by the hammer is thus only 12 pounds instead of 100 or more for good hard steel, and, of course, the pressures for intermediate hardnesses as on brass and soft or tempered steel are always in proportion to the physical hardness of the brass or steel.

Application to Shop Work

The manufacturer who wishes to get high efficiencies out of his tools will not benefit by the help of such a commodity as the scleroscope in detecting good and bad tools, unless he is willing to amend the errors in practice which he may find. The observation of this principle is the foundation of the success which hundreds of firms in this country and Europe are having with this instrument. While tool work is a line requiring the most careful attention, the material worked and produced is none the less important. In this connection the scleroscope is very commonly applied to industrial systems, with admirable results. An instance may thus be cited showing how these results are obtained.

More than a year ago the Brown & Sharpe Mfg. Co. adopted the new method as a guide in the laboratory, particularly for the study and selection of such fine steel as is required in standard commercial tools. The attention of the company was then turned to its high-grade automobile gears of alloy steels, etc. Meanwhile the Packard Motor Car Co. used the scleroscope to study the past performances of the various gears and parts of old Packard cars, and made careful records. This was also done by many other concerns, and these records showed that alloys, steel or nonferrous metals would give a certain efficiency if the hardness was just right. As the best is, in the end, the cheapest, in high grade apparatus, the Packard engineers began to issue orders to their various auto part making houses for material which was specified to require a given degree of scleroscope hardness. Gears were made for them by the Brown & Sharpe Mfg. Co. and the Gleason Works both of whom were using the scleroscope to aid them in filling orders. Wyman & Gordon, who supply forgings to Brown & Sharpe, were able to make them to the required specifications, but, in order to do so, they had to see that the raw material was of the proper hardness. This brings the matter back to the open-hearth or crucible and chemical laboratory where again the scleroscope is used to great advantage. Before the completion of an automobile of the guaranteed kind, often a dozen instruments are used among the specialty makers who supply the various parts. The ball-bearing manufacturers are required and prefer to test every part before assembling. The Hyatt Roller Bearing Co. and the Hess-Bright Mfg. Co. are obliged to use a number of scleroscopes which are operated by women, carefully trained, who are able to pass on a large number of pieces daily. This testing is to ascertain principally two factors on which success in service depends, *viz.*: the right degree of hardness, and the uniformity of this hardness—and both are equally important. In the latter case it is necessary to test the parts in a number of places, which must be done very rapidly to keep down the additional costs, particularly as in the manufacture of standard parts such as these, there are always losses due to the rejection of some parts which do not conform to the specifications.

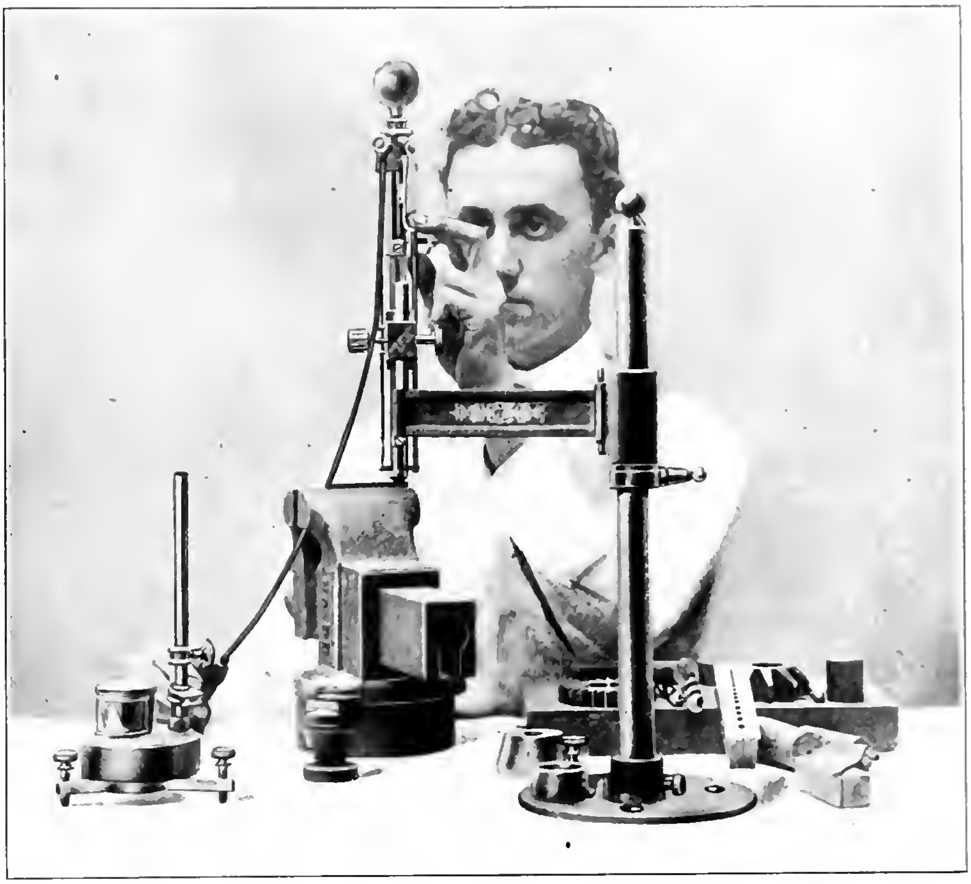

Fig. 2. Scleroscope equipped with Swinging Arm for Testing Pieces clamped in Bench Vise

The Lunkenheimer Co., the Light Mfg. & Foundry Co., and other up-to-date manufacturers, use the scleroscope in the standardization of castings adapted to various needs. These houses also make auto parts for the Packard Co., etc., and by the use of the scleroscope are enabled to live up to their specifications. In these auto shops the instrument is used for all classes of work, although it is most needed in the inspection department for the examination of parts and material, particularly of those not made by the builders.

Tool Steel and the Scleroscope

Since for most uses (other than for turning or planing tools) plain carbon steel is as yet adequate, many manufacturers have turned their attention to the art of obtaining much

higher efficiencies by aid of the scleroscope after good steel has been selected. The method of doing this is interesting, and was first hailed as a revelation by many authorities. Thus, when a steel having a carbon content of 0.90 of one per cent and over is heated to the right temperature and is then properly quenched, the limit of hardness and strength is obtained. Now, attaining this temperature is such a delicate matter, that unless the very best facilities are at command, anything but the exact heat required may be obtained, and if the heat is too low the tool will be hard only on the edges, while if it is only a trifle overheated such as is regularly done by the average hardener who takes chances by depending on skill of the eye, something like from 50 to 75 per cent of the strength due to rolling or forging is lost. This appalling loss in strength so vitally important in any tool is accompanied by a slight drop in the hardness—not more than 5 per cent. This is detected by the scleroscope as shown in charts, Figs. 3 and 4. The former is a hardness curve taken from a tool steel of about 0.90 carbon, while the latter is one taken from a steel having 1.65 per cent. The difference between these curves is indeed very striking and very significant to those who have mastered the elementary principles of the study of tool steels by aid of the scleroscope. The curves are obtained from the Metcalf test as follows: A piece of steel a few inches long and about one-half inch square is heated to a bright yellow on one end and manipulated so that the temperature is less and less toward the other end until a red is scarcely visible. The piece is then quenched in water, ground clean, and tested by the scleroscope at intervals of about ¼ inch along the bar, beginning at the unhardened end. As each section is tested, a reading is obtained which corresponds with the exact hardness that would be obtained by quenching a similar piece at whatever heat the said test piece had in that location. This hardness number is plotted out on a chart in the usual way so that a true curve is obtained showing the character of the changes in hardness and strength which vary directly with the carbon content. In fact the most accurate analyses of this element are made in this way—but that is a subject by itself.

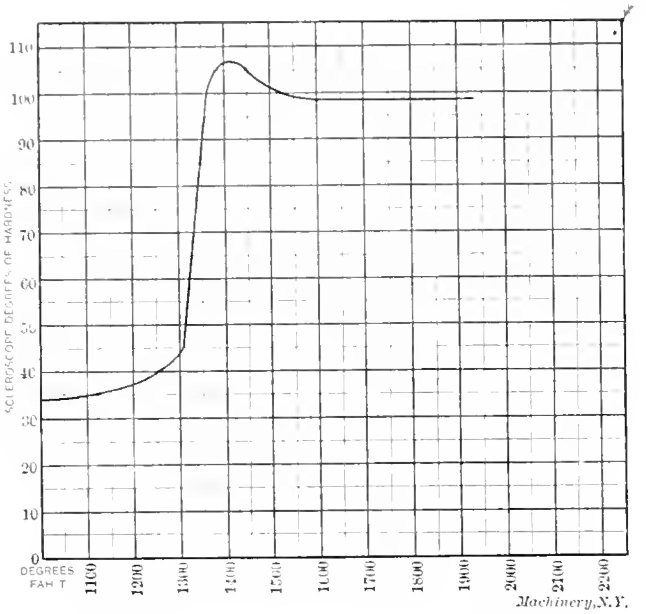

Fig. 3. Hardness Curve for Tool Steel of about 0.90 Carbon

The test piece thus obtained represents a stock bar, of the steel which is to be worked into tools, dies, etc., hardened at temperatures that vary more widely than could occur in any well-regulated hardening room, and somewhere within these limits is the temperature that yields the maximum hardness. It supplies an expedient whereby the hardener may know exactly what temperature is most suitable for each tool made from the steel thus tested. His future work is guided and facilitated by stamping on each tool a number corresponding to the hardness number given to the said stock bar. It also enables the hardener or the inspector to intelligently test all hardened tools. Thus, if a die is hardened to 95, we can determine by referring to the test piece of steel, whether this is the highest degree of hardness obtainable with this steel. If the test piece showed the hardness to be, say, 100 or 110, and the die only showed 95, it would indicate that the die did not fulfill the necessary requirements.

SCLEROSCOPE HARDNESS SCALE

Name of Metal	Annealed	Hammered
Lead (cast)	2—5	3—7
Babbitt metal	4—9	
Gold	5	8½
Silver	6½	20—30
Brass (cast)	7—35	
Pure tin (cast)	8	
Brass (drawn)	10—15	24—5
Bismuth (cast)	9	
Platinum	10	17
Copper (cast)	6	14—20
Zinc (cast)	8	20
Iron, pure	18	25—30
Mild steel, 0.15 carbon	22	30—45
Nickel annode (cast)	31	55
Iron, gray (cast)	30—45	
Iron, gray (chilled)		50—90
Steel, tool, 1 carbon	30—35	40—50
Steel, tool, 1.65 carbon	35—40	
Vanadium steel	35—45	
Chrome—nickel	47	
Chrome—nickel (hardened)		60—95
Steel, high-speed (hardened)		70—105
Steel, carbon, tool (hardened)		90—110

NOTE.—These figures are subject to variations owing to nature of composition or compression of metals.

Advantage of Testing

It is noticeable in every shop that out of every lot of tools made there are always some "freaks"—tools that are jewels among others—although all are seemingly made alike. Some reamers will hold their size ten times longer than others; lathe tools, particularly thread and cutting-off tools, remain faithful to the setting through thick and thin and are usually kept in reserve for critical jobs. This may be because of defective steel, but usually the good and bad are made from the same bar, in which case we must look to our methods of hardening since the finest steel is most easily ruined, and is thus apt to make the poorest tools.

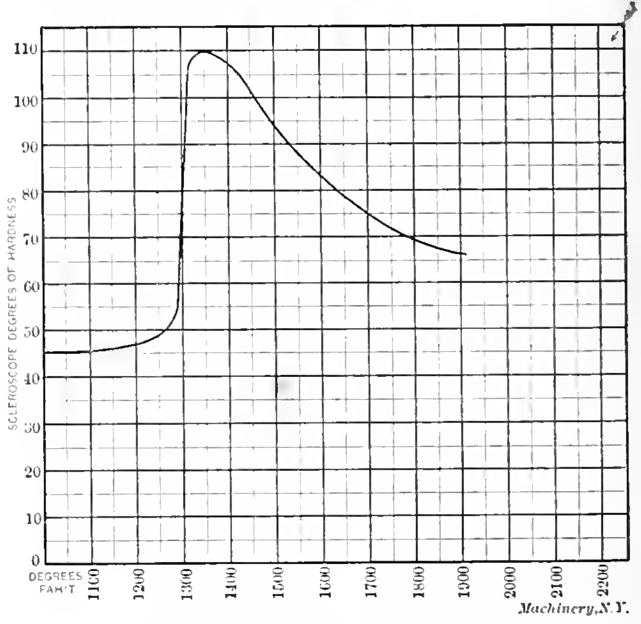

Fig. 4. Hardness Curve for Tool Steel of 1.65 Carbon

This latter fact has been known to steel makers for years, and because the abuse of tool steel is so general, none of the finest steels can be procured on the open market, but are made to order only. The explanation of this condition is simple. Tool steel is so sensitive to heat and water that only the photographic plate can be compared to it; it will produce a tool having 100 per cent efficiency only when treated just right. Like the novice in photography who occasionally gets a good picture if his lens is good, so is tool hardening a hit-and-miss process unless the workman be guided constantly. In this way workmen are enabled to acquire such precision of judgment that results seemingly incredible are obtained, and often testing instruments are used less constantly than one would think. Among many instances thus noted by the writer, one particularly interesting is the way in which the Winter Bros.

Co., Wrentham, Mass., who manufacture taps and dies, undertook to produce tools of the "jewel" variety as a regular product. Some of their taps were used on tough bronze in a turret lathe on a large scale, and often freaks were found which would never break until worn out. The most remarkable of these (7/16 inch diameter) held out three weeks at the rate of 10,000 holes per day as against only a few hours service for some taps. This tap was returned to the maker to be studied by aid of the scleroscope. The stock used was of tempered high-speed steel. The hardness remaining was measured although it was not known what the original hardness was nor exactly what temperature was used to draw it down to that hardness. The manager then ordered that 50 taps be made of high-speed steel and tested by the scleroscope. All these taps were hardened the same as the "freak" sample, and all were tempered with a heat which was variable (in fact it was unknown, except for the average) for the object in view was to get all pieces of the same hardness in the end, which was accomplished. The whole lot was next put to work and watched. After all had been worn out it developed that each tap proved to have the same efficiency as the freak. This resulted in the formal adoption of this method of hardening for taps of this steel and for the class of work mentioned, while other problems involving carbon steel were also gradually being solved along similar lines.

As a matter of fact, if only part of the new methods adopted since the first appearance of the scleroscope were described in detail, it would reveal something more than an incipient revolution, not only in metallurgy, but in most of the allied lines of industry and wherever tools are used and made.

The scleroscope is now regularly used to great advantage in naval construction, in the selection of materials for construction as castings and forgings, alloys, steel of all kinds and particularly in testing the hardness of projectiles and armor plate. All the United States government arsenals are thus equipped as well as those of foreign governments, including Japan. Likewise numerous mints and engraving bureaus are guided in their work, in which great economy must be practiced. Similar instruments are also to be found at the Bureau of Standards of Weights and Measures, and the leading railroads are using the scleroscope in their laboratories in the study of newer and superior rails, and rolling stock materials. In the steel mills a new departure has been made in that carbon content and other determinations can be made before the molten metal is poured from the hearth into the ladles, by means of a new dynamic method made possible by the scleroscope. This method allows the metallurgist the chance of making corrections before it is too late, which is of great importance. In the manufacture of non-ferrous metals such as brass sheet, rods, wire, etc., much can be told, by measuring the billets after casting, as to what will happen to the rolled or drawn products as well as what must be added or subtracted from the melts. The scleroscope also works very well on carbon, which fact was first demonstrated by the General Electric Co. All American carbon manufacturers now use it, and every dynamo or motor brush made of this material is first tested as to its suitability for the special work for which it is intended. Applied to glass, etc., it shows at once whether or not these materials are too brittle to be good. Wood rubber and other fibrous materials can only be tested by an especially sharpened drop hammer.

HIGH SPEEDS

TOUCHING ON THE EXTERIOR BALLISTICS OF THE MODERN HIGH-POWERED RIFLE

J W JR

Probably the highest speed of rotation familiar to the layman is that of the later automobile engines which turn 3,000 R. P. M. more or less, while that which is best known to the engineer is the 30,000 R. P. M. which the rotor of the smaller De Laval steam turbine acquires. These speeds are high enough to present extraordinary difficulties to the designer but fast as they are they are quite outclassed by an object familiar to us all to a greater or less extent, the ordinary rifle bullet.

While the enormous number of revolutions per minute which one of the higher velocity bullets makes is not appreciated, yet every huntsman or target shot knows that it must acquire a rotation around its geometrical axis on account of the twist of the lands of the rifling in the barrel. The terrific speeds attained with some of the latest military ammunition are realized only by the ballistic expert, but play a very important part in the design and balancing of the bullets for the finer target ammunition.

Of the smaller calibers the best known and most popular all-round cartridge is probably the 0.22 "long rifle," the bullet of which is made of lead and weighs 40 grains. Its velocity as it leaves the muzzle of the gun is approximately 1,000 feet per second or a little over 11 miles a minute, quite a fair speed even in this day of fast automobiles and high-speed trains. The lands of the rifling have a twist of one turn in 18 inches, imparting to the bullet a rotative speed of 660 revolutions per second, or 39,600 R. P. M., which is "going some" but still quite within our conception. On account of its light weight, however, the 0.22 caliber bullet strikes a blow of less than 100 foot-pounds, enough nevertheless to put the ordinary squirrel or woodchuck out of business.

Fig. 1. Springfield Model 1903 Army Rifle, Latest Pattern, with Cartridge Clip in Place ready for Loading

The most talked of and deservingly most popular of the higher power sporting rifles for use with smokeless powders is the 0.30-30 Winchester, Marlin or Savage. The cartridge for this gun is loaded with a metal-cased or soft-point bullet weighing 165 grains, which upon being fired attains a muzzle velocity of 2,020 feet per second, or 23 miles a minute, and strikes a blow of 1,480 foot-pounds. After all it is not so wonderful that this little missile carries a message of death with every shot. The twist in a 0.30-30 barrel is generally about one turn in 12 inches, which imparts to the bullet a rotative speed of 2,020 revolutions per second, or 121,200 R. P. M. From this it appears that the steam turbine "is not in it" for speed, although it may be doing far more for the industrial development of society.

The most interesting problems for mechanical analysis, however, are presented by the new rifles and cartridges recently adopted by the United States Government. The new 0.30 caliber Springfield ammunition is the first to be scientifically developed, using a pointed or Spitzer bullet. This new bullet is slightly over an inch long, tapered like the end of a cigar to a point 0.050 inch diameter and weighs only 150 grains, by far the lightest bullet ever used for a military arm with the exception of the 6 mm. (0.236 inch) U. S. Navy Model which was soon discarded. The idea of using such a light bullet is to

produce an exceedingly high muzzle velocity with the same or only slightly increased pressure in the rifle chamber. The result of this high velocity is that the bullet travels in a trajectory which is very flat, requiring far less accurate estimates of target distances and so producing a much more efficient and deadly weapon in the hands of the inexperienced marksman.

The velocity of the bullet as it leaves the muzzle of the rifle is 2,700 feet per second, or over 30 miles a minute, which gives it a tremendous shocking power, striking a blow of 2,500 foot pounds, enough apparently to put a whole regiment out of commission. The great linear velocity of this bullet produces an unexpected effect when fired from a rifle equipped with one of the new Maxim silencers. There is no doubt that this silencer destroys practically all of the noise caused by the sudden escape of the expanding powder gases, yet a shot fired under these conditions can be heard, under normal circumstances, for nearly a mile away from the firing point. This noise is undoubtedly caused by the rapid passage of the bullet through the air, which is separated so quickly that it returns with a crack or crash, producing an effect very similar to that caused by lightning.

While not only attaining such remarkable linear velocity this little high-speed projectile also rotates on its own axis at the rate of 194,400 R. P. M., the twist in the rifle lands being one turn in 10 inches. We have nothing to serve as an example for comparison with this speed and can only partially comprehend it when we realize that the periphery of this small nickel cylinder has a linear velocity of 3 miles a minute, or three times as fast as we consider it safe to run the best of cast iron fly-wheels.

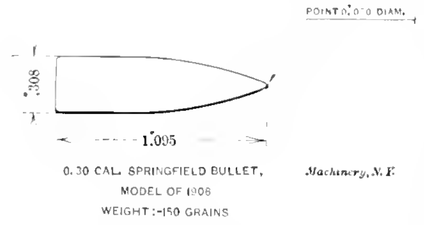

Fig. 2. Dimensions and Shape of Spitzer 150-grain Bullet

The amount of energy which this bullet possesses is much out of proportion to its size, and consists of the sum of that due to its rotation and that due to its linear velocity. To get at the amount of rotative energy involved, suppose we consider the bullet is made up of a cylinder 0.308 inch diameter, 0.595 inch long and a cone 0.308 inch diameter at the base with an altitude of 0.500 inch, the cylinder weighing 113 grains and the cone 37 grains. If M_1 is the mass of the cylinder; M_2 the mass of the cone; r the radius of the cylinder and the base of the cone; n the revolutions per unit of time; g (32.16) acceleration due to gravity; and I_p the moment of inertia around the geometrical axis of the bullet (polar moment), then

$$I_p = \tfrac{1}{2} M_1 r^2 + 0.3 M_2 r^2$$

The angular velocity $= \omega = 2 \pi n$.

Hence the rotative energy

$$\tfrac{1}{2} I_p \omega^2 = \tfrac{1}{2} (\tfrac{1}{2} M_1 r^2 + 0.3 M_2 r^2) 4 \pi^2 n^2$$

If the energy is required in foot-pounds per second we have:

$M_1 = 113 \div 7000g$,

$M_2 = 37 \div 7000g$.

$r = 0.154 \div 12$.

$n = 194{,}400 \div 60 = 3{,}240$ revolutions per second.

Substituting these values in the equation above and carrying out the calculation we get:

$$1/2\ I_p\ \omega^2 = 10 \text{ foot-pounds per second.}$$

This figure is of course negligible when we consider the 2,500 foot-pounds per second, or 4.5 H. P. which this small missile develops by virtue of its linear velocity at its maximum speed in flight.

The jacket of the bullet is composed not of steel as is commonly supposed, but of an alloy of 85 per cent copper and 15 per cent nickel. This metal possesses a high tensile strength which we find is quite necessary to prevent the jacket from stripping, *i. e.*, tearing apart and separating from the enclosed slug. The tearing effect of fouling in the rifling is of course an unknown factor, but we do find that the tensile strain set up by centrifugal force alone is very important and must be allowed for. Suppose we consider a small section of the bullet as a fly-wheel with the jacket acting as the rim, the thickness of which is about 0.020 inch, making the mean diameter 0.288 inch.

The mean velocity of the rim $= V = \pi \times \dfrac{0.288}{12} \times 194{,}400 =$ 14,650 feet per minute $= \dfrac{14{,}650}{60} = 244$ feet per second.

The sum of the centrifugal (radial) forces of the whole rim of a fly-wheel is

$$F = \frac{Wv^2}{g\,R} = \frac{4\,W\,\pi^2\,Rr^2}{3{,}600\,g} = 0.000341\ WRr^2,$$

where F = centrifugal force in pounds,

W = weight of rim in pounds,

v = velocity of rim in feet per second,

$g = 32.16$,

R = mean radius of rim in feet,

r = revolutions per minute.

The resultant of half of this force tends to disrupt one half of the rim from the other half. The rupture is resisted by the two sections of the rim at each end of the diameter. The resultant of half the radial forces is to the sum of half of the radial forces as the diameter of a fly-wheel is to half its circumference, or

$$\frac{\text{resultant}}{\text{sum of half the radial forces}} = \frac{1}{\frac{1}{2}\pi};$$

$$\text{resultant} = \frac{2}{\pi} \times \text{sum of half the radial forces}$$

$$= \frac{2}{\pi} \times \frac{0.000341\ WRr^2}{2} = 0.00010854\ \ WRr^2.$$

As this resultant force is resisted by the section at each end of the diameter, each section must resist a force

$$S = \frac{0.00010854\ WRr^2}{2} = 0.00005427\ WRr^2.$$

The weight of a rim of cupro-nickel, one square inch in section, is about 23.95 R pounds, R being in feet. Hence $S = 0.0013\ R^2r^2$.

But as $v = \dfrac{2\,\pi\,Rr}{60}$, and $v^2 = \dfrac{4\,\pi^2\,R^2r^2}{3{,}600}$, we have

$$S = \frac{0.0013\ v^2 \times 3{,}600}{4\,\pi^2} = 7{,}070 \text{ pounds per sqnare inch.}$$

Without doubt this is well within the safe stress for the metal used, but when one becomes familiar with the highly trying conditions to which it is subjected and appreciates the rapidity with which the bullet is accelerated within the rifle barrel, the uniformly satisfactory results obtained are surprising. The Ordnance Department and the commercial manufacturers are constantly at work to produce more efficient and more deadly ammunition and if the progress in the next few years is anything like that made since the Spanish-American war, the mechanical problems presented will be by no means inconsiderable, and will become as essential a part of bullet design as the ballistic problems are to-day.

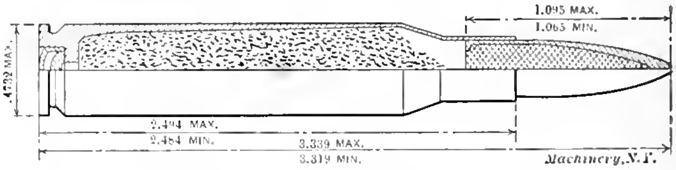

Fig. 3. Longitudinal Section of Springfield Army Rifle Cartridge with Spitzer Bullet

* * *

Mike.—Pat, man, me fortune is made!

Pat.—How is thot?

Mike.—I've invinted a machine for sweepin' the sthreets that will do the wurrk of six min.

Pat.—An' ye think ye're a great man to take the bread and butther out of the mouths of yere fellow min——

Mike (softly).—Hush, man! it takes siven min to wurrk the machine!

FORM GRINDING OPERATIONS IN THE SHOPS OF THE LANDIS TOOL CO.

RALPH E. FLANDERS*

The grinding wheel has found but a limited application for grinding other than plane, cylindrical and conical surfaces. In this respect its field is not so universal as that of the milling machine and the lathe, which readily adapt themselves to the use of form cutters and tools. In the grinder the difficulty lies in the shaping of the periphery of the wheel to the form it is desired to reproduce in the work. This operation offers more of a problem than in the case of a cutter or lathe tool, it being necessary to provide attachments with mechanical means for guiding a diamond point to follow the outline desired on the wheel surface. Despite this handicap, the Landis Tool Co., of Waynesboro, Pa., has found it profitable to make extensive use of such truing attachments for simple operations. Examples of work formed in this way are herewith illustrated and described.

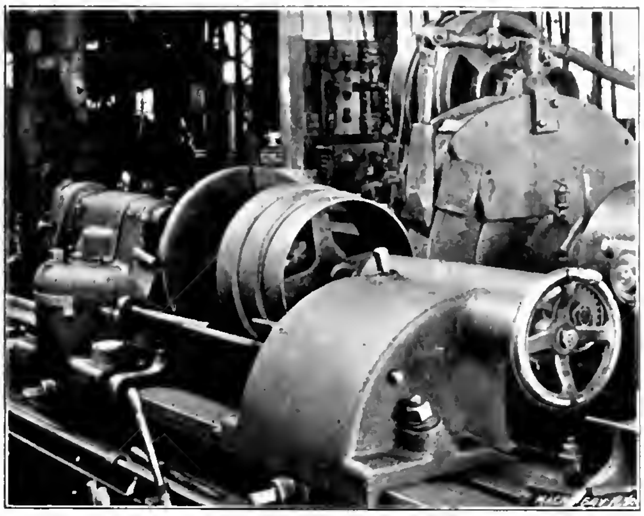
Fig. 1. Grinding the Crown on the Faces of Cone Pulleys in a Landis Grinder

Crowning Cone Pulleys

In Fig. 1 is shown a cone pulley, mounted in a large plain grinding machine, which carries a wheel shaped to give the desired crowning for the belt surface. To produce this, the wheel is concave to the proper radius and fed directly into the face of each step of the pulley, thus giving it the proper shape and the desired fineness of finish in the same operation.

The interest in this operation attaches, of course, to the means provided for grinding the concave contour on the wheel. The attachment shown in use in Fig. 2 is employed for this purpose. This consists, it will be seen, of a base mounted on the clamping surface of the work-table, and carrying a pivoted arm through which is adjustably mounted a swiveling diamond holder. This holder may be rotated about an approximately horizontal axis by means of the worm and worm gear and hand-wheel shown. By adjusting the arm about its pivot and the holder about the arm, the axis of the latter may be so located with reference to the wheel, that a concave surface of any reasonable radius may be cut out from the wheel. The adjustment is so flexible, in fact, that a practically straight, or even a convex surface can be produced on the wheel if it is required.

Grinding Fillets on Crank-shafts

Another example of form grinding occurs in the finishing of crank-shafts. The crank-pins and journals are provided with fillets at their junction with the cheeks of the crank. To produce a satisfactory job, these fillets should be formed by the edges of the wheel, which should be carefully shaped to the desired radius. Figs. 3 and 4 illustrate the fixture designed for this operation.

The frame of the fixture *A*, is mounted on top of the regular back-rest of the machine as shown. The diamond is set in the end of holder *B*, which is in turn supported by arm *C*, which swivels about axis *x x*. The radius to which the corner of the wheel is formed is determined by the distance from the point of the diamond to this axis. This radius is adjusted by thumb-screw *D*, suitable graduations (not shown in the engraving) being provided for making this adjustment. Holder *C* is supported at the upper end in the bearing in frame *A*. At the lower end it is provided with a roll *E*, which bears against a semi-circular seat in frame *A*, concentric with axis *x x*. By adjusting the nut and stud at *F*, thus clamping together the split shown in arm *C*, roll *E* is kept firmly pressed against its seat. This takes the thrust of the diamond against the wheel at the lower end of *C*. The diamond and its holder are rocked about axis *x x* by handle *G*, playing between stops *H*.

The operation of the device is as follows: The diamond in *B* having been adjusted by thumb-screw *D* and the graduations to the proper radius, stops *H* are set in the proper holes for the corner of the wheel to be trued. These stops give 90 degrees of movement, allowing the diamond to swing from the front face around to the side. Holding handle *G* in the position shown, so that the diamond is in front of the axis of rotation, the wheel is first trued up on its front face by the usual movement of the wheel back and forth past the diamond. When this has been trued up, without disturbing the cross feed of the wheel, the diamond is moved off to one side and handle *G* is rocked down to the 90 degree position on that side as determined by the stops. Rocking handle *G* back and forth through the 90 degrees, the table is gradually fed up to the corner of the wheel until the latter is completely rounded to the radius desired. For the other corner, handle *G* is brought back to the central position, stops *H* are changed to permit 90 degrees of movement in the other direction, and the diamond is fed back to the other corner, which is rounded in the same way.

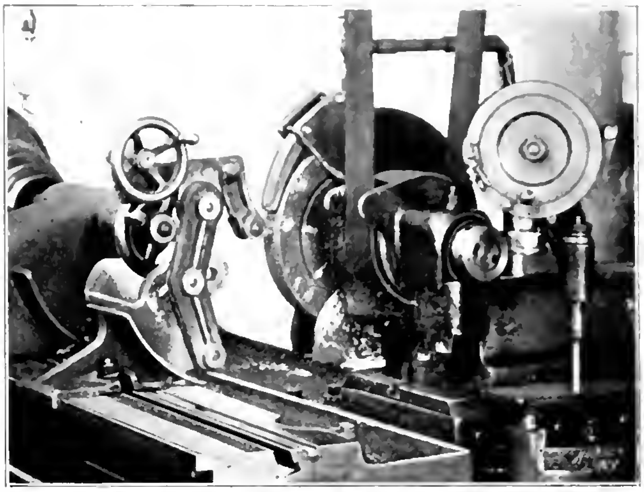
Fig. 2. Fixture for Shaping a Concave Face in the Wheel for Crowning Pulleys

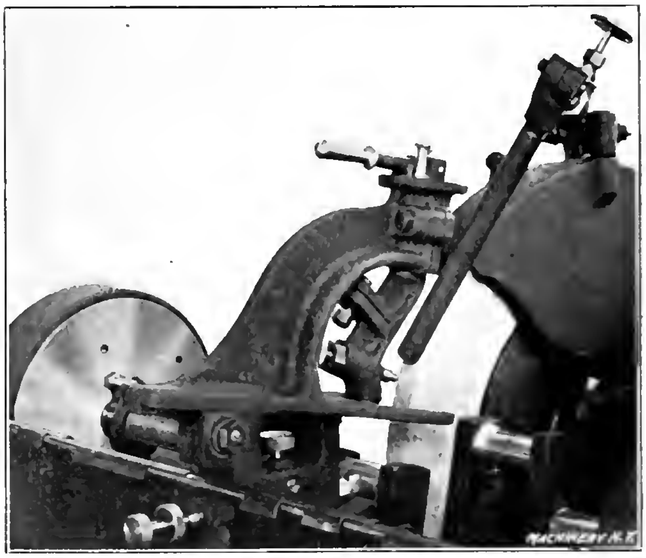
Fig. 3. Truing Device for Forming Wheel to Grind Fillets on Journals and Pins of Crank-shafts

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* Associate Editor of MACHINERY.

Fig. 4 also shows quite plainly the construction of the regular back-rest used in the Landis grinding machine. The work is supported by two rests of maple at *J* and *K*. The lower rest *K* is mounted on a pivoted arm *L*, which may be swung toward or away from the work by thumb-screw *M*. This adjustment does not have to be changed often, since the variation in the height of the work makes practically no difference in the diameter. Thumb-screw *M* is therefore provided with a clamp-bolt at *N*. The upper rest *J* is mounted in the end of a plunger *O*, which is backed by thumb-screw *P*, having knurled lock screws *Q*. In long, slender cylindrical work this rest is constantly set up by the workman as the grinding progresses, the adjustment being made for each rest at a time when the wheel is at work at another part of the shaft; it is possible at that time to be guided by the sense of touch in setting up the back-rest. For crank-shaft grinding it is ordinarily not necessary to adjust the rests during the operation.

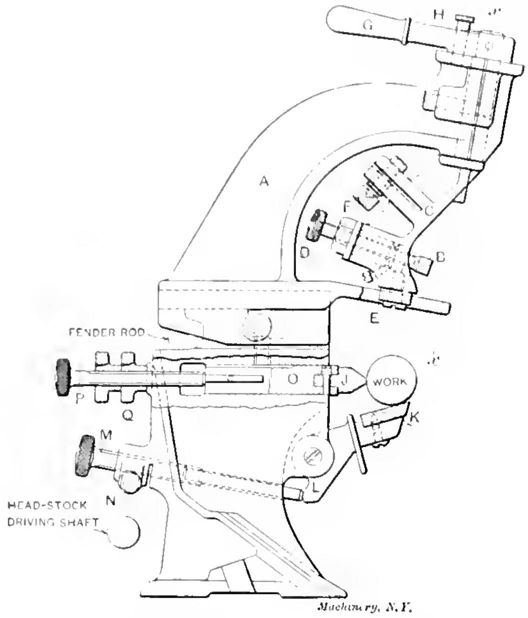

Fig. 4. Detail of Radius Forming Attachment

What may be considered a form grinding operation, though of the simplest order, is performed on the piece of work in Fig. 6. This shows a wheel spindle for the Landis grinding machine. It will be noticed that a portion of the spindle at the right end is turned down to a small diameter to receive the thrust and adjustment collars. This shaft is case-hardened. Difficulty was experienced in the hardening from the breaking off of this ⅝-inch diameter extension. To remedy this, the present method is to carry the 1.488-inch diameter clear out to the end of the shaft at the right, and case-hardening it in that condition, the shaft being finished except for this portion. After hardening, the spindle is placed in the grinding machine again, and a wheel the full width of the part to be machined (that is to say, about 3 inches face) is used to grind below the case hardening. The wheel is not traversed back and forth as in ordinary grinding, but is fed straight in, reducing the diameter about 3/16 inch. It is then possible to finish the arbor at this point in the lathe, as the core of the spindle is soft. It will be seen that this is a form grinding operation, in spite of its simplicity.

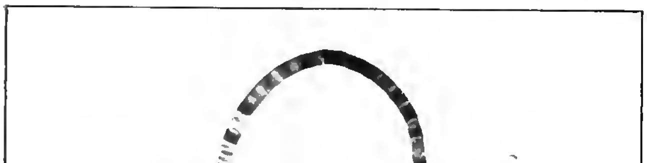

Fig. 5. Example of "Chip" Produced in Heavy Cross-feed Grinding

An interesting, though now well-known, phenomenon is connected with this operation. If the hardness and grain of the wheel is exactly right, forcing it into the work with a heavy feed will produce a "chip" very strongly resembling that produced with a wide form tool under the same conditions. When these chips first appeared, there was considerable discussion as to their nature, but it is now pretty definitely settled that they are formed of molten bits of metal, which rapidly accumulate and are fused together into the solid, ribbon-like form shown in Fig. 5. There is no advantage in producing these chips, but they are bound to appear if conditions are right for them.

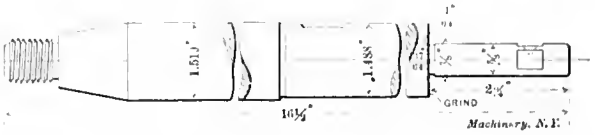

Fig. 6. A Grinding Machine Spindle; the ⅝-inch Diameter is machined after Case-hardening

* * *

THE SILVER DOLLAR CHECK SYSTEM

W. L. B.

When I was running a lathe in the old railroad shops at Scranton, a new man came in one morning and took a big lathe opposite mine. He was a country jay of the greenest kind, but he soon showed that he could do a good piece of work, though his queer way of doing it would make us wonder what kind of a country shop he came from. The boys gradually broke him in to our ways by their own gentle methods. Jim, who ran a lathe which was on the other side of the new man, was particularly active; he soon fixed up a game with one of the apprentice boys, and started right in. Jim called the boy, and pitching him a big silver dollar in a way to attract the attention of the country man, told him to go to the tool-room and get a file. The boy did so, and then, on the quiet, returned the dollar. Soon Jim called the boy and, again pitching him the silver dollar, told him to get a wrench, and so it went on, Jim calling the boy and every time giving him the dollar as he told him to get some tool.

The country man observed this careless exchange of money until he couldn't keep in any longer; then he asked Jim why he gave the boy a dollar every time he wanted a tool. Jim's chance had come and he started right in to improve it. He said that the rule of the place was that fifty cents had to be deposited for every tool taken from the tool-room, and when the tool was returned it was examined and a charge made for the wear. The other fifty cents was graft for the tool-room keeper, who was a crank and who wouldn't give the men any tools unless they put up the fifty cents which he put in his own pocket. Jim went on to say that it was useless to kick against the system as the foreman insisted on the work being done, and as they had to get the tools from the tool-room, there was no other way.

The country man was taking the bait fine, and in his interest he asked Jim how much he made a week. Jim said twelve dollars, but as his board was five and drinks five more and as the tools cost him a couple of dollars a day he was not getting along very fast.

Our country friend went back to his lathe in a dazed condition, and it was comical to watch the exceeding slowness with which the bright light of truth percolated that country head.

He made good in the shop all right, but for some reason he and Jim never became chums.

* * *

Brass for brazing should contain at least seventy-five per cent of copper in order to prevent its melting and flowing away during the brazing.—*Brass World.*

DON'TS FOR DRAFTSMEN*

JOHN S. MYERS†

Don't forget fillets.
Don't forget impact.
Don't omit oil holes.
Don't scoff at theory.
Don't omit oil grooves.
Don't omit dimensions.
Don't forget check-nuts.
Don't slight the details.
Don't repeat dimensions.
Don't use fancy lettering.
Don't show fancy oil grooves.
Don't claim credit not due you.
Don't despise accepted practice.
Don't crowd bolts too near ribs.
Don't work without a slide rule.
Don't be stingy about clearances.
Don't forget the value of graphics.
Don't start unprofitable arguments.
Don't be afraid to soil your hands.
Don't put foolish notes on a drawing.
Don't put unnecessary finish on parts.
Don't pretend to be what you are not.
Don't bend levers if it can be avoided.
Don't imagine you own the company.
Don't forget to allow for adjustments.
Don't get the patent bee in your bonnet.
Don't forget clearance for moving parts.
Don't be unpractical in applying theory.
Don't fail to keep notes on valuable points.
Don't repeat same detail in different views.
Don't put figures of no account on drawings.
Don't be timid or you will soon be a door-mat.
Don't leave too much for the tracer to fix up.
Don't go into needless refinement of figures.
Don't work all the time—recreation brightens.
Don't show plan view of nuts—life's too short.
Don't, if a checker, make unnecessary changes.
Don't raise a howl when asked to make changes.
Don't forget that blacksmith work is expensive.
Don't look for snaps—they are not worth having.
Don't be afraid to acknowledge you were wrong.
Don't think the company cannot do without you.
Don't make two parts where one will do the trick.
Don't think a checker has a cinch; try it yourself.
Don't be biased; keep your mind open to conviction.
Don't hesitate to make some original investigations.
Don't forget that looks sometimes sells the machine.
Don't make new patterns when old ones can be used.
Don't scale drawings when dimensions are available.
Don't provide awkward or poor means for lubrication.
Don't be disloyal to an employer who uses you square.
Don't forget the old saw, "Experience is a dear teacher."
Don't trust set-screws to deliver much power; use a key.
Don't forget that keys sometimes have to be drifted out.
Don't hold extended conversations during working hours.
Don't section line a lead pencil drawing except free-hand.
Don't forget that a little knowledge is a dangerous thing.
Don't use cast gears for high speeds; cut teeth are better.
Don't be afraid to show enough views to make things clear.
Don't use a slide-rule for calculations which must be exact.
Don't save ink—heavy lines and bold figures are the thing.
Don't put set-screws 180 degrees apart; 90 degrees is better.
Don't give dimensions in 32nds when 8ths are close enough.
Don't put ribs in tension if they can be put in compression.

Don't put important dimensions where they may be overlooked.

Don't be without one or two good papers bearing on your work.

Don't forget what class of workmen are to handle a machine.

Don't omit minor details, it causes endless confusion and delay.

Don't put a stud where a through bolt can just as readily be used.

Don't set down dimensions from scale until you have checked them.

Don't forget that any fool can criticize, but any fool cannot do.

Don't join a $\frac{5}{8}$-inch rib on a section 3 inches or 4 inches thick.

Don't lay a thing out when you can trace it from an old drawing.

Don't put dimensions on top of lines; make them out in the open.

Don't use any other kind of note-book but the loose leaf variety.

Don't forget that most calculations are at best but approximations.

Don't worry over infinitesimals or non-essentials—eliminate them.

Don't waste your noon hour—a trip through the shop will help you.

Don't be close-fisted with your data. Swap with your associates.

Don't balk at an excursion into the unknown; it may be profitable.

Don't imagine a man falls onto success like a blind pig into a well.

Don't stay out late with the boys—a big head is not a clear head.

Don't consider strength alone—rigidity is often the prime object.

Don't draw anything without some idea of how it is going to be machined.

Don't use standard nuts on parts much adjusted—use special long ones.

Don't trust to the eye for proportions of important parts—calculate them.

Don't hesitate about changing a drawing when the design can be improved.

Don't imagine every idea you get is a new one—this earth is fairly old.

Don't forget that drop forging saves money when in sufficient quantity.

Don't forget your ideas are your own if not worked up on the company's time.

Don't be unsystematic; you may thereby be going the longest way round.

Don't accept matters of opinion when matters of fact can be clearly shown.

Don't branch off onto matters extraneous to the points under consideration.

Don't hesitate to propose improvements or new ideas—you will gain thereby.

Don't make special parts when a standard part can be made to fill the bill.

If weak in the chest, don't be a draftsman—be a surveyor or get a milk route.

Don't forget it is easier to rub out lines on paper than to change iron and steel.

Don't wear cuffs; take off your coat and roll up your sleeves—be untrammeled.

Don't forget that good judgment is often the highest court of appeal in design.

Don't forget that your view-point might be changed if you owned stock in the company.

Don't locate holes which have to be laid out, in angular measure—give the chord.

Don't put bosses on opposite sides of forged levers if it can be avoided.

Don't expect to have everything ideal; you will nearly always have to compromise.

Don't tell all you know unless it doesn't take long, in which case it is immaterial.

Don't forget that a hand pointing to an important note will catch the workman's eye.

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* For "Don'ts" previously published in MACHINERY see: Don'ts for the Blacksmith, February, 1909; Don'ts for Inventors, January, 1909; Don'ts for Machinists, March, 1908; More Draftsmen's Don'ts, June, 1906; Hard Lines for Draftsmen, October, 1905; Practical Don'ts for Machinists, 1, June, 1905; 2, January, 1906; 3, February, 1906.

† Address: 2456 Almond St., Philadelphia, Pa.

Don't change dimensions from your figures to the checker's until you have confirmed them.

Don't forget that the tracer wants to be a draftsman, and give him a chance whenever you can.

Don't forget to consider the pattern-maker and molder—their work costs money.

Don't search all over the room for a protractor; use your tables of sines and tangents.

Don't start a job until all the requirements and available data are secured and digested.

Don't refrain from calling attention to points you know the chief would like a say-so on.

Don't put 1/16-inch and ⅛-inch finish pads where ¼-inch and ½-inch ones can be used.

Don't forget that force travels in straight lines or else produces bending stresses.

Don't forget that curved ribs are more expensive in the pattern shop than straight ones.

Don't forget that new drawings of old parts can best be made directly on the tracing cloth.

Don't forget center lines. A circle without its center lines looks like a bald-headed man.

Don't forget that the company is not running an art gallery, but a manufacturing establishment.

Don't have too much all-abiding faith in the factor of safety to cover up inadequate design.

Don't get the graphic bug (or any other) in your head to the exclusion of better methods.

Don't put a lot of cored work on a "one-casting-only" job. A little extra metal is cheaper.

Don't disregard the erector; take the machine apart and assemble it while making the drawings.

Don't use dowel pins for heavy thrusts when fitted bolts or tongues can be used to advantage.

Don't have a different tool for each different line; a few simple ones save time in the end.

Don't forget the machinist when dimensioning; his dimensions should be from finished surfaces.

Don't use an over-hung pin if it can be supported on both ends as readily.

Don't ask the chief questions you can answer yourself by second thought or by the use of your eyes.

Don't imagine rough castings come just like the drawing; they vary and you must allow for it.

Don't set down a dimension without laying your scale on it—it is a mighty good check.

Don't be given to snap judgment. Have some foundation upon which to base your opinions.

Don't imagine that all parts have to be made in your own shop. Sometimes you can do better outside.

Don't use studs when tap-bolts make the part easier to remove, unless for other good reasons.

Don't say theory when you mean hypothesis; call a thing by its right name, whatever it be.

Don't make picture drawings for the workman—when such drawings are required, hire an artist.

Don't make extra machine work on parts to save a little metal unless weight is mighty important.

Don't form the whistling habit—it annoys others and distracts your own mind from the work.

Don't, when lines are close together, make arrows so the workman cannot tell which line they go to.

Don't forget that a change of position often kicks a man out of a bad rut.

Don't say "¾-inch cored holes" or "core ¾-inch holes for ⅝-inch bolts"—say ¾-inch core.

Don't say, "drill and tap for ¾-inch gas pipe"—it makes the machinist tired. Say ¾-inch pipe tap.

Don't put special threads on the drawing until you know how they are going to be cut.

Don't forget that cores require support and vent, and that provision must also be made for clearing them out.

Don't raise objections to everything proposed—manage to see the good points also.

Don't try to impose your personal opinions on others—remember the old woman who kissed the cow.

Don't change patterns for mere personal preferences of design—the next man may change them back again.

Don't think you are the whole show—there are others who have trouble before the design is working.

Don't put all dimensions on, then all arrow heads; you are sure to miss some of the latter by this method.

Don't forget that natural functions are quicker to use than logarithmic when multiplying by even figures.

Don't make changes in a half-hearted, dispirited, sloppy manner. Make them as good as the rest of the job.

Don't make parts right and left when it can be avoided, even if some changes in the drawing are necessary.

Don't mix styles of printing; for instance, Italics and Roman, vertical and slanting, or backhand and vertical.

Don't forget that while you are young and single is the time to do your moving for a varied experience.

Don't lead ropes off the bottom of a drum when it can be avoided; they lead much better from the top.

Don't try to smoke and draw simultaneously—you don't enjoy the smoke and it interferes with your work.

Don't ask a tracer to do a job for you which takes longer to explain to him than it would to do it yourself.

Don't wait until the tracing is made before writing the bill of material; there are many good reasons for this.

Don't, unless an expert, attempt to dictate a proposal or specification without first roughly blocking it out.

Don't forget the value of free-hand sketching; it is a great aid towards securing a mental picture of what is required.

Don't waste time rubbing and redrawing which could be avoided by roughly sketching out the scheme first.

Don't commence a layout blindly when it is possible to secure a good mental picture of the requirements.

Don't forget the value of sections or little true plane projections of parts which are at an angle to the main body.

Don't put a ⅜-inch bolt or set-screw where a ⅝-inch or ¾-inch one would remove all doubt as to security.

Don't be industrious only when the chief is around, but plug away faithfully and you will some day be discovered.

Don't scoff at theory; theory is crystallized fact. There is a wide divergence between theory and hypothesis.

Don't forget to allow for the efficiency of various mechanisms; friction is often a very important factor.

Don't perform extended trigonometrical calculations when scaling a layout is sufficiently accurate and quicker.

Don't let a stop strike a moving part at a great distance from its center of percussion if it can be avoided.

Don't use abbreviations no one understands but yourself; *you* may even forget what they mean in a year or so.

Don't draw two arcs tangent for a reverse curve—they give a hump-backed appearance. Connect them by a straight line.

Don't forget the Lord did not make man with ribs on the outside of his body, and that smooth contours are pleasing.

Don't draw a moving part in a dozen different positions for clearance—trace it and shift the tracing over the layout.

Don't say, "Bore 6-inch diameter" or "6-inch diameter bored"—say bore 6-inch. (Any fool knows it is not square.)

Don't put little undercuts on castings; they seldom save much metal and cause the pattern-maker and molder lots of trouble.

Don't send a solid wheel out as a repair or additional part when it would save money in erection by having the wheel split.

Don't forget that the draftsman should be a designer, and to reach that stage he must study outside of working hours—life is short.

Don't undervalue the process of elimination when attempting to arrive at a decision where numerous factors are apparent.

Don't copy other concerns' designs; you may get your employer into trouble, and besides it is poor policy. Study designs, but don't copy.

Don't treat the shop man with contempt or disrespect; he knows a thing or two and dollars to doughnuts he's as much a man as you.

Don't destroy mechanical publications; save, at least, the articles you are interested in and file them in some way so that you can find what you are looking for.

Don't think that you know more than the chief; maybe you do on some things, but it is bad to look through glasses of that color.

Don't make shrouded pinions just a little wider than the gear; leave plenty of room, say (3/16 × pitch) + 1/4 inch on each side of gear.

Don't try to draw all of one view first, work your different views up together, thus seeing the relation of parts; this is very important.

Don't use long compound names like "Second Intermediate Shaft Bearing"—call it "bearing." Assembly drawing should show where it goes.

Don't, when given a scheme to work out, immediately try to work in something else, but make the scheme given you work if possible.

Don't use gold where clay will do; for instance, if machinery steel case-hardened answers the purpose, what is the use of using tool steel?

Don't give up in despair when ideas will not come; take a little walk out into the shop, come back and try again. It helps wonderfully sometimes.

Don't imagine a shroud has to be thick for strength; it is entirely a matter of casting. Thickness = (¼ × pitch) + ¼ inch is writer's rule.

Don't repose explicit faith in figures when things look out of proportion—you may have made an error in calculating or a wrong assumption somewhere.

Don't leave a thing just good enough, or on the ragged edge, when opportunity exists for making it positively and absolutely adequate to all requirements.

Don't spoil the entire appearance of a machine by one or two cheap details; for instance, an unsightly rough lever, or an old bent flat for a bracket.

Don't waste too much time in explaining the mental processes whereby you fell in error; although if they can quickly and clearly be shown, it lets you down easier.

Don't imagine the workman only needs measurements from the pitch line for cut bevel gears. Give outside diameter, face and pitch angle, and backing from point of tooth.

Don't be ignorant of structural design because you are in a mechanical line; many of the principles are valuable in machine design.

Don't, if a boss, imagine your men will stay just to help you out when they can do better elsewhere; if you want to keep your men make it profitable for them to stay.

Don't prohibit the use of 2- and 4-inch scales; they are as readily scaled as the 1-inch-to-the-foot drawings and are often better in every way than 1½, 3, or 6-inch scales.

Don't forget that the stub tooth, of higher angle of obliquity than the present standard, is going to be the coming thing. (It is here now, but too few persons recognize it.)

Don't go to war without arms; for instance, don't tackle a job without preparation (especially a new line of work), or go out to measure up a job without a steel scale and calipers.

Don't run an old men's home or a kindergarten; either extreme is liable to require excessive philanthropy, for the old ones die and leave you, and the young ones leave of their own account.

Don't forget that multiplication of parts costs in clerical work on orders, cost accounts, etc., besides being more parts for the erector to handle and to carry in stock, and for the user to replace.

Don't be helpless if required to do a simple mechanical job just because you are a structural man—acquire a certain amount of general knowledge; it will be very helpful even in your special line.

Don't use thin nuts where standard ones will do just as well; for thin nuts are generally made from standard ones, therefore cost more; and standard nuts avoid all doubt as to the old check-nut argument.

Don't imagine thought grooves can be readily obliterated; it is doubtful if they can ever be filled up entirely. Start a new and better groove; wear it deeper by using it oftener and thus short circuit the old path.

Don't imagine an idea to be valueless, or a man incompetent, on account of being old; old is but a comparative term, and age is a condition, not a quality. The condition may indicate certain qualities, but they vary with the individual.

Don't forget that kinetic energy varies as the square of the velocity; this fact sometimes changes the complexion of things.

Don't forget that weight varies as the cube of like dimensions and that a part twice as large as another therefore weighs eight times as much, and if rotating at the same angular velocity has $2^3 \times 2^2 = 32$ times the energy of the part one-half as large.

* * *

GOOD AND BAD DESIGNS OF OFFSET LEVERS

JOHN S. MYERS[*]

Don't make levers like Figs. 1 and 3; make them like Figs. 2 and 4, and thus avoid excessive torsional stresses and resultant deflections. The reason is as follows: On section AA, Fig. 1, the bending moment equals Pl and the torsional moment equals Pl_1; on section BB the bending moment equals Pl_2, and the torsional moment equals Pl_3. Thin rectangular pieces are not suitable for torsion, hence the form illustrated in Fig. 1 will be subject to excessive deflection as compared with Fig. 2 in which the weight of the lever is the same or even less.

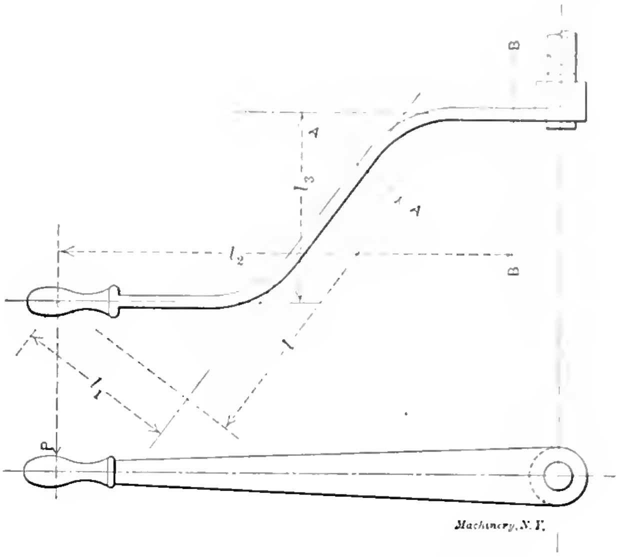

Fig. 1. Poor Design of Offset Lever; Torsional Moment High

In Fig. 2 the bending moment on section BB equals Pl, and the torsional moment equals Pl_1. The reduction in torsion in comparison with Fig. 1 is evident. With the same rectangular section Fig. 2 will not suffer the same torsional deflection as is shown in Fig. 1.

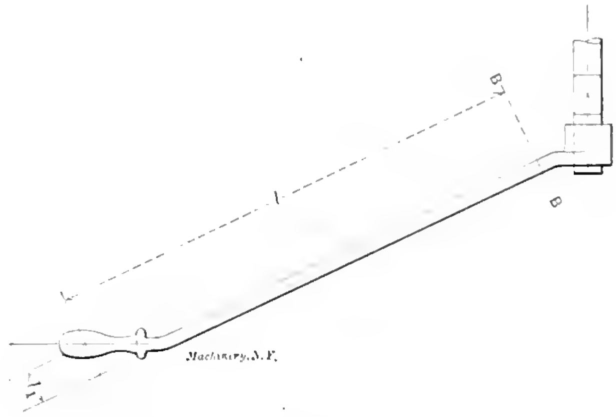

Fig. 2. Good Design of Offset Lever. Torsional Moment Low

The same principle is illustrated in the clutch lever in Figs. 3 and 4. The sections AA and A_1A_1 are each subjected to a torsional moment equal to ½ Pl in addition to a bending moment equal to ½ Wl_1. The torsional deformation causes excessive deflection and much higher fiber stresses than

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the designer is likely to anticipate, if he has not given the matter consideration.

The preferable form is that shown in Fig. 4. The sections AA and A_1A_1 are subjected to bending only, the moment on each being equal to ½ Pl. The tension in the top fibers t and t_1 in consequence requires a thrust T to balance it. This puts the top fibers of the cross-piece C in compression, and the lower fibers in tension. (See section BB.) To determine the value of T, calculate the unit stress t_1 and lay out as shown to the right. Scale off T and multiply by $b \div b_1$. The product is the unit stress in C.

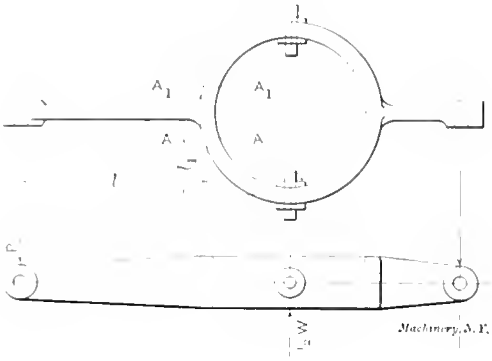


Fig. 3 Poor Design of Clutch Lever

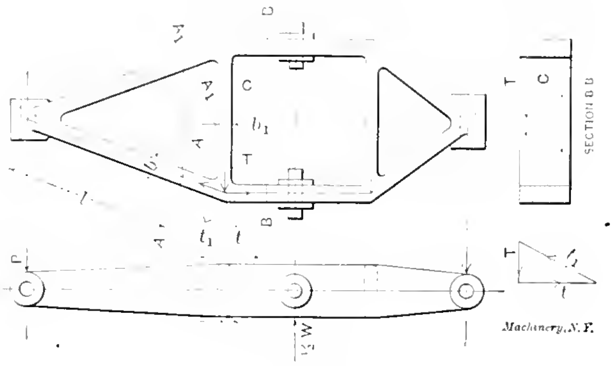


Fig. 4. Preferred Form of Clutch Lever Design

* * *

An ingenious camera has been devised for recording the speed of automobile speed violators and furnishing the evidence to convict them in court. The camera is the invention of Professors D. F. Comstock and H. T. Kalmus of the Massachusetts Institute of Technology. It comprises two plate holders and a stop watch, and is so constructed that a picture of the stop watch appears in each exposure, thus giving an automatic record of the time elapsed between each exposure. The operator takes his place on the highway where speed violators pass, within focusing distance of the road. When a speeding automobile passes a certain point, the upper plate in the camera is exposed, and the second plate is exposed at another angle as soon as possible thereafter. A simple mathematical calculation enables the exact distance traveled to be deduced, and the watch face pictures record the exact time elapsed between the two points, thus making irrefutable evidence of the speed.

* * *

No sooner had flying machines of various types become successful enough to command the attention of military experts than the latter began to busy themselves to invent means of destruction of dirigible balloons and aeroplanes. The Krupp firm has a special department devoted to the construction of guns intended for disabling air ships, and two models have been brought out, one for discharging explosive shells and another for throwing a burning projectile, and it is, perhaps, no exaggeration to say that as much genius and energy is expended on these means of destruction as is expended on the constructive work in perfecting the flying machines. This is the price great nations pay for being world powers.

EXPERIENCES OF A YOUNG TOOLMAKER

T. COVEY

After an experience of about two years in a machine shop Jim the apprentice boy had proved that there was material in him for a first class mechanic. He was able to do good work on many of the machines, and had also spent some time in the erecting room. Jim was anxious to become proficient in every branch of the trade, and therefore he hailed with delight an order to report to the toolroom foreman. From this point we will follow him for a while and see how he and the average apprentice obtains his knowledge of the trade.

Mr. Corbin, the foreman of the toolroom in which Jim was to work, was also in charge of the blacksmith shop, storehouse, and the oil room, and consequently his time was so taken up with matters that the firm considered more important, that he really was unable to devote the time and personal attention to training his apprentice boys that he would have liked to. These conditions exist in a great many of our shops throughout the country, and the natural consequence is that boys are thrown on their own resources and left to "pick up" the business as best they can; and it is a fact that they get their training mostly from the journeymen with whom they work, whose instructions are sometimes good and sometimes bad. Mr. Corbin realized this condition, and the advice that he gave to Jim could be summed up in these words: "Keep your eyes open and think for yourself; if you get stuck don't be afraid to ask questions."

Jim's first job was to make a dozen 1½-inch novo steel end-mills, with straight flutes, or teeth. He was given the stock and a finished end-mill in good condition as a sample, and was told that he could get a gage for the shanks from one of the boys that passed out tools. He was also instructed to leave the straight portion 1/32 inch large, and to allow the shanks to project 3/16 of an inch through the gage. Jim carried the stock to a vacant place on the bench and proceeded to center it. When this was done he asked the foreman what lathe he was to use, and was told to use any idle machine that was suitable for his work. He found a Hendey-Norton lathe with a taper attachment that was not in use, and went ahead with his work on that. After getting the gage out of the tool department, he tried it on the shank of the sample mill that he had been given and found that the shank projected ⅜-inch; turning to the man working next to him he remarked that he guessed that the foreman was afraid to let him turn his work to size.

"How is that?" the man asked.

"Why he told me to leave the straight portion of these mills about 1/32 inch large, and to allow the shanks to project 3/16 inch through this gage; this sample projects ⅜ inch."

"Well that is all right—we all turn them that way. It is done to leave stock for grinding after the mills are hardened. You will notice that the gage you have is marked plainly 'No. 9 Brown & Sharpe taper. Tang to project ⅜ inch.' These gages were made up to insure uniform results in making taper shanks. This is a female gage (B Fig. 1) and is made ⅛ inch longer on the large end than the standard taper; this is done to make sure that the socket will not strike on any shoulder that may be left on the shank before the taper fits properly. The male gage (A Fig. 1) of this size is made the proper length and size except that the small end is about 1/16 inch longer than the standard. If you were to try gages of this size together, you would find that the male gage was apparently too small (or the female gage too large) as it would project 1/16 inch through the small end of the female gage, and the large end of the latter would overlap the large end of the male gage ⅛ inch. But you will readily see that if a shank fitted to the female gage be placed in a socket fitted to a male gage, the small end will not go home by 1/16 inch, and there will be a portion of the shank at least ⅛ inch long extending out of the socket. (See Fig. 2.) This allows for driving the shanks in until they fit tight, and also for wear to a certain extent. I don't think you will find gages like these in every tool-room, but there should be."

"Yes, I should think they were a good thing," Jim replied. "By the way, what should the taper be for a No. 9 Brown & Sharpe shank?"

"All Brown & Sharpe tapers, except No. 10, are ½ inch to the foot. No. 10 has 0.5161 inch to the foot. Morse tapers vary from 0.600 to 0.630 inch per foot. There is a blue-print over there mounted on a board giving all the dimensions in detail for both Brown & Sharpe and Morse tapers of all sizes."

"Thank you," said Jim, "I begin to see that there is more to this job than I thought"; and he proceeded to turn up his mills without any trouble until he wanted to recess the ends. Then he went to the man again and asked: "How would you put this recess in the ends of the mills? Chuck one end and run the other in the steady-rest?"

"Well, of course you could do it that way, but there is an easier and much quicker way. All of our lathes in here are fitted with half centers (Fig. 3), and to cut out that recess you should replace the regular center with one of these half centers, placing the cut out portion toward the front of the lathe, and then use a regular boring, or hook tool to make the recess. Of course you will be cutting out the center, but when it gets too small to hold the work safely the mill can be removed and the center drilled deeper with a combination center drill and reamer. I usually face the ends of my mills and put the recess in first, because if the drill runs off a little in re-centering it is less liable to do damage."

Jim followed instructions and completed his work in the lathe. Upon looking for a milling machine in which to complete his job, he found them all in use. One man named George was nearly through and Jim asked him how much longer he would be in the machine.

"About ten minutes," said George.

"How many teeth are you cutting in that reamer?"

"Twelve."

"Good! Just what I want. I'll clean up the lathe I was using and you will be through by that time," and he was.

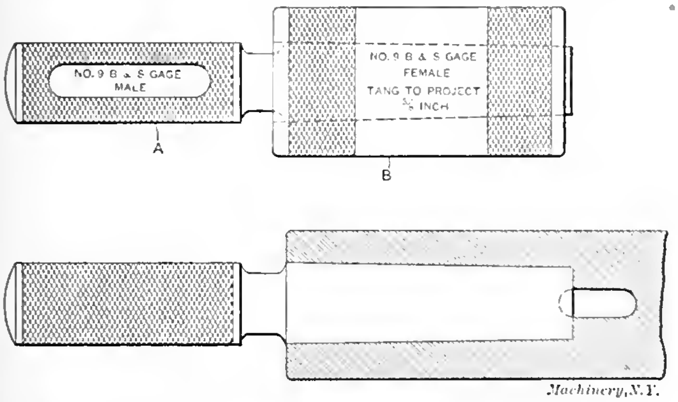


Fig. 1. The Way in which Male and Female Gages for End Mills should fit together, and Male Gage properly fitted into Socket

Jim put one of the mills in the machine, and was starting to mill the teeth when Mr. Corbin came up and said, "You should mill the tangs first then you can put the shanks in a collet, place it in the index head and mill the teeth. You would have to hold them in a collet to mill the ends, and if the tangs are not milled the shanks will not fit."

While Jim was milling the tangs he noticed that the index pin of the dividing head was in the 21-hole circle, and looking at the table he saw that for twelve divisions it gave 3 turns and 13 holes in the 39-hole circle. Going over to George, he said: "How is this? You said that you were cutting 12 teeth in that machine and the index pin is in the 21-hole circle."

"The machine is set up for twelve divisions, and I just cut twelve teeth on this reamer," said George.

"But for twelve divisions the table gives 3 turns and 13 holes in the 39-hole circle."

"Well I seldom use the table. I index in the quickest way and I don't change the index plates unless it is necessary."

"Then there must be other circles you can use instead of the ones given in the table?"

"Yes, in most cases there are."

"But how do you tell which ones they are?"

"I figure it out."

"You must be good at figures if you can do that quicker than you can look it up in the table, or change the index plates either. How do you do it?"

"Well it's simple enough when you understand it. You know that the ordinary index head is in the ratio of 40 to 1, that is, it takes 40 turns of the index handle to make one turn of the spindle. Now I'll give you the little rule I use. It will work on any index head of any ratio. You take the ratio, to 1, of the index head and put it down as the numerator of a fraction, and use the number of divisions you wish to make as the denominator, like this: 40/12. Now reduce this to a mixed number and you have 3 and 4/12. There it is, the whole number represents the number of turns; the numerator of the fraction, the number of holes and the denominator the circle. You learned at school that you could multiply or divide both terms of a fraction by the same number without changing its value. Now we will divide both terms of this fraction by 4 which reduces it to its lowest terms, or 1/3. So to get 12 divisions the index handle must be turned three and one-third times, no matter what circle you use; and it is plain that any circle having a number of holes that can be evenly divided by 3 may be used. For instance, 18 ÷ 3 = 6, or 6 holes in the 18-hole circle; 21 ÷ 3 = 7, or 7 holes in the 21-hole circle, and so on."

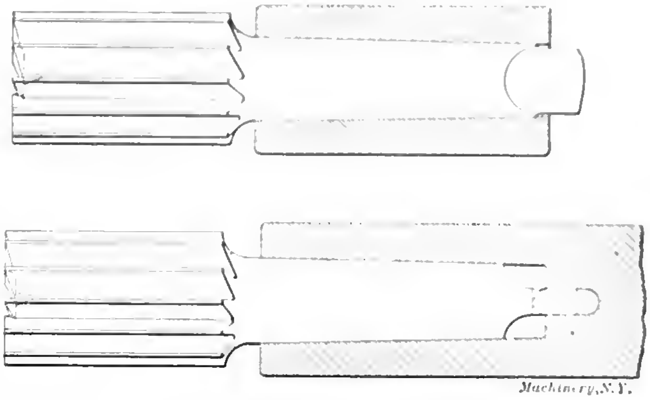


Fig. 2. Shank of an End Mill properly fitted to the Gage and Socket

"That looks easy," said Jim.

"Yes, and it is easy," replied George. "You try it every time you have a job of indexing to do, and you will soon find that you can do it without pencil and paper, and it will save you lots of time hunting up tables and changing index plates."

Jim got on fairly well in milling the teeth; only making one mistake in indexing by failing to move the marker the one-third turn. He told the foreman about it, and Mr. Corbin replied that that would not spoil the mill entirely, but he should be careful about such things. As Jim was finishing up this operation he began to think about how the machine was to be set up for milling the teeth on the ends, but could reach no satisfactory conclusion. Going over to George he said: "Say, I am a little puzzled as to how to mill the teeth on the ends of these mills. Will you kindly give me a few suggestions?"

"I'll help you all I can," said George. "What is the angle of the cutter that you used on the flutes?"

Fig. 3. Half-center for the Lathe

"I don't know," said Jim. "I took the sample mill to the window and asked for a cutter like the one used in making it."

"Well it should be 60 degrees, as that is what we use on the flutes or side teeth of practically all mills, and for cutting the teeth on the ends we generally use 70-degree cutters. The reason for this is that the teeth on the ends do not want to be as deep as they do on the sides, as the chip room would not be in proportion to the work the teeth are to do; the teeth would also be weak on the corner where the most work is done. First tip the index head up to about 75 degrees from the horizontal, but don't be particular about the setting, as you will have to make changes after taking a couple of trial cuts in order to get the lands of equal width from the outside

to the center. Tables have been figured out that will give you the angle to which the head should be set for a certain number of teeth and for a cutter of specified angle, but there are so many varying conditions affecting this angle that it would have to be a pretty elaborate table to cover them all, and even then the errors in the angles of the cutters due to grinding would be sufficient to make at least one trial cut necessary to get the correct angle. As you are cutting a right-hand mill you should get a left-hand 70-degree cutter and place it on the arbor with the side that is at right angles to the hole next to or facing the spindle of the machine. Set the saddle of the machine so that this side of the cutter is in line with the index centers. Move the table over until the index head is at the right hand side of the cutter or spindle, or loosen the head and move it along the table if necessary; then place the mill in the collet, bring it up to the cutter and revolve the index head until the edge of a tooth just comes in line with the edge of the cutter. Then move the saddle in four or five thousandths so that you will not score the teeth on the side of the mill, and take a cut, being careful not to go too deep. When one tooth is finished index for the next and take another cut. This will give you one land; if it is wider at the center than at the outer edge, tip the head up a little more and take another cut. If the index is turned so that the work revolves in the opposite direction to the hands of a watch, as you are looking down upon it, each new cut you make will give you a land true with the last change you made in the angle of the head, but if you turn it in the opposite direction, two cuts will be necessary after each change to secure a true land. After you get the land perfect note what angle the head is set to, and remember it, as you will have to swing the head back to a horizontal position each time you wish to remove a mill before you can drive it out. After the ends are milled take a file and smooth off the face of the teeth, so that they will have the appearance of matching perfectly, as it is practically impossible to match the two cuts so perfectly that no difference can be noticed, and the error always appears greater than it really is. I guess you will be able to get on all right now, and if you don't I am always willing to help you to the extent of my ability."

"Thank you," said Jim. "I think I understand it much better now."

On getting the teeth all milled and the faces smoothed off Jim took them to Mr. Corbin for his inspection.

"They are all right except that you have not marked them," said Mr. Corbin. They should be marked $1\frac{1}{2}$ inch on the large end of the shank, and the brand of steel underneath the size. Never make up a tool without marking on it plainly the brand of steel of which it is made. There are a great many different kinds of tool steel, and they are nearly all treated differently in tempering. No tool hardener can be sure of results unless he knows what steel he is handling. When you get your mills marked, turn them in and I will send them over to the blacksmith shop to be hardened."

* * *

An interesting method for producing an internal thread in castings while in the mold is referred to in a recent issue of the *Brass World*. This method can be used in cases where a good fit between the screw and the internal thread is not required and it obviates the need of tapping out the hole in the usual manner. Wire of about the same diameter as the pitch of the thread of the screw is bent in the form of a helix or spiral, with the coils closed up and inserted in the mold. The metal is cast around it and holds it firmly in place. The wire then forms a thread which will fairly well fit the screw. While this method would not answer the requirements for high-class work, it gives satisfactory service for many classes of low-grade machinery.

* * *

A fuel testing plant is being established by the Canadian government for investigating the natural fuel supplies of Canada. An important field of investigation will be that of peat, which is found in immense quantities in both Ontario and Quebec, and an attempt will be made to discover a method of using it successfully in gas producers.

DETERMINING THE ACTUAL COMPRESSION IN A SMALL GAS ENGINE

GEORGE M. STROMBECK*

Upon the proper compression of the explosive mixture in a gas engine depends the power and economy of the machine. This, together with the rapidly increasing number of gas (and gasoline) engines in the small and medium sizes, gives importance to methods of determining the compression. The simplest and most satisfactory way is by the use of a gas engine indicator which not only gives the compression, but also the force of the explosion. The compression alone can be obtained by the use of an ordinary steam gage, attached in the following manner: Next to the engine is placed a steam valve, opening into a check valve beyond which is a small air-tight chamber holding the gage. To determine the compression, run the engine, with the steam valve closed, until it is thoroughly warmed; then cut out the ignition and immediately after explosions have ceased open the valve. A few strokes of the piston will produce compression pressure in the small equalizing chamber holding the gage. The check valve serves to keep this pressure constant.

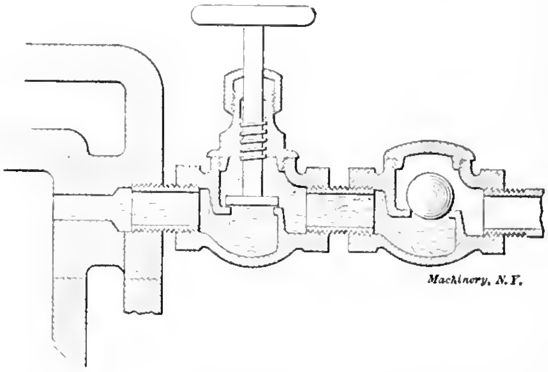


Fig. 1. When determining Compression by the Use of a Gage, Allowance should be made for the Increased Space indicated by the Shaded Portion

If neither indicator nor steam gage is at hand, a very close estimate of the compression can be made by filling the compression space (the space beyond the piston when it is nearest the head) with water, care being taken that no pockets are left containing air. The most convenient way is to either weigh or measure a quantity of water, then fill the engine and determine how much remains. The difference will give the volume of the compression space (one cubic inch of water weighs 0.577 ounce.) After thus filling an engine with water it should be run a while to prevent rusting. Gasoline may be used in place of water. To the volume of the compression space thus found add the piston displacement (the product of the area of the bore of the cylinder and the stroke). This gives the volume of the fresh charge.

It has been found that the relation between pressure and volume of a charge that is being compressed in a gas engine is very closely represented by

$$P\,V\,\sqrt[3]{V} = \text{a constant},$$

where P is absolute pressure in pounds per square inch and V is the corresponding volume. In gasoline engines the inflowing air must have a certain velocity to vaporize the gasoline. To produce this velocity requires a vacuum of two or three pounds per square inch. For this reason the pressure at the end of the suction stroke may be taken at 12 pounds above absolute vacuum. Knowing the volume and pressure at the beginning, and the volume at the end of the stroke the compression is found by use of the following equation:

$$P_1\,V_1\,\sqrt[3]{V_1} = P_2\,V_2\,\sqrt[3]{V_2}$$

$$P_2 = \frac{P_1\,V_1\,\sqrt[3]{V_1}}{V_2\,\sqrt[3]{V_2}}$$

The cube roots of the volume may be taken from a table of cube roots. From the value of P_2 thus obtained subtract 15 pounds for atmospheric pressure, and the remainder will be the compression of the engine.

---

* Address: 333 Third Ave., East Moline, Ill.

If the compression is obtained with the gas engine indicator, or steam gage, allowance must be made for the increase in the compression space due to the volume in the indicator and fittings, in one case, and steam valve and check valve as far as to the valve seat in the other case. The space beyond the check valve being sealed from the engine need not be considered. The spaces in question are shown shaded in the illustrations. That even a very little addition to the compression space will cause serious error in indicating small engines, will be shown by an example from actual practice. An engine having a bore of 4⅜ inches and a stroke of 5½ inches had a compression of 78 pounds when indicated. What was the compression with the indicator removed?

The volume of the air space in the indicator and fittings was measured with gasoline and found to be 2.3 cubic inches, which ought therefore to be added to the compression space.

Knowing the compression space in the indicator and fittings, that in the engine is readily computed as follows:

The piston displacement is

15.03 sq. in. (area of bore) × 5.5 in. (stroke) = 82.7 cu. in.

$P_1 = 12$ pounds absolute = pressure at beginning of stroke,

$P_2 = 15$ pounds (atmospheric) + 78 pounds (gage) = 93 pounds absolute = pressure at end of stroke.

Determine first the original volume of the gases compressed into the indicator. In the equation

$P_1\, v_1 \sqrt[3]{v_1} = P_2\, v_2 \sqrt[3]{v_2}$ all but v_1 are known. $v_2 = 2.3$ cubic inches = volume in indicator.

$$v_1 \sqrt[3]{v_1} = \tfrac{93}{12} \times 2.3 \sqrt[3]{2.3} = 23.5$$

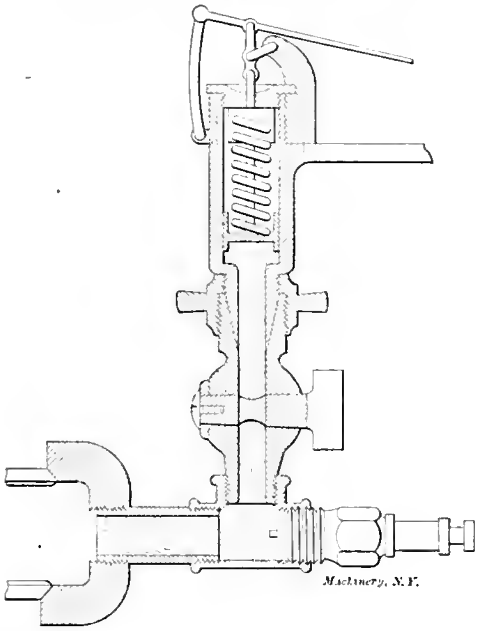


Fig. 2. When determining Compression by the Use of an Indicator, Allowance should be made for the Increased Space indicated by the Shaded Portion

From a table of cube roots pick out the number which when multiplied by its cube root will give 23.5, or

$$\sqrt[3]{v_1^4} = 23.5 \quad v_1^4 = 23.5^3 = 12{,}980$$

Extracting the square root twice $v_1 = 10.67$ cubic inches. Or solve with the aid of logarithms.

Of these 10.67 cubic inches, 10.67 — 2.3 = 8.37 cubic inches, originally occupied part of the space swept through by the piston. The rest of the gases displaced by the piston (82.7 — 8.37 = 74.33 cubic inches) must have been compressed into the normal compression space of the engine, which is the space to be determined. Since the pressure was the same in the engine as in the indicator, the relative size of the two parts of the compression space, in the engine and in the indicator, was proportional to the amount of additional gas forced into each, or

$$V_2 : v_2\ (= 2.3 \text{ cubic inches}) :: 74.33 : 8.37$$
$$V_2 = 20.4 \text{ cubic inches.}$$

By actual measurement with water and computation the compression space was placed at 20.57 cubic inches, a difference of less than one per cent from value above deduced. Having determined the normal compression space in the engine, the true compression is easily obtained:

Let $P_1 = 12$ pounds = absolute pressure at beginning.

$V_1 = 20.4$ (compression space) + 82.7 (piston displacement) = 103.1 cubic inches,

$V_2 = 20.4$ (compression space) cubic inches

Find P_2:

$$P_1 V_1 \sqrt[3]{V_1} = P_2 V_2 \sqrt[3]{V_2}$$

$$P_2 = \frac{12 \times 103.1 \sqrt[3]{103.1}}{20.4 \sqrt[3]{20.4}} = 104 \text{ pounds absolute}$$

104 — 15 = 89 pounds = true compression, which is 11 pounds higher than shown by indicator.

Fig. 1. Attachment for Automatically Starting and Stopping Bench Lathes

From this it is clear that in determining the compression by the use of an indicator or steam gage, one may be led to very erroneous conclusions unless the proper correction is made. The error will be larger, the smaller the engine or the larger the space in the indicator.

* * *

SOME INTERESTING SHOP APPLIANCES

When bench lathes are being used for turning small parts that have to be put in and taken out of the chuck by hand, the usual method of starting and stopping is by operating a belt shifter, or switch by a foot-lever. A method of starting and stopping these machines is employed in the shops of Adolph Muehlmatt of Cincinnati, whereby the control is entirely automatic. When on a job such as just outlined, the switch wires of the motor are connected at *A* and *B*, Fig. 1. As the tool carriage is pushed forward to the work, the circuit is closed at *C* and the motor starts. When the cut is finished and the carriage is drawn back, the circuit is broken and the motor stops. The long screw *D* which is adjusted by the knurled thumb-nut shown, allows the circuit to be opened or closed at any point desired.

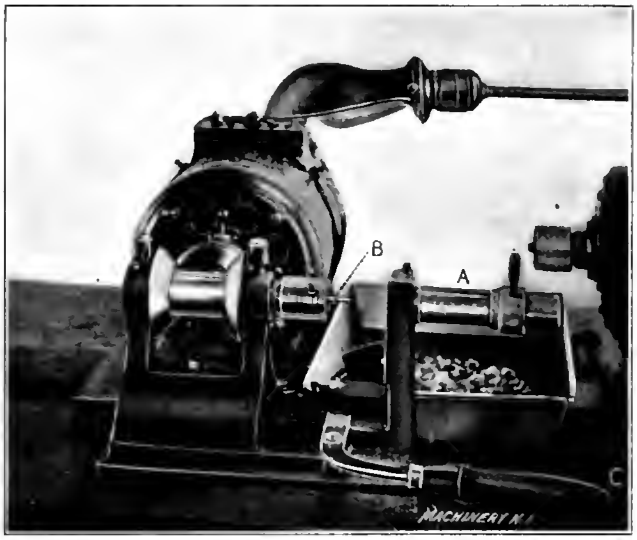


Fig. 2. Simple Form of Electrically-driven Tapping Machine

The engraving Fig. 2 shows a motor-driven tapping machine employed in these shops which will doubtless be of

interest. *A* carries a split chuck for holding the work and *C* is the lever which moves the work up to the tap. The spindle which carries the tap *B* is loose endwise so that it will not revolve either way when not in use; but, with the motor running right hand, as soon as the work is pressed against the tap, the end play of the spindle allows it to move over far enough to engage the pulley on the motor shaft and the tap is then fed into the work. By retarding the carriage the other pulley is caused to turn, and the tap is backed out. A girl can work this tool with great rapidity.

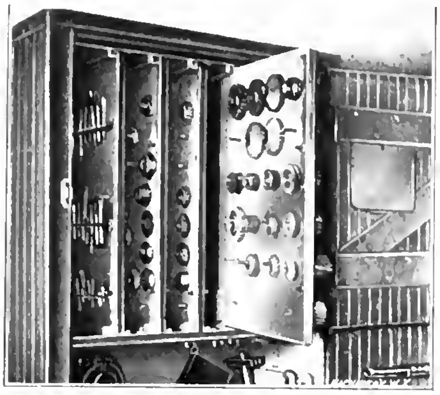


Fig. 3. A Compact Form of Cutter Cupboard

A very compact closet for milling-cutters is shown in Fig. 3. This closet has upright board partitions that slide in and out and they are hinged so that when they are pulled out against the stops they can be swung either way.

Fig. 4 shows one of the most compact batteries of small punch presses that I have ever seen. The motors and presses are all easily accessible, which is a point sometimes lost sight of in attempts to crowd a number of machines in a small space. E. V.

* * *

BOB'S BALKY PUMP

C. TUELLS

Bob was a good-natured, curly-headed apprentice boy in the best and largest machine shop in town. He had passed the days when the men used to send him to the blacksmith shop to get the teeth of a file drawn out a little longer, or to the stock room for a half-inch counterbore with a five-eighths pilot. As he was in his second year, he got fairly good work —compared with turning pulleys and snagging castings, or running errands and "chasing the broom."

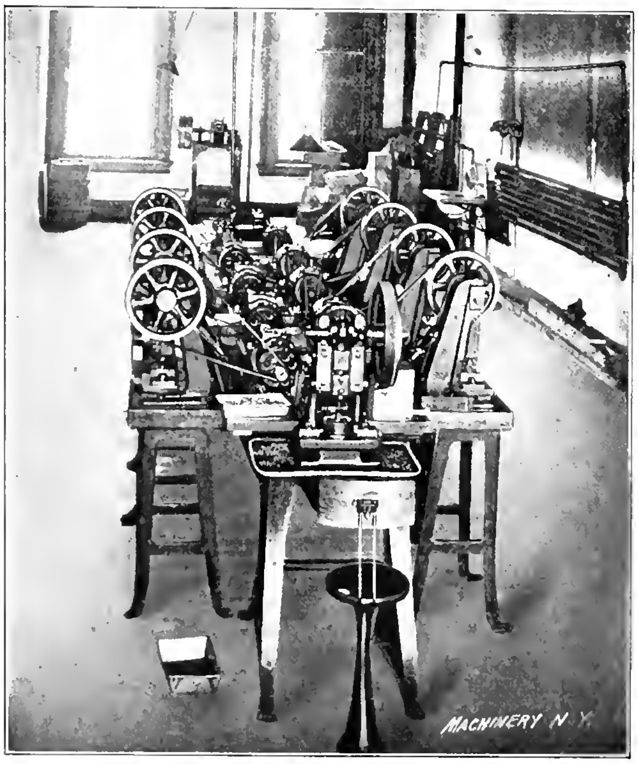


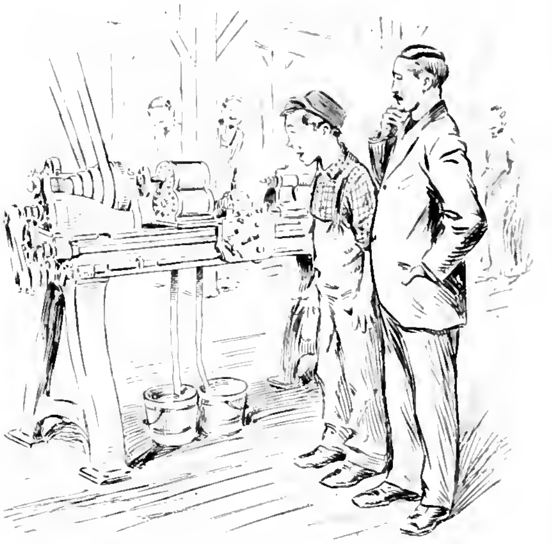
Fig. 4. A Compact Battery of Punch Presses

He was now at that stage of the trade where he was commencing to earn a little money for the company, for he could make a simple machine or a plain jig as well as most of the journeymen, and there was quite a difference between his thirteen cents an hour and the journeyman's thirty, which went on the right side of the books.

One day the boss brought around the blue-prints and castings for a rotary pump and gave Bob instructions how to make it. It was his first pump, so with all the vigor of ambitious youth he "waded into his job." He bored out his casting for the pump casing, turned up his gear blanks, and made his union as good and as quickly as the best of the men could do. True, he slipped up cutting one of the gears, but he hustled out a new blank, and this time his gears were cut the right number of teeth and the proper pitch.

After three or four days of interesting work his pump was completed and ready to be tested before being sent out of the shop. In "trying out" a rotary pump, it was customary to set it up on the ways of an old lathe, with the pump spindle in the chuck and the inlet and outlet pipes reaching to the floor into buckets; in this way, by starting the lathe, a bucketful of water was pumped from one bucket to the other, when everything went right.

Well, Bob got his pump set up all right, and it pumped, and pumped good, too. After pumping a few bucketfuls he shut off the power and went to get the boss to inspect the pump and see it work—his mind in that harmonious state that always accompanies a successful job.


"There was nothing doing at the outlet end, and all attempts to make it pump were in vain"

In the meantime, two of Bob's brother apprentices conceived the brilliant idea of inserting a large cork stopper in the end of the inlet pipe and pushing it up out of sight.

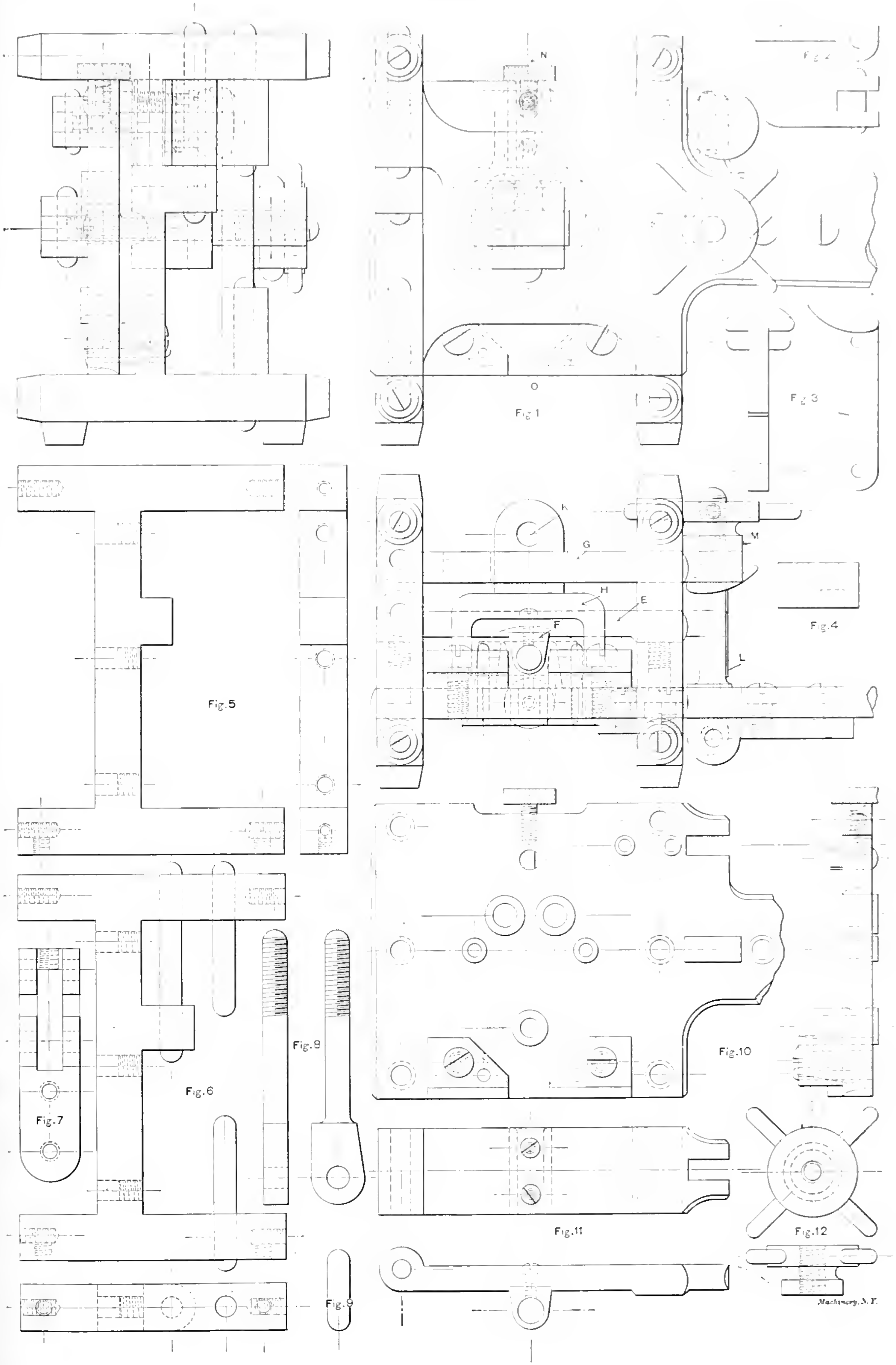
Bob soon came back with the boss, who, after looking it all over, ordered him to start the pump. The pump started all right, but, strange to say, there was "nothing doing" at the outlet end, much to Bob's astonishment, and all attempts to make it pump were in vain.

The boss looked dubious and Bob looked worse, but the sly glances his fellow apprentices cast in his direction were full of fiendish glee. After telling Bob to "pull her to pieces and see what's the matter" the boss left Bob to work out his own salvation. Although he took the pump apart and examined every inch of it thoroughly, he could find nothing wrong, until he tried to look through the inlet pipe—he couldn't see light. Then Bob knew what the trouble was, and another leaf was added to his book of experience.

Back together went that pump in double-quick order, and this time it worked fine and to the satisfaction of the boss. Bob's detective abilities traced the stopper to the empty bottle in his shop-mate's dinner box, and it wasn't long before he was paid back in his own coin—but that's another story.

* * *

Aluminum paint is made by blowing air or gas through molten aluminum while it is setting, and at the same time stirring violently. This forms a spongy or granulated metal that is easily pulverized. The powdered metal is sized and polished in polishing mills.—*Mechanical World.*

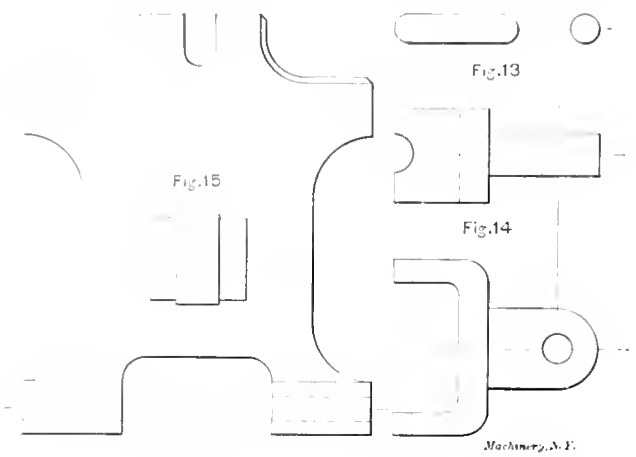


Standard Jig Design No. 4 for Manufacturing Small Interchangeable Parts. See next page

STANDARD DESIGNS OF JIGS AND FIXTURES FOR THE MANUFACTURE OF SMALL INTERCHANGEABLE PARTS—2

FRANK P. CROSBY*

In the July issue three designs of drill jigs were shown, indicating the possibility of standardizing the design of tools of this kind. In the accompanying illustrations are shown two additional jig designs, and dimensions are given for standard jig parts.

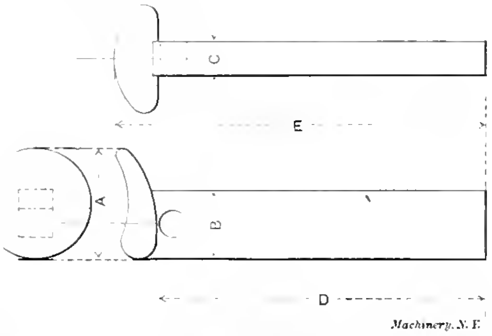


Detail of Upper Leaf and Equalizing Clamp, Jig Design No. 4

Design No. 4

The jig designated as Design No. 4 is used for drilling and hollow milling the piece shown in detail in Fig. 16. The holes *A*, *B* and *C* are drilled, and the projections *D* are hollow milled. Fig. 1 shows the assembled jig with the work in place. The work is of such a form that it necessitates an extra swinging plate *E* to hold the drill guide *F*. The top plate *G* holds the equalizing clamp *H* in position. This clamp is hinged at *K* to allow for any inequality in the castings. The lower swinging plate *E* is held in place by the latch *L*. The work is held in place by the pressure brought to bear upon it by the upper plate *G*, which is held in place by a latch which at its upper end is provided with a nut *M*. The head of a binding screw *N* forces the works against the V-block *O*, previous to closing the upper plate.

TABLE I. DIMENSIONS OF THUMB LATCHES FOR JIGS

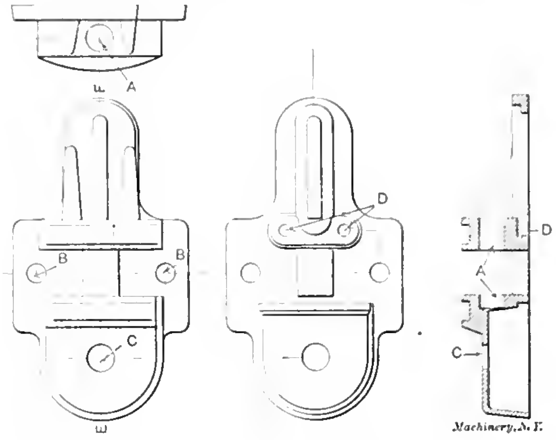


No.	1	2	3	4	5
A	1/2	5/8	3/4	7/8	1
B	5/16	3/8	7/16	1/2	5/8
C	1/8	5/32	3/16	1/4	5/16
D	1 1/2	1 3/4	2	2 1/2	3
E	1 11/16	2	2 1/4	2 3/4	3 3/8

The various parts are plainly shown in detail. Fig. 4 is an end view of a half of the V-block showing the screw and dowel pin holes. Fig. 10 shows the lower plate with bushings, V-blocks and adjusting screw in position. Fig. 11 shows the lower leaf with its drill guide, and Fig. 15 shows the upper leaf to which the equalizing clamp is attached.

Design No. 5

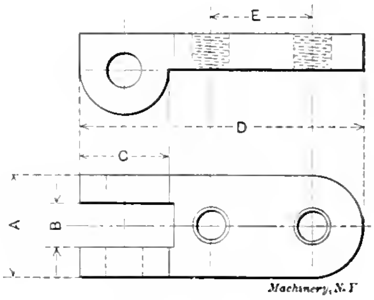
The design of a drill jig for drilling and hollow milling the piece Fig. 11, Design No. 5 is shown in Fig. 1. This jig has double swinging plates the same as the previous one, but these plates both swing on the same pin. The equalizer *C* is mounted on the top of the top plate, and, as shown in Fig. 3, is provided with pins which run down and clamp the work at *D*, Fig. 1. The locating screw *E* brings the work into contact with the wall *A*, Fig. 7, and the screw *F* brings it into contact with the stop at *G*. The shoulder screw *H* prevents the lower plate from remaining down when the jig is open; the upper and lower leaves both must open simultaneously. The thumb screw *M* forces the lower plate firmly against the stop plugs *N*, Fig. 6, and prevents it from lifting during the operation of the mill. The upper leaf is finally clamped down by the swinging bolt *J*, provided with a knurled nut *K*. Fig. 7 shows the lower plate with its bushings and holding plugs in place, while Figs. 8 and 13 show the upper and lower plates or leaves. The other details are of the same standard form as used for the jig designs previously described.



VIEW FROM BELOW VIEW FROM ABOVE SECTION E-F

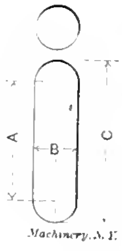
Work which is drilled and hollow milled in the Jig, Fig. 1, Design No 4

TABLE II. DIMENSIONS OF LATCH HOLDERS



No.	1	2	3	4	5	6
A	3/8	7/16	1/2	5/8	3/4	7/8
B	1/8	5/32	3/16	1/4	5/16	3/8
C	5/16	3/8	7/16	1/2	5/8	3/4
D	1	1 1/8	1 3/8	1 9/16	2 1/16	2 1/16
E	3/8	7/16	1/2	9/16	3/4	7/8

TABLE III. DIMENSIONS OF LATCH HOLDER PINS



No.	1	2	3	4	5	6
A	3/8	7/16	1/2	5/8	3/4	7/8
B	3/32	1/8	5/32	3/16	1/4	5/16
C	15/32	9/16	21/32	13/16	1	1 3/16

TABLE IV. DIMENSIONS OF LATCH PINS

No.	1	2	3	4	5
A	7/16	1/2	5/8	3/4	7/8
B	1/8	5/32	3/16	1/4	5/16
C	9/16	21/32	13/16	1	1 3/16

Standard Parts for Jigs

The accompanying tables give dimensions for a number of standard jig parts which can advantageously be kept in stock

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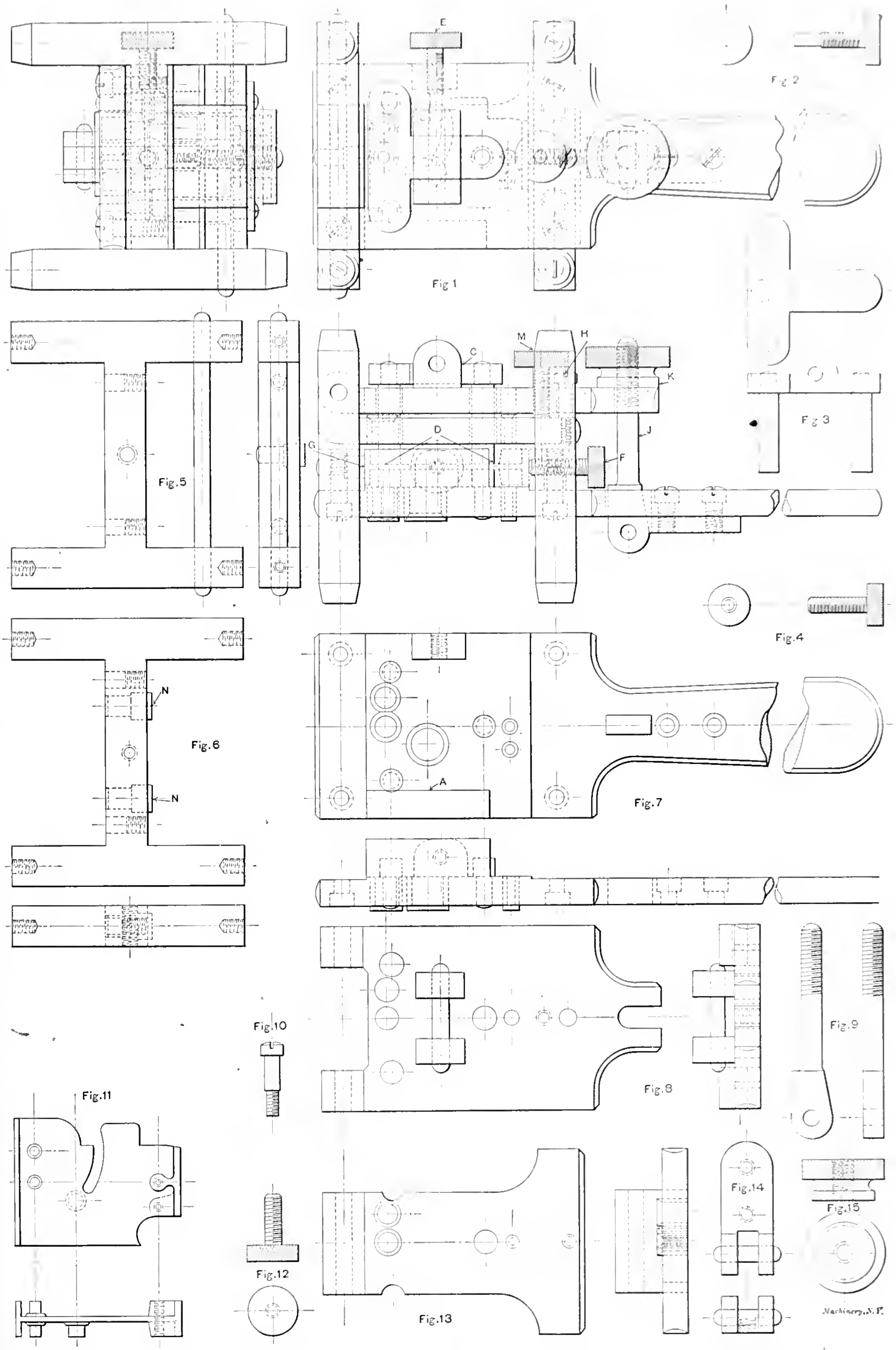
* Address: 43 North State Street, Chicago, Ill.



Standard Jig Design No. 5 for Manufacturing Small Interchangeable Parts

ready for use. A great saving in the expense for jigs and fixtures will result if jigs are made up along the lines of the standard designs shown, and standard parts kept on hand, these parts being made up in quantities. Of course, it is understood that it may not be possible to adapt the jig details tabulated to all classes of work. The designer must make his own standard to suit the work on which he is employed, but the dimensions given have been found to work well on small interchangeable work, and the main point to be impressed upon the jig designer is that a system can be devised for standardizing the general design of jigs, as well as the details used.

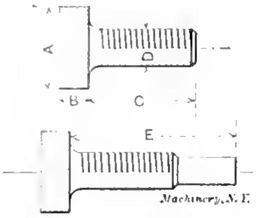
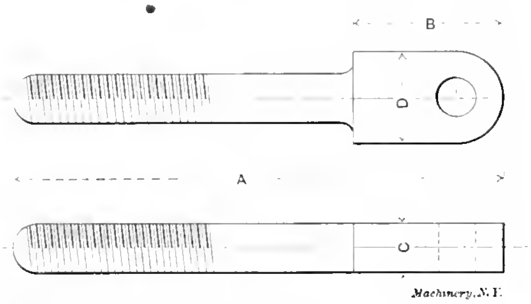


TABLE V. KNURLED HEAD THUMB SCREWS

No.	1	2	3	4	5	6
A	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{7}{8}$
B	$\frac{3}{32}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$
C	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$
D	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
E	$\frac{3}{4}$	$\frac{15}{16}$	$1\frac{1}{8}$	$1\frac{5}{16}$	$1\frac{1}{2}$	$1\frac{3}{4}$

TABLE VI. DIMENSIONS OF JIG SCREW LATCHES



No.	1	2	3	4	5	6
A	$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{3}{8}$	$2\frac{7}{8}$	$3\frac{1}{2}$	$4\frac{1}{8}$
B	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{4}$
C	$\frac{1}{8}$	$\frac{5}{32}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$
D	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$

But little is necessary to say in explanation of the tables. The latch holders in Table II should be made of machine steel, case-hardened and the pin hole lapped to fit the pin with a close sliding fit. The latch holder pins and the latch pins in Tables III and IV are made of tool steel and hardened. The knurled head thumb screws in Table V should only be used for clamping when a light pressure is required. The latch nuts in Table VII are made of machine steel and case-hardened. The pins in Table VIII are made of machine steel and left soft. The screws for the jig feet, Table X, are not standard screws. The diameter *A* is smaller than regular, and the length of the head is also less.

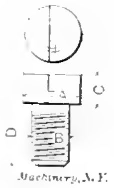


TABLE X SCREWS FOR JIG FEET

No.	1	2	3	4	5	6	7	8	9
A	.160	.191	.213	.233	.256	.299	.343	.386	.426
B	$\frac{1}{8}$	$\frac{9}{64}$	$\frac{5}{32}$	$\frac{11}{64}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{9}{32}$	$\frac{5}{16}$
C	110	.123	.137	.150	164	.192	.219	.246	.273
D	$\frac{9}{32}$	$\frac{5}{16}$	$\frac{11}{32}$	$\frac{3}{8}$	$\frac{13}{32}$	$\frac{7}{16}$	$\frac{15}{32}$	$\frac{1}{2}$	$\frac{17}{32}$

* * *

A correspondent to the *Pittsburg Dispatch* states that Hankow, China, possesses a large modern steel plant, employing, in all, 20,000 people, only twenty of whom are Europeans. The latter largely do the designing and engineering work, while the Chinese carry on the work in the steel mills and the shops entirely by themselves. The wages are very low; steel mill rollers are paid from $4 to $6 per month and helpers from $4 to $5. Blacksmiths are better paid, and receive up to $20 per month if exceptionally skilled, while boiler-makers may get up to $10. Common unskilled labor is paid 7½ cents a day. Unskilled men are paid off in full each night, and are hired anew each morning.

EFFECTIVE FLOATING REAMER HOLDER USED BY THE LANDIS TOOL CO.

Only in recent years has it been considered practicable to finish ream holes in the machine on which the hole is roughed out. It has always been the customary practice to bore and rough ream in the machine and finish ream by hand, holding the work in a vise or a special reaming stand. The difficulty in machine reaming has been that of properly holding the reamer so that it will cut from the side of the hole the infinitesimal amount desired. If the reamer is not held properly, either it will not finish the hole out, leaving the marks of the roughing reamer on one side, or it will dig in and break the blades or cause other damage.

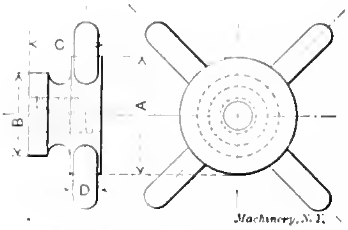
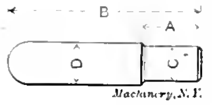


TABLE VII. DIMENSIONS OF LATCH NUTS

No.	1	2	3	4	5	6
A	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$
B	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
C	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$
D	$\frac{5}{32}$	$\frac{6}{32}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{5}{16}$

TABLE VIII. LATCH NUT PINS



No.	1	2	3
A	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{5}{16}$
B	$\frac{11}{16}$	$\frac{7}{8}$	$1\frac{1}{8}$
C	$\frac{3}{32}$	$\frac{5}{32}$	$\frac{3}{16}$
D	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$

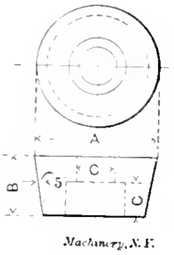


TABLE IX. STANDARD JIG FEET

No.	1	2	3	4	5	6	7	8	9
A	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{13}{16}$	$\frac{3}{4}$	$\frac{7}{8}$	1
B	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{9}{32}$	$\frac{5}{16}$	$\frac{13}{32}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$
C	$\frac{1}{8}$	$\frac{9}{64}$	$\frac{5}{32}$	$\frac{11}{64}$	$\frac{3}{16}$	$\frac{7}{32}$	$\frac{1}{4}$	$\frac{9}{32}$	$\frac{5}{16}$

The problem of machine reaming is then one of devising a suitable reamer holder. This must be of the "floating type," so that the cutting edge is guided by the hole itself, otherwise it will not center itself properly with the rough reamed surface. About the best thing in this line the writer has previously seen is the holder used by the Bullard Machine Tool Co., in which the reamer is fed through the hole by a loose joint connection with the arbor near the front end of the body. The arbor itself is provided with a loose drive at the rear end, where it is connected with the holder in the turret. By pivoting the reamer body at the front end in this way, it is in effect *drawn* through the hole, which thus guides it in a way superior even to the best hand reaming. The holder

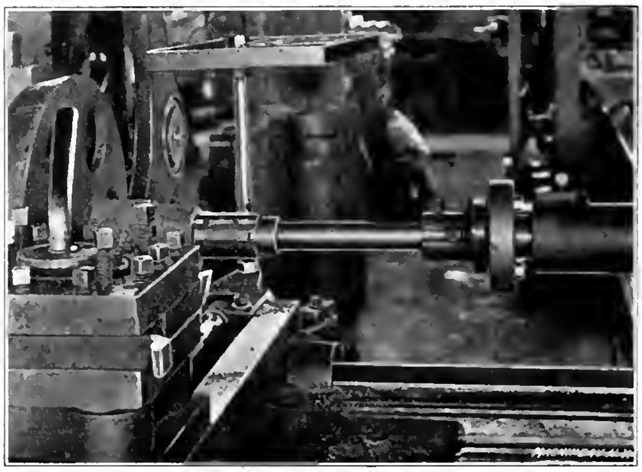


Fig. 1. Floating Reamer Holder for Turret Lathe Use, Guided by Adjustable Center

shown herewith was developed by Mr. Steiner, superintendent of the Landis Tool Co., of Waynesboro, Pa.; besides being of the floating type, it is so arranged that it can be used with reamers much smaller than in the design just described, adapting it to all kinds of work, both large and small.

The tool is shown at work in a Gisholt turret lathe in Fig. 1, while Fig. 2 shows a section of the holder and plainly illustrates its construction. The reamer at *A* is held in the taper socket *B*, which is, in turn, firmly threaded into the flange *C*. The body of the tool *D* is carried in a taper tool holder *E*, mounted in the turret of the machine. In a recess in *D* is contained the floating center holder *F*. Two screws *G* (only one of them is shown) are tapped into *F* from the back side of *D*, passing through holes large enough to allow a slight adjustment in any direction. With this provision center *H* may be accurately lined up with a similar, truly-ground center, mounted in the spindle of the machine. Four screws, of which one is shown at *K*, assist in this centering operation.

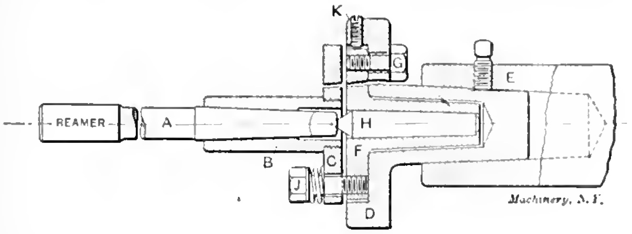


Fig 2 Section through Reamer Holder, showing Details of Construction

When the two points are in line, screws *G* are tightened down, thus holding the adjustment. Reamer *A* has its center hole supported on the point of center *H*, being drawn onto it by two screws, of which one is shown at *J*. These screws pass through clearance holes in *C* and press upon it, through the medium of springs as shown, thus allowing reamer *A* to find its own center without interference.

Besides using reamers from the largest to the smallest sizes, as previously mentioned, this arrangement has the added advantage of straightening out the holes it reams, at the same time that it follows them. It is supported at the back on a center which has been adjusted concentric with the axis of the spindle, about which the work revolves and is supported. If the hole, in spite of the boring and rough reaming operations, is not quite parallel with the axis of rotation, the tendency of this reamer, supported on center *H* as it is, is to correct such slight errors, and bring the bore back into the proper center line. R. E. F.

* * *

HOW TO FIND INCLUDED ANGLE OF INLET AND EXHAUST CAMS

A. F. M.

Much has been written about the laying out of cams, but one reads little about the mathematical calculation of cams. The simple formula given below saves the designer the work of laying out the included angle of inlet and exhaust cams of gas engines. In laying out this angle some small inaccuracies very often occur, and it is, therefore, of special advantage to be able to calculate this angle; when desired, a layout can be used to check the result. The angle in question, shown at c in the illustration, necessarily must be correct, or a more or less incorrect opening and closing of the valves will result. Angle a represents the angle on the cam shaft, during which the valve is open. R and R_1 are the radii of the cam base circle and the cam roller, respectively, while C is the clearance between the plunger and valve stem. Then the distance between the center of the cam and the center of the roller at the moment of the opening of the valve equals $R + R_1 + C$. Assuming a line drawn from N parallel to AB, and extending MB, we get the right triangle MNP, in which

$$MN = R + R_1 + C \text{ and } MP = R + R_1.$$

Then,

$$\cos b = \frac{R + R_1}{R + R_1 + C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

But $d = 90° - \frac{1}{2}a - b$, and $d = \frac{1}{2}c$; therefore $\frac{1}{2}c = 90° - \frac{1}{2}a - b$, and

$$c = 180 - a - 2b \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

In case no clearance between cam and roller is allowed, Then $C = 0$, and

$$\cos b = \frac{R + R_1}{R + R_1 + 0} = 1, \text{ and } b = 0$$

This value of b substituted in formula (2) gives

$$c = 180 - a$$

Suppose we want to find the value of angle c for an exhaust cam which should keep the valve open during 240 degrees, measured on the crank-shaft. This corresponds to 120 degrees on the cam circle. Let the base circle of said cam be 2 inches and the roller $1\frac{1}{2}$ inch in diameter. The clearance is 1/16 inch. Then $a = 120$ degrees, $R = 1$ inch, $R_1 = \frac{3}{4}$ inch, $C = 1/16$ inch.

Substituting these values in formula (1) we get:

$$\cos b = \frac{1 + \frac{3}{4}}{1 + \frac{3}{4} + 1/16} = \frac{28}{29} = 0.9655; \quad b = 15 \text{ degrees } 5 \text{ minutes.}$$

Substituting this value of b in formula (2)

$$c = 180 - 120° - 30° 10' = 29 \text{ degrees } 50 \text{ minutes.}$$

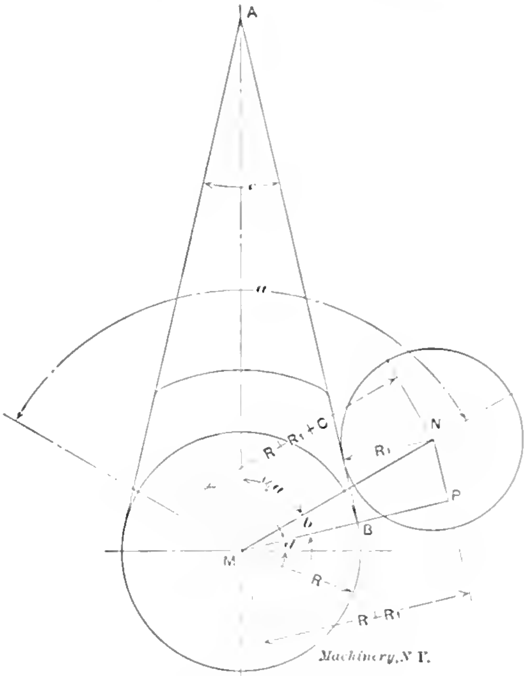


Diagram illustrating the Method of Calculating Included Angle of Inlet and Exhaust Cams

These formulas are correct only for a valve mechanism in which the center line of the valve plunger passes through the center of the cam shaft. In case the valve plunger is offset (to diminish side thrust), an irregular cam will result. This is mentioned only to avoid any possible misapplication of the formula.

* * *

As has been previously stated in these columns, extensive use will be made of blast furnace gases for power production at the new steel works at Gary, Ind. With the sixteen furnaces in operation it is estimated that 44,800,000 cubic feet of gas will be produced daily, and of this over one-half will be used for power generating purposes. Part of this will be required for the blowing engines and about 45 per cent of the total available gas will be used for power. With the sixteen furnaces in blast, it will be possible to generate in this way over 200,000 H. P.

* * *

According to the *Scientific American*, a new form of arc lamp has been devised in which carbon disks are used instead of carbon rods. The disks are constantly rotated, and the arc takes place between their peripheries; owing to the continuous rotation, the disks are consumed uniformly. The lamps are small as compared to the ordinary type of arc lamps, and it is claimed that a lamp of this type will burn fifty per cent longer than lamps of the rod type.

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CURVES VS. TABLES

The presentation of certain data in the form of curve diagrams, of the Cartesian coordinate form, is advantageous for several reasons. First, in a curve there may be an infinite number of intersections of ordinates and abscissae, and therefore of values within the limits of the diagram; whereas a table is limited to the precise values given, and interpolation in any but tables agreeing with straight line curves must of necessity be inaccurate unless calculated by the curve formula. Again, plotted curves clearly indicate the rate of change, and values plotted outside the limits of the diagram can be estimated or calculated with precision when the curve can be expressed by an equation. Hence, it is not strange that the plotting of curves is a common and generally acceptable method of graphically showing a great and varied mass of engineering data.

But we find curves used for data when they are not properly applicable to the case. When certain exact data have been determined and accepted, the use of curves for the drafting room or shop is not so desirable as ordinary tables. For example, take the case of pipe thread dimensions: these data were recently submitted to us in a diagram of curves, the contributor being under the impression, evidently, that the curves possess some advantages over the usual pipe thread table. Obviously, the reading of precise values, that is, to thousandths of an inch, is impossible on an ordinary diagram. A toolmaker given the job of making gages for pipe fittings would have absolutely no use for the diagram; what he needs is the table of precise values reading to thousandths. So it is with all screw tables and much other data in which all values of a series between limits have been precisely determined.

Curves have their use in the derivation of such data when a series of values are being tentatively determined. Having given the dimensions of the largest and smallest sizes, and perhaps of one or more intermediate sizes, a curve may be drawn and the other values approximately found without calculation. For illustration, suppose that a special list of thread pitches is to be laid out for certain fittings ranging in size from one inch to ten inches diameter, the sizes varying by half inches. Having given the data for the largest and smallest and one or more intermediate sizes, the curves drawn through the intersections with the ordinates and abscissae will express the intermediate pitches for each desired size. The approximate values will be changed, of course, in most cases to make them read to the nearest even figures. The values once having been determined and crystallized, so to speak, the use for the curves disappears.

* * *

THE PSYCHOLOGY OF MAGNIFIED DIMENSIONS

Not many years ago the micrometer was an unknown instrument of measurement, and is still comparatively unused outside of manufacturing plants producing parts on the interchangeable plan. The steel scale graduated in sixty-fourths of an inch is a gage by which the large majority of mechanics make all their measurements from the coarsest to the finest, and for most of them measurements made with the steel scale generally answer practical purposes. The machinist who is able to fit a locomotive axle or crank-pin, making the proper estimate for a press fit of 50 to 100 tons, depending on the diameter, by the use of outside and inside calipers, and gaging the allowances by the difference on a steel scale, has a "good eye" and good judgment.

While these measurements may vary slightly day by day, the average is surprisingly accurate and leaves little to be desired. But ordinarily it takes the common man several years before his fingers and eyes acquire the sensitiveness that makes his estimates uniformly reliable. Give the same man a micrometer, and under proper direction he will learn to make more accurate measurements in a few months than is possible with years of experience with the calipers and scale. The reason is simply magnification of differences. The ratio on the ordinary micrometer barrel is about sixty to one, thousandths of an inch between the anvils being about one-sixteenth inch on the barrel. An apparent difference of one-sixteenth inch from the measurement desired is an amount that even a tyro will not ignore when he knows how to use the micrometer, and realizes that it is an instrument of touch rather than a C-clamp.

The principle of magnification of small dimensions is common in the apparatus used in scientific and mechanical work, and is accepted by all users as a matter of course, but we suspect that most users of such instruments never quite realize the extent of the impression made by small values through this principle of magnifying them. A new pyrometer recently described in these columns carries the principle to an extreme, fractions of a degree of temperature difference being expressed by the needle swinging over a large portion of the visible arc of action. The effect of minute differences of temperature indications on the attendant when shown by so great a movement of the pointer is very marked. He cannot ignore, if he would by reason of ordinary slothfulness, differences that on an ordinary indicator would be almost imperceptible, and therefore negligible.

* * *

An interesting observation has been made in connection with tempering of hardened tools in electrically heated baths. It was found that the obtaining of a certain tempering color is not a function of the temperature only, but that time also is an important factor. As an example it may be mentioned that a dark blue was produced by heating an object either to 200 degrees C. (392 degrees F.) for four minutes, or to 350 degrees C. (662 degrees F.) for one minute. This statement was made in an exhaustive paper on electric hardening and tempering by Messrs. E. Sabersky and E. Adler, read before the Faraday Society (Great Britain), and if correct practically upsets the generally accepted idea that tempering colors are dependent solely on temperatures. Whether the color determines the degree of temper of the tool or not is not stated; most likely it does, but it might be conceived that the time factor influences the degree of temper also. Experiments along this line should be of great value, and may lead to a new conception of the tempering process.

CARRIAGE-BOLT SCREW THREADS

On the "How and Why" page of this number are certain data on carriage bolt screw threads, shanks, and heads, that doubtless will be of interest and value to a considerable number of tool- and die-makers, but for the screw thread part, we feel an apology is required. We do not mean an apology for our presentation of the matter, but for the existence of such an anomalous form. Carriage and loom bolts are used in great quantities, but strange to say, the screw threads as made by the largest concerns are bastard forms, not easily reproduced, and for which there is no commonly recognized standard. A few concerns using large quantities of carriage bolts specify the United States standard thread and pitches, and one maker at least recommends them, but why the demand for the recognized standard has not become universal is somewhat of a mystery. Perhaps the approximately square carriage-bolt thread has an advantage over the United States standard thread when driven through a closely fitted hole in wood, in not having so great a tendency to tear and damage the wood, but it is easily damaged and hard to repair. Other disadvantages outweigh the feature named, and it should have been discarded long ago.

The vogue of the carriage-bolt threads may be largely due to the conservative policy of manufacturers who have maintained them because of the mistaken belief that the obscure forms tend to discourage competition. Such a petty business principle is out of place in modern manufacturing, and is of little avail. A screw thread, gear tooth or profile of any description, no matter how irregular, can be copied by an expert tool-maker; such work is done daily, and an odd screw thread offers little discouragement to the copyist if there is assurance of profit. Let the irregular and difficult carriage screw threads be relegated to the limbo of forgotten things; and when they are discarded we shall score another triumph for standardization.

* * *

LOCATING DEFECTS IN MECHANISM

The ability to quickly locate defects in machinery is possessed by comparatively few men. Competent engineers and mechanics, having years of experience, often, when trouble is encountered, find it necessary to send for an "expert" to solve what appears to be a great mystery. In many instances, the real reason why engineers and others are unable to locate simple mechanical defects is because they at once jump at the conclusion that the trouble is due to something complex and mysterious. As every mechanic knows, the disarrangement of some small part will often render a piece of mechanism inoperative or greatly impair its efficiency; but as a rule the seat of the trouble can be located by a careful and systematic inspection. Such inspection however is often not made because of a sort of superstitious belief that any trouble which is unusual must be the result of something mysterious, and this belief is always augmented when attempts are made to locate the defect by haphazard methods. It is a common experience of men sent out by manufacturers to locate and remedy trouble in machinery to find simple causes —so simple sometimes as to make the call for help ridiculous.

The chief engineer of a large plant discovered, upon starting an air compressor which had been idle for some time, that it would only compress to twenty pounds, which was sixty pounds below the required pressure. After a few futile attempts had been made to remedy the trouble, the manufacturer was notified by wire to send an "expert." In order to appreciate the situation a brief description of the construction of the compressor is necessary. This machine had two single-acting air cylinders, the plungers of which were connected to the ends of a piston-rod common to both, which passed through the steam cylinder located midway between the two air cylinders. The inner ends of the air cylinders were open, exposing the plungers. One suction and one discharge valve was used for each cylinder. The suction valves were located in the centers of the plungers, and the discharge valves, which were slightly larger in diameter than the bore of the cylinders, covered the outer ends of the latter. The counterbore into the bottom of which each discharge valve seated, was sealed by the cylinder head. A cylindrical projection on the back of each discharge valve, was a sliding fit in the head, and served to keep the valve in position as it moved back and forth. In order to insure a pressure of one atmosphere in the cylinder at the beginning of the compression stroke, three small holes were drilled through the cylinder wall, just ahead of the plunger when it was in this position. As these holes were uncovered just before the end of the suction stroke, an inrush of air occurred, the magnitude of which depended largely upon the stiffness of the closing springs for the suction valves. When the manufacturer's "expert" arrived and the compressor was started, it was very noticeable that instead of an inrush of air through the holes of one cylinder, there was a strong discharge to which attention was attracted by the sound emitted. This indicated at once that the cylinder was in communication with the receiver, and it was also evident that the discharge valve was either broken or displaced. When examined it was found to be rusted fast to the head in an open position. Less than a thimble of oil jumped the pressure to eighty pounds, much to the discomfort of the chief engineer.

Still another incident from the log-book of a "trouble man" will be given to show how easy it is to overcome the cause of a defect when the search is conducted along intelligent lines. The suction valves of a high-pressure pump, working under a pressure of about 2,000 pounds per square inch, had given considerable trouble, evidently due to a leak through the valves on the discharge stroke, as then a sibilant sound could be heard, which was pretty good evidence. The leak, however, had not occurred until after a new set of valves made by one of the chief engineer's assistants had been installed, which added to the mystery, as the valves were carefully ground to a perfect bearing in their seats. These valves were of the poppet type, and on the top of each there was a guiding stem that was a sliding fit in a cap above. On the original valves the stems were fluted so that air would be admitted to the space above them. On the new valves these flutes were omitted, with the result that they closed so slowly, owing to the partial vacuum formed above the stems during their descent, that there was considerable discharge through them during the early part of the discharge stroke. In this particular instance a little elementary knowledge of physics was a greater help in discovering the trouble than practical mechanical training, and the incident teaches the value of acquiring knowledge other than that necessary to hold a position, for such knowledge is often the key to the door of opportunity. Of course the causes of defects in mechanism are not always so easily located, nor of such a simple nature as those mentioned in the foregoing, but experience teaches that work of this kind may be greatly facilitated by a careful and systematic inspection, after having observed any abnormal action.

* * *

In a paper on the preservation of iron and steel by Mr. Allerton S. Cushman, assistant director, office of public roads, United States Department of Agriculture, presented before the May meeting of the Iron and Steel Institute, the author refers to the fact that iron containing 20 per cent of silicon is not attacked by acids and, therefore, such material should theoretically be non-rustable. He has found that iron containing 10 per cent of silicon is almost incorrodible, but unfortunately is not easily worked, and has peculiar properties. He suggests that inasmuch as silicon is similar to carbon in its characteristics, chemically speaking, it might be worked into the surface of steel by modifying some of the well-known casehardening processes used for impregnating iron and steel with carbon. If a method for applying a coating of silicon on metals should be discovered, it would be a valuable contribution to the art of metallurgy and the world at large.

* * *

According to the *Engineering Record*, an interesting means of heating a building will be tried at Detroit, Mich. The hot water from the jackets of a 1,400-horse-power gas engine now being built for the Ford Motor Co. will be utilized for this purpose.

THE TRANSMISSION OF POWER BY ROPES*

When compared with belts, ropes have some very distinct advantages, the most important being that they slip less and that the drive is more positive. As the rope acts in a groove, the loss due to the centrifugal force is lessened as compared with belt driving, and ropes can therefore be run at a higher velocity than belts. While few cases of rope transmission exceed a velocity of 5,000 feet per minute, there are cases of ropes running satisfactorily on specially constructed pulleys at a speed of over 7,000 feet per minute. The accompanying table gives the horse-power which may be safely transmitted by cotton ropes of different diameters at various speeds. Ample, though not extravagant, margins of safety against breakage of individual ropes are provided, and the table applies to the average good quality of rope, giving to superior makes the benefit of greater durability. With regard to the relative cost of ropes and belts, experience has shown the former to be cheaper; this advantage is more marked in the case of small ropes than in the case of larger sizes.

Rope driving may be divided into two systems, known as the American or continuous system, and the English or multiple rope system.

The Continuous Rope System.—The continuous or American rope system consists of winding one long rope as many times around the driving and driven pulleys as there are grooves to fill, carrying the rope across the whole width of both pulleys and then carrying the rope from the last groove back again to the first groove by means of an idler pulley held at the required angle. This system possesses certain advantages under special conditions, as, for instance, when driving paper-making machinery by a series of expanding rope pulleys so arranged as to permit a variation of a few inches in the respective diameters. Under ordinary conditions, however, the comparative imperfections of the method are so pronounced that numerous installations have been transformed to multiple rope drive. A great disadvantage of continuous driving is that of having to depend upon one rope for the entire drive, and the resulting stoppage of the machine in the event of breakage. In case of multiple driving, an accident to one of the ropes means only running without it for the remainder of the day, as a good reserve of power is generally allowed in the remaining ropes.

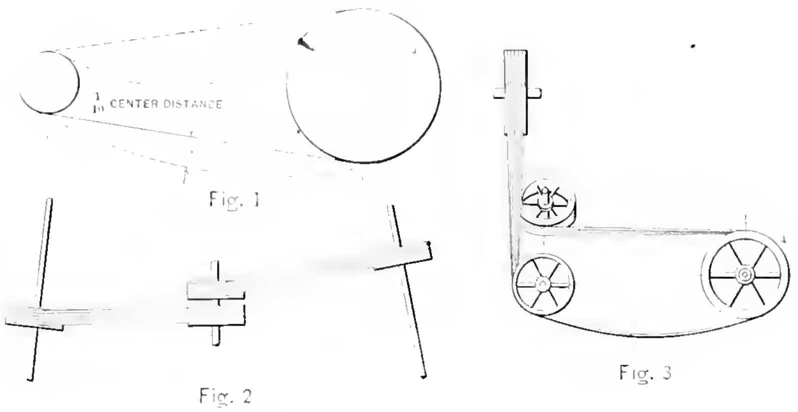

Fig. 1

Fig. 2

Fig. 3

Figs 1 to 3. Power Transmission by Ropes.

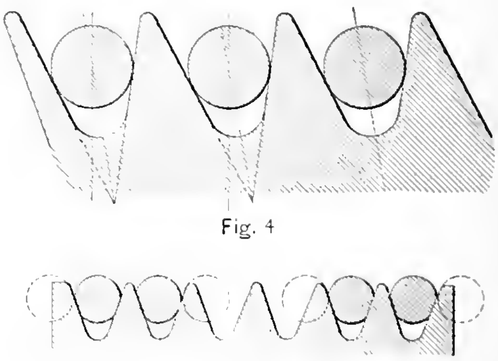

Fig. 4

Fig. 5

Figs. 4 and 5. Tilted Grooves for Angular Drives and Arrangement of Drive for Crossed Ropes

Another objectionable feature of continuous driving is the irregular rope tension. The trailing span reaches its highest tension immediately after leaving the idler pulley and gradually slackens down with each successive lap of the pulleys.

Casing of Pulleys.—It is important when arranging for rope driving to encase the sides of the pulleys with sheet metal or boards, as otherwise the displacement of air by the arms of large high-speed pulleys adds materially to the load. It has been stated that a saving of five per cent of the power may be thus effected. Some firms advocate the casing of all pulleys, large or small, while others do not consider casing necessary unless the pulleys be at least seven feet in diameter and run at a peripheral velocity of 4,000 feet and over.

Minimum Diameter of Smallest Pulley.—For ordinary cotton ropes used as main driving ropes the smallest pulley diameter should be thirty times the diameter of the rope. If this rule is adhered to the rope will cling firmly to the pulley.

Durability of Ropes on Large and Small Circumferences.—Too much importance cannot be attached to the question of relative proportion of pulleys and ropes, and great losses in driving power are caused by non-observance of the "thirty-diameter" rule. Instead of adding a number of heavy ropes to make up for the loss of power transmitted, when large pulleys are impractical, it is far better to divide the total power nominally required between the necessary number of smaller ropes.

Arc of Contact.—When the pulleys are of equal size the arc of contact of each is practically 180 degrees, but when the pulleys are of an unequal size the arc of contact of the smaller pulley is less than 180 degrees. Long center distances, however, are conducive to a greater degree of contact for the smaller pulley, and whenever short center distances can be avoided it is advisable to do so. When short centers are required, the disadvantages can be overcome by adding a sufficient number of ropes to make up for the deficient contact, and a case is on record where spur gears were removed from two shafts and rope pulleys fixed upon the same centers, permitting a clearance of only eight inches between the rims, 360 horse-power being thus easily transmitted with sixteen ropes, 1¾ inch in diameter. In another case two rope pulleys were placed so close together that there was less than an inch distance between the outside of the rims.

The arc of contact is also affected by the position occupied by the trailing span of the ropes which, when above the pulleys, gives the maximum bearing surface. This position, however, is not always obtainable, as sometimes a variable load may set up oscillations in the rope of such violence as to fling it off the pulley. In this case, if the trailing span is below the pulleys, any tendency on the part of the rope to wander from its appointed track is held in check by the pull at the tight side.

Long Center Distances.—Referring to Fig. 1, it will be observed that in under-driven installations, center distances are governed by the size of pulleys employed, which should allow sufficient clearance between the slack of the trailing span, (which should be not more than 1/10 of the distance between the centers) and the tight portion of the ropes. Over-driven installations permit a greater latitude, and center distances are successfully extended to distances of over 100 feet without intermediate support. In drives of this kind, however, it is necessary to provide against the extra strain imposed on shafts and bearing by the weight of the ropes. Center distances in ordinary mill driving seldom exceed 90 feet. As a rule, it is preferable to divide distances which are too great for one span into two drives, rather than merely to support the ropes between the pulleys by idlers. In cases where supporting pulleys are necessary, it is advisable to distribute them along the drive at unequal intervals. The possibility of continued oscillations along the whole track

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* Abstract of paper read by Mr. Edwin Kenyon before the South Wales Institute of Engineers. For additional information on this and kindred subjects see the following articles previously published in MACHINERY: Rope Drive for Machine Tools, October, 1907, engineering edition; Notes on Rope Drives, January, 1908, engineering edition; Experiments with Rope and Belt Drives, February, 1909.

is thereby obviated, so that initial wave-like movements quickly diminish to small oscillations. This prevents the ropes from leaping out of the grooves.

Angular Driving.—No class of power transmission lends itself better to angular driving and drives around corners than does rope driving. When transmitting power to shafts set in an angular position, the tight side of the rope should be directed by a pulley deflected to a suitable angle, while the slack side of the rope should be carried over an idler revolving on a horizontal axis, as indicated in Fig. 3. The grooves in guide pulleys require to be turned deeper than in the regular pulleys, to prevent the ropes from falling away. As a rule, guide pulleys are made too small for the ropes passing over them, and as a result the ropes suffer considerably from over-straining in passing over sharp bends. The wear of ropes is due more to the bending than to the driving strain, and the "thirty-diameter" rule should be applied to idler pulleys as well as to the driving and driven pulleys.

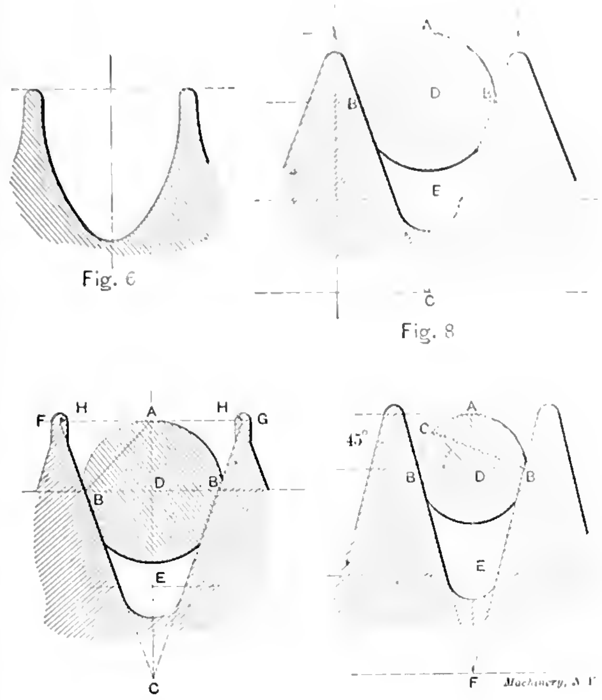

Fig. 6

Fig. 8

Fig. 7

Fig. 9

Figs. 6 to 9. Grooves for Rope Pulleys

Shafts Slightly Out of Alignment.—When shafts are only slightly out of alignment, the ropes will direct themselves without the aid of guide pulleys, but the extent to which the angularity may be carried depends largely upon the center distances and the pulley diameters. With center distances not less than three times the average diameter of the pulleys, a deflection of seven degrees is safe. Sometimes an angle too large for direct drive may be divided up into two drives by the introduction of an intermediate shaft and pulleys, as shown in Fig. 2. Tilted grooves, as shown in Fig. 4, are advantageous for out-of-parallel driving because of aiding the rope to "catch on" and slide down the side having the greatest inclination from the vertical until it reaches the true driving position. The tilted groove, however, has its disadvantages; the pressure becomes one-sided and even impact is impossible. Wide-angled and highly finished grooves appear to be the best solution for this class of driving. Long keyways cut on both shafts are a decided advantage in the arrangement of angle drives, as they permit the movement of the pulleys to their most effective working position, which may be discovered only by practical tests.

Driving with Crossed Ropes.—When it is necessary to transmit power between shafts revolving in opposite directions by crossed ropes, the friction at the crossing point can be materially lessened by running the ropes in pairs, the two tight portions running together while the slack portions pass with slight pressure on the outside as indicated diagrammatically in Fig. 5, where the full circles show the tight parts and the dotted circles indicate the slack parts of the rope passing on the outside of the tight parts at the crossing point. If more than two ropes are employed, it is, of course, necessary to allow sufficient space between the various pairs of ropes to permit free passage of their trailing spans. Therefore, a crossed drive with four ropes will require six grooves, as shown in Fig. 5. One-half crossed rope drives are arranged on practically the same lines as one-half crossed belt drives; that is, the leading side follows a straight line from pulley to pulley, while the other side is drawn away at an angle governed by the relation of the center distances to the pulley diameters.

Vertical Drives. In vertical drives it is advisable to have the ropes running without much slack, particularly if the bottom pulley happens to be the smallest, and to use fairly acute angles not exceeding 40 degrees for the grooves.

Grooves.—Grooves with curved sides, as shown in Fig. 6, have proved to be of no advantage, but on the contrary to result in loss of power, and should, therefore, be discouraged. These grooves are conducive to a rolling action of the rope in the groove, which is not always avoided even in straight-sided grooves, except if their angle is fairly acute. For this reason an included angle of not more than 40 degrees is recommended. It is estimated that the life of a rope is reduced by at least one-third when revolving in the groove.

In general, it may be said that the groove with a 40-degree included angle, as shown in Fig. 7, is the best for ropes above 1¼ inch in diameter, and a 30-degree groove, as shown in Fig. 9, is preferable for ropes below that size. However, for ropes of very small diameter, say ½ inch in diameter and less, used for driving cotton machinery, the included angle may be as acute as 15 degrees. Care should be used never to make the grooves too shallow, remembering the rope will not merely be tangent to the sides of the groove, but will take a wedge-shaped form and thus press itself down toward the bottom of the groove. In Fig. 7 flanges are shown at *F* and *G*, but as flanges of this character do not contribute in any way to facilitate but rather to prevent the rope falling directly in its working position when the driving is unsteady, many rope pulleys are laid out with flangeless grooves, as shown in Fig. 8. Grooves for idler pulleys, having no power to transmit, may be so constructed that the rope rests at the bottom of the groove so that as small an amount of power as possible is lost in passing over the pulley.

TABLE OF HORSE-POWER TRANSMITTED BY THREE-STRAND COTTON DRIVINO-ROPES RUNNING ON PULLEYS NOT LESS THAN THIRTY TIMES THE ROPE DIAMETERS

Rope Diameters	1"	1⅛"	1¼"	1⅜"	1½"	1⅝"	1¾"	1⅞"	2"
Minimum Diameter of Smallest Pulley	2' 6"	2' 10"	3' 2"	3' 5"	3' 9"	4' 1"	4' 5"	4' 8"	5'
Velocity in Feet per Min.									
1000	3.3	4.1	5.1	6.1	7.4	8.6	10	11.5	13.0
1100	3.6	4.5	5.6	6.7	8.1	9.5	11	12.6	14.3
1200	3.9	4.9	6.1	7.3	8.9	10.3	12	13.8	15.6
1300	4.2	5.3	6.6	8.0	9.7	11.2	13	14.9	16.9
1400	4.6	5.7	7.1	8.6	10.4	12.0	14	16.0	18.3
1500	4.9	6.1	7.6	9.2	11.1	12.9	15	17.2	19.6
1600	5.2	6.6	8.1	9.8	11.9	13.8	16	18.4	20.9
1700	5.5	7.0	8.6	10.4	12.6	14.6	17	19.5	22.2
1800	5.8	7.4	9.1	11.0	13.4	15.5	18	20.7	23.5
1900	6.2	7.8	9.6	11.6	14.1	16.3	19	21.8	24.8
2000	6.5	8.2	10.1	12.2	14.9	17.2	20	22.9	26.1
2200	7.1	9.0	11.1	13.4	16.3	18.9	22	25.3	28.7
2400	7.8	9.9	12.1	14.7	17.8	20.7	24	27.6	31.3
2600	8.4	10.7	13.1	15.9	19.2	22.4	26	29.9	33.9
2800	9.1	11.5	14.1	17.1	20.8	24.1	28	32.2	36.5
3000	9.7	12.3	15.1	18.3	22.3	25.8	30	34.5	39.1
3200	10.4	13.2	16.2	19.6	23.8	27.6	32	36.8	41.8
3400	11.0	14.0	17.2	20.8	25.3	29.3	34	39.1	44.4
3600	11.7	14.8	18.2	22.0	26.7	31.0	36	41.4	47.0
3800	12.3	15.6	19.2	23.2	28.2	32.7	38	43.7	49.6
4000	13.0	16.4	20.2	24.5	29.7	34.5	40	46.0	52.2
4500	14.6	18.5	22.7	27.5	33.4	38.8	45	51.7	58.7
5000	16.2	20.6	25.3	30.6	37.1	43.1	50	57.5	65.3
5500	17.8	22.6	27.8	33.6	40.9	47.4	55	63.2	71.8
6000	19.5	24.7	30.3	36.7	44.6	51.7	60	69.0	78.3
6500	21.1	26.8	32.9	39.8	48.3	56.0	65	74.7	84.9
7000	22.7	28.8	35.4	42.8	52.0	60.3	70	80.5	91.4

Laying out a Groove of Approximately 40-degree Included Angle.—In Fig. 7 a circle is shown representing a section of the rope pressed into the groove so that the points *BB* of the

half circle *BAB* touch the sides of the groove. When laying out the groove, draw first the center line *BB*, and then the center line *AC* at right angles to *BB*. Then connect *A* and *B* and set off the length *AB* from the center *D* to *E*, which is the center of the circular section at the bottom of the groove. From *E* set off *EC* equal to *AB*, and draw lines from *C* through the points *BB*. These lines indicate the sides of the groove; their intersections with the line *FAG*, which is tangent to the top of the rope, mark the centers *HH* of the top of the flanges. The flangeless grooves shown in Fig. 8 are laid out in the same manner as the flanged grooves in Fig. 7, except that the sides of the groove are continued to sharp corners at the top, and then slightly rounded off as shown.

The 30-degree groove in Fig. 9 is laid out approximately in the following manner: Draw from the center *D* a line at forty-five degrees angle to the line *BB*, until it intersects the periphery at *C*. Connect *C* and *B* and set off the distance *BC* from *D* to *E* and the same distance from *E* to *F*. The point *E* is the center of the circular section at the bottom of the groove, and the lines *FB* give the sides of the groove.

Cotton Versus Manila Ropes.—In selecting the ropes for the drives, too much stress should not be laid upon initial cost, for although cotton is more expensive than manila, its superior qualities as a driving rope make it possible to transmit at least one-third more power with cotton ropes of the same diameter; besides, cotton ropes will wear approximately three times as long as manila ropes, and in some case considerably longer. The life of cotton ropes, of course, depends upon their size and the conditions under which they work. The most economical diameters range from 1½ inch to 1¾ inch, the last size being most commonly used for transmitting large powers. In a specific case twenty-four cotton ropes, 1¾ inch in diameter, are employed to transmit 820 horse-power at a velocity of 4,400 feet direct from the engine flywheel, which is twenty-eight feet in diameter, to the various rooms in a cotton mill. This installation was completed in September, 1878, and all the ropes driving one of the departments have been running until the present time, a period of over thirty years, without any attention more than tightening two of the ropes which accidently were saturated with water. Another set of cotton ropes has been working an average of twenty hours a day since April, 1885, and appears almost as good as new.

The three-strand rope is superior to the four-strand rope, and it is possible to transmit the same power with a fewer number of ropes when the three-strand rope is used.

Lubrication of Driving Ropes.—The chief function of lubricating material, as supplied to cotton driving ropes, is that of providing a smooth, filmy coating to prevent friction between the twisted surfaces of the strands in contact with each other. Re-lubrication is seldom necessary unless the ropes are working in an unusually dry atmosphere, and should even then be only sparingly used at long intervals. The most serviceable lubricant is compounded from saponified tallow, wax and plumbago, which sets hard like domestic soap. Greasy compounds likely to penetrate the fibers should be avoided as they increase the tendency to slipping. If ropes have been so treated, a liberal application of whiting is usually recommended, which absorbs the grease and falls away in flakes.

* * *

EFFICIENCY OF WATER WHEELS

Speaking of the methods employed in his practice, Mr. Charles T. Main, mill engineer and architect of Boston, says: "Some tests of water wheels show a maximum efficiency of about 85 per cent. It is probable that over 80 per cent is rarely realized in practice after wheels have been installed for a short time, and this is for three-quarters to full-gate opening. When the gate opening is less than about three-quarters, the efficiency begins to drop. After wheels have been run for some time the buckets and guides are not as smooth as when they are new, and the efficiency drops off. For these reasons I usually allow an average efficiency, for wheels running under ordinary conditions of age, repair, and variable gate opening, of about 75 per cent. Under exceptionally good conditions and where there are several wheels this could be increased."

SIMPLE METHOD OF STACK DESIGN[*]

A. J. HAIRE, JR.[†]

The engineer with a chimney or stack to erect, knowing the conditions he must meet with regard to boiler horse-power, draft, coal consumption, etc., usually turns to the hand-books, boilermaker's catalogues, and similar literature, rather than to one of the many exhaustive treatises we have on the subject of stack design. These catalogues and hand-books are often inadequate, treating the subject either so simply as to be incomplete, or so technically as to be practically useless. Matter that is found in one is often repeated in the others, and nine out of ten reproduce the familiar table that Kent worked out originally for his hand-book on mechanical engineering. All of these catalogues, however, are of some value, but nearly all fail in one respect or another to satisfy the needs of the busy engineer, who is not interested in learning the whole theory of the design, but wants definite information on how to build his stack with the conditions he has, so that it will work out as he wants it to after it is built. Ninety-nine times out of a hundred such an engineer decides on Kent's rule, and lets it go at that. Any values between those given in the table, he disregards, and, for any rate of coal combustion, or for any draft conditions other than those in the table, his percentage of errors is more or less great. He may overlook the fact that the values given by the table are based on a coal consumption of five pounds per hour, which is rather a high figure, and a figure that the average power plant should cut down materially with even a fair grade of coal and boilers loaded economically. He may also overlook, and generally does, that the draft figured in reaching the values of the table is presumed to be the best, a state of affairs not always found in the average station. If he does not use this table, making allowances for the differences between his conditions and those for which the table was drawn, he has to resort to the literature on stack design, and make a lengthy computation, and the chances for error will be twice as great as if he used the table.

The diagrams in the Data Sheet Supplement represent the medium between relying solely on a table drawn up for an arbitrary set of conditions, and making a separate design with great waste of time and possibility of error for each stack. Exact results can be obtained from them with ease and quickness. Every element that would come in any computation is met in these diagrams, as a glance will show, and there is absolutely no guesswork in any decision, no necessity for interpolation of values as in the case of the table, and no need of using constants to correct the final answer to suit your own case.

Use of the Diagrams

Diagram No. I, in the accompanying Supplement, gives a double set of curves which are plotted between temperatures of flue gas, or inside and outside air, with varying heights of stacks, and the draft pressure in inches of water. By it we can determine the relation of the height to the draft pressure desired with the different temperature changes. This diagram can also be used in determining the draft if we know the height of the stack and the temperatures of the inside and outside air.

Diagrams Nos. II and III show the relation between the height of stack, the amount of boiler horse-power, and the cross-sectional area. Diagram No. II provides for boiler horse-power up to 850, and No. III for values beyond that. Knowing the height, from Diagram No. I, and knowing the horse-power, we use these curves to get the effective cross-sectional area necessary for the stack.

Diagram No. IV makes it possible to determine at a glance the side of square stack having the necessary cross-sectional area, or the corresponding diameter of a round stack.

For example, we will design a stack for 2,000 boiler horse-power, stack temperature to be 550 degrees F. and outside temperature 80 degrees F., the maximum summer temperature. The pressure on the stack is to be one inch pressure of water. From Diagram No. I, starting at 550 degrees F. at the right of the sheet, run over to the curve representing 80 degrees F.,

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[*] With Data Sheet Supplement.

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temperature of outside air. From this point drop down to the horizontal line representing one inch pressure for the desired stack, in inches of water. The point found here gives us 160 feet for the stack height. Refer to Diagram No. III to find the cross-sectional area, since the boiler horse-power equals 2 000. Where the vertical line at 2,000 boiler horse-power crosses the line of the 160-foot stack, we get a point which, projected to the left of the sheet, gives a cross-sectional area of about 47 square feet. From Diagram No IV we find the value of 47 square feet cross-sectional area on the curve, and running to the left we get the diameter of the stack corresponding to that area, which is 96 inches, or 8 feet. The side of the square stack with corresponding area as shown to the right of the diagram would be slightly less than 7 feet square. Hence, from the curves we have a stack 160 feet high, effective cross-sectional area of 47 square feet, and either 8 feet in diameter or 7 feet square.

These curves have been carefully worked out, and are exact. They are now in use by some of the largest engineering concerns in New York, and several universities have adopted them in their courses of instruction for power station work. The engineer who gives them a fair trial will undoubtedly find them of great value and superior to all general tables or arbitrary rules in the current literature or catalogues of the day.

* * *

METHODS OF TESTING THE HARDNESS OF METALS*

Few properties of iron and steel are of more importance than that of hardness. In some cases, as with a cutting tool or a pressure die, the metal is practically valueless unless it can retain a sharp edge; while in other instances, where the material has to be machined or cut and trued to shape, even a relatively slight increase of hardness is the cause of much inconvenience and expense. In a third class of material a good wearing surface is of prime importance; while, lastly, hardness may often serve as an indication of a degree of brittleness and untrustworthiness which might perhaps be otherwise unsuspected.

Hardness may be defined as the property of resisting penetration, and, conversely, a hard body is one which, under suitable conditions, readily penetrates a softer material. There are, however, in metals various kinds or manifestations of hardness according to the form of stress to which the metal may be subjected. These include tensile hardness, cutting hardness, abrasion hardness, and elastic hardness; doubtless other varieties could also be recognized when the experimental conditions are modified so as to bring into operation properties of the material in addition to that of simple, or what may be conveniently called mineralogical hardness. This has been defined by Dana as "the resistance offered by a smooth surface to abrasion." The usual quantitative tests for hardness are static in character, but the conditions are profoundly modified when the penetrating body is moving with greater or less velocity. The resistance to the action of running water, to the effect of a sand-blast, or to the result of the pounding of a heavy locomotive on a steel rail, afford examples of what might perhaps for purposes of distinction be called dynamic hardness, which is a branch of the subject which has received little examination.

Comparison will be made in the following of four typical methods of measuring hardness. Those selected include the sclerometer, introduced by the author in 1886; the scleroscope, recently invented by Shore; the form of indentation test adopted by Brinell about ten years ago; and the drill test introduced by Keep a few years earlier. Each of these methods has been used in actual works practice, and by various persons other than the inventor, and may thus be regarded as being typical of the particular class of test to which it belongs. Among the many other forms of test the microsclerometer and wearing tests call for special mention, though to these only incidental reference can be made.

The principles underlying the four methods selected for comparison may be briefly described as follows.

Turner's Sclerometer

In this form of test a weighted diamond point is drawn once forward and once backward over the smooth surface of the material to be tested. The hardness number is the weight in grammes required to produce a standard scratch. The scratch selected is one which is just visible to the naked eye as a dark line on a bright reflecting surface. It is also the scratch which can just be felt with the edge of a quill when the latter is drawn over the smooth surface at right angles to a series of such scratches produced by regularly increasing weights.

Shore's Scleroscope

In this instrument a small cylinder of steel, with a hardened point, is allowed to fall upon the smooth surface of the metal to be tested, and the height of the rebound of the hammer is taken as the measure of hardness. The hammer weighs slightly over 2 grammes, the height of the rebound of hardened steel is in the neighborhood of 100 on the scale, or about 160 millimeters, while the total fall is about 10 inches or 255 millimeters.

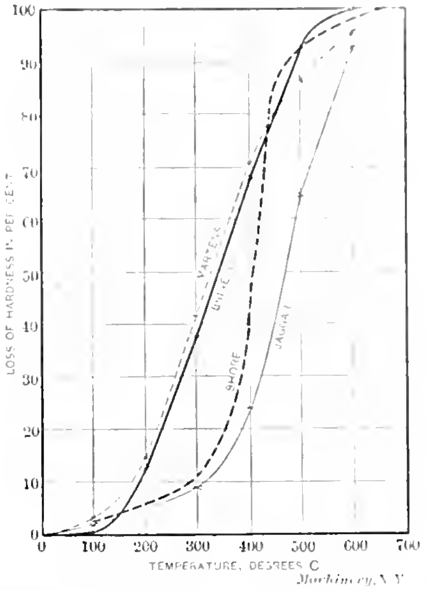

Diagram showing Percentage of Loss of Hardness of Hardened Steel when tempered to Various Temperatures, as measured by Different Hardness Testing Apparatus

Brinell's Test

In this method a hardened steel ball is pressed into the smooth surface of the metal so as to make an indentation of a size such as can be conveniently measured under the microscope. The spherical area of the indentation being calculated, and the weight being known, the stress per unit of area when the ball came to rest is calculated, and this gives the hardness number. Within certain limits the value obtained is independent of the size of the ball, and of the amount of pressure. In the original tests the steel ball was 10 millimeters in diameter, and the pressure was equal to a weight of 3,000 kilogrammes; but a more convenient form of apparatus is now supplied by Mr. Brinell for works tests, while Mr. Stead has introduced a small and portable instrument.

Keep's Test

In this form of apparatus a standard steel drill is caused to make a definite number of revolutions while it is pressed with standard force against the specimen to be tested. The hardness is automatically recorded on a diagram on which a dead soft material gives a horizontal line, while a material as hard as the drill itself gives a vertical line, intermediate hardness being represented by the corresponding angle between 0 and 90 degrees.

Each form of test has its advantages and its limitations. The sclerometer is cheap, portable, and easily applied, but it is not applicable to materials which do not possess a fairly smooth reflecting surface, and the standard scratch is only definitely recognized after some experience. The Shore test is simple, rapid, and definite for materials for which it is

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* Abstract of paper read before the Iron and Steel Institute (Great Britain), May 14, 1909, by Prof. Thomas Turner, of the University of Birmingham. For additional articles previously published in MACHINERY see "The Brinell Method of Testing the Hardness of Metals," September, 1908, engineering edition; "A New Mechanical Test for Hardness," October, 1908, engineering edition.

suited, and appears likely to have an important future. But further information is yet needed as to the exact property which is measured by this form of test. As shown by De Fréminville, the result obtained varies somewhat with the size and thickness of the sample, while if the test-piece is supported on a soft material, such as a plasticine, the results are valueless. It should also be pointed out that india-rubber gives a rebound of 23, which is equal to that of mild steel, while light soft pine wood gives a rebound of 40, which is nearly twice as great as that of gray cast iron. Curiously enough, hard wood, like teak, gives a rebound of about 12, while some samples are considerably lower than this. As illustrating the influence of the support, a sample of exceptionally hard rolled copper, about 1/25 inch in thickness, when supported on a block of hard steel, and tested with the blunt or "magnified" hammer supplied, gave a value of 30, which was increased to 34 when the copper was supported on wood. A sample of brass only gave a value of 17, and yet this brass would scratch the copper, while the copper would not scratch the brass. From these results it is evident that the Shore test is only applicable to a certain class of substances. It appears to test what may be termed the "elastic hardness," and gives high results with metals in the "worked hard" condition. Tests appear to show that good results are, however, obtained with glass and with porcelain, as well, of course, as with most metals.

The Brinell test is specially useful for constructive material; it is easily applied and definite, and is now of all hardness tests the one most employed. It appears to give satisfactory results with wood, but cannot be applied to very brittle materials, such as glass, or to hard minerals; Keep's test is specially suited for castings of all kinds, as it records not merely the surface hardness, but also that of the whole thickness, and gives indications of blowholes, hard streaks, and spongy places. Obviously, it can only be applied to materials the hardness of which is less than that of hardened steel.

A very important question arises in connection with these various tests—namely, as to whether there is any observed agreement between the results which are arrived at by such entirely different methods. It will be noticed that in each case an arbitrary scale is adopted. If the weights used on the sclerometer had been ounces instead of grammes, the hardness numbers would naturally have been different. Similarly, Brinell's tests might have been expressed in tons and inches, or a different weight of hammer and height of scale adopted by Shore. Hence all that can be expected is a proportionality in the results, and if this is ascertained it should be possible to convert values on one scale into results on another.

TABLE I. HARDNESS SCALES COMPARED

Metal	Sclerometer	Scleroscope	Brinell
Lead	1.0	1.0	1.0
Tin	2.5	3.0	2.5
Zinc	6.0	7.0	7.5
Copper, soft	8.0	8.0	....
Copper, hard	..	12.0	12.0
Softest iron	15.0	....	14.5
Mild steel	21.0	22.0	16–24
Soft cast iron	21–24	24.0	24.0
Rail steel	24.0	27.0	26–35
Hard cast iron	36.0	40.0	35.0
Hard white iron	72.0	70.0	75.0
Hardened steel	....	95.0	93.0

An examination of results obtained by the four methods dealt with shows that, for relatively pure metals in their cast or normal condition, there is a general agreement which must be regarded as remarkable. In Table I will be found, in the first column, results which were published in the author's original paper on the hardness of metals in 1886. In the second column are the author's results with the Shore scleroscope, and these figures are in good agreement with those supplied by the maker of the instrument. In the third column are values taken from published results by Mr. Brinell and by Mr. Stead, but the numbers given have been divided by 6, as this figure has been found to suitably reduce the Brinell hardness values for purposes of comparison. It will be observed that either by accident or design the scale adopted for the scleroscope is, for practical purposes, identical with that of the sclerometer, while Mr. Brinell's values are proportional. The angles in Keep's tests are, or could easily be made, in pretty close agreement with the other values. It would therefore appear that each instrument, with simple and homogeneous substances, must measure one and the same physical property and gives results which are either in actual agreement with, or proportional to, the results obtained by the other forms of test.

In practice, however, the use of relatively pure metals in the unworked or annealed condition is comparatively rare, unless we include in this category wrought iron and mild steel. Carbon steels and special steels consist largely of alloys, the complexity of which is profoundly modified by heat treatment; while copper, zinc, and their alloys are frequently hardened by rolling, drawing, or other mechanical treatment. The very important question therefore arises as to the extent to which the different methods of testing agree in their values for the hardening and tempering of steel, and for the hardness caused by mechanical treatment. From preliminary observations on the latter point the author is inclined to believe that metal which has been mechanically treated, as with hard-drawn rods or rolled sheets, has its tenacity increased out of proportion to its hardness as measured by a file or cutting tool. The sclerometer shows relatively little difference, for example, between hard-drawn and annealed copper, while the scleroscope shows an exaggerated effect, at all events in some cases. As the Brinell test closely follows the tenacity, it too may be expected to show marked difference between worked and annealed samples. The result in some cases is likely to be a confusion between elasticity or tenacity on the one hand, and true or mineralogical hardness on the other. For example, a piece of hard-rolled copper may give a greater hardness number than one of mild steel. Yet a tool made of mild steel will always cut copper, and no amount of cold-rolling will make copper cut steel. Hence great care is required when hardness values for different materials are compared and further information in this direction is desirable.

TABLE II. PERCENTAOE OF LOSS OF HARDNESS OF HARDENED STEEL WHEN TEMPERED TO VARIOUS TEMPERATURES, AS MEASURED BY DIFFERENT HARDNESS TESTING APPARATUSES

Temperature of Heating, Degrees C	Brinell Method (0.83 per cent Carbon)	Martens Sclerometer (0.95 per cent Carbon)	Jaggar Micro-sclerometer (0.86 per cent Carbon)	Shore's Method (0.88 per cent Carbon)
160	..	2.5	1.8	3.7
200	13	14.0	5.4	2.7
300	38	41.0	9.1	11.1
400	68	70.6	23.6	33.0*
500	94	87.5	64.0	92.5
600	100	95.7	94.5	100

* At 380 degrees C.

Hardness of Steel in Hardened, Tempered or Annealed Condition

The question of agreement in reference to the true hardness of a sample of steel in the normal, hardened, tempered, or annealed condition is perhaps of even greater importance. To illustrate the kind of difficulty which arises, reference may be made to some recently published results by E. Maurer, in which samples of steel with varying content of carbon were heated to ascertained temperatures, quenched, and afterward tempered or annealed at given temperatures. The hardness of the samples was then determined. When the tempering heat was 300 degrees C., the loss of hardness in a sample containing 0.83 per cent of carbon was 11.1 per cent by the Shore method, and 38.0 per cent by the Brinell test. A steel with 0.95 per cent carbon tested in a similar manner by Heyn and Bauer with a Marten's sclerometer gave a loss of hardness of 41.0 per cent; while lastly Boynton, with a Jaggar sclerometer, using a steel with 0.86 per cent carbon, has recorded a loss of hardness on tempering at 300 degrees of only 9.0 per cent. The question may be put in this way: The steel is suited for making wood-working tools, if properly hardened and tempered. Is 300 degrees C. a proper tempering heat? According to the Shore test and the Jaggar test the tool should be hard and cut well; but according to the Brinell test and the Martens sclerometer it has lost nearly half its original hardness, and should rapidly lose its cutting edge. Maurer states that every-day experience shows that with this class of tool steel a tem-

pering heat of 300 degrees renders the metal useless for woodworking.

The results of the four sets of experiments are given in Table II.

The values are graphically represented in the accompanying illustration, from which it will be seen that the greatest difference occurs at about 300 degrees C., the loss of quenching hardness due to tempering being about four times as great when tested by the two first methods as compared with the results obtained when the steel is tested by the two latter methods given in the table.

Further, Martens and Heyn have recently pointed out that in the ball test for hardness the indentations are frequently not circular, and are therefore difficult to measure, and that when testing hard materials the ball itself is appreciably flattened while under load. To diminish these sources of error Martens has introduced a special form of apparatus for measuring the depth of the indentation.

It is evident, therefore, that further research and comparison is required before agreement in principle can be arrived at with hardness tests for hardened, tempered, or mechanically treated metals.

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ALLOY STEELS FOR MOTOR CAR CONSTRUCTION*

The cost of the materials used in automobile construction amounts to about sixty per cent of the total cost of production. In view of this fact, the kind of material best suited for the more vital parts is highly important. In the following the composition and treatmnt of some of the most commonly used alloy steels are reviewed.

TABLE I. NICKEL STEELS

Carbon	Manganese	Nickel	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.21	0.86	3.48	68	112	13.7	45	1550 F. oil 600 F.
0.25	....	3.50	85	109	13.4	..	1550 F. oil 600 F.
0.27	....	3.50	86	110	13.3	51	1550 F. oil 600 F.
0.18-0.28	0.60-0.90	3.5	68	103	12.9	54	1550 F. oil 600 F.
0.18-0.28	0.60-0.90	3.5	84	116	12.4	48	1600 F. brine.
0.25	0.60-0.90	3.5	88	121	12.2	48	1600 F. brine.
0.23	0.61	3.54	103	114	14.0	50.7	1550 F. water 212 F.
0.14	0.63	3.64	78	88	15.0	54.6	1500 F. water 212 F.
0.14	0.63	3.64	30	41	33 5	72.4	1400 F. oil 1200 F.
0.35	0.45	3.39	77	84	15.5	55.5	1500 F. water 900 F.
0.35	0.45	3.39	130	137	10.0	36.3	1500 F. water 430 F.
0.25	0.86	3.45	31	45	31	60	Natural, as rolled.

Nickel Steel

Nickel steel is the most generally used of the alloy steels. The best quality contains 0.20 to 0.25 per cent carbon, 3.50 per cent nickel, 0.60 to 0.90 per cent manganese, and not over 0.04 per cent sulphur and phosphorus. With carbon and nickel as given above, the manganese content ought never to exceed the limits mentioned. A slightly lower carbon content is sometimes used for case-hardening purposes, and a higher carbon percentage is much used for crank-shafts. Nickel steel is usually made in the basic open-hearth furnace. It is an excellent steel for case-hardening, and is easier to machine than other alloy steels.

Chrome-Vanadium Steel

The chrome-vanadium alloy steels are preferably made in the crucible or electric furnace, although the open-hearth process is also much used for the purpose. The open-hearth product, however, is somewhat uncertain, and while springs of steel made by this process may be better than those made from ordinary crucible steel, they cannot be compared with springs made of crucible chrome-vanadium steel. For excellent quality the latter product constitutes the highest attainment of the steel makers' art.

Chrome-vanadium steel made with high carbon content is suitable for oil-hardened gears and springs. When made with a low carbon content it is used for case-hardened gears, and, when oil quenched and annealed, for axles, shafts and steering knuckles. When a better material than the best nickel steel is needed, the various kinds of chrome-vanadium steel are to be recommended. They can be easily forged and can be machined more readily than chrome-nickel steels of corresponding carbon percentages.

Chrome-Nickel Steels

Chrome-nickel steels are made either with a high carbon content, and used for oil-hardened gears and springs, or with a low carbon content, in which case the steel is used for axles, shafts, forged parts, and case-hardened gears. The high carbon steel carries about 0.5 per cent of carbon, while the low carbon alloy carries 0.25 per cent. The nickel content is from 2 to 3.5 per cent, while the chromium varies from 1 to 1.5 per cent. A special nickel-chrome-tungsten steel is sometimes used for springs. Nickel-chrome steels possess excellent static qualities, but present difficulties in heat treatment, forging and machining.

Silico-manganese and silico-chrome steels with medium and low carbon contents are used to a considerable extent abroad for springs and gears. Their relatively low cost favors their use, but they do not stand up well when subjected to shocks, and are too sensitive to heat treatment. When handled with great care they give good results where the temperatures for the heat treatmeat can be accurately gaged. Chrome steels with high carbon content are used to a considerable extent for balls and ball races. Tungsten steels are universally used for making magneto magnets.

TABLE II. NICKEL-VANADIUM STEELS

Carbon	Manganese	Nickel	Vanadium	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.34	0.17	3.88	....	29	43	27.3	54	Natural as rolled.
0.33	0.16	3.72	0.12	41	51	23.8	53	Natural as rolled.
0.33	0.16	3.40	0.24	49	66	17.8	40	Natural as rolled.
0.34	0.17	3.88	....	37	51	16.5	51	1500 F. oil 1150 F.
0.33	0.16	3.72	0.12	51	59	24.0	61	1500 F. oil 1150 F.
0.33	0.16	3.40	0.24	59	62	21.0	61	1500 F. oil 1150 F.
0.34	0.17	3.88	...	59	66	15.5	55	1500 F. oil 600 F.
0.33	0.16	3.72	0.12	70	76	14 5	56	1500 F. oil 600 F.
0.33	0.16	3.40	0.24	82	85	15.0	55	1500 F. oil 600 F.
0.24	0.72	3.33	0.12	38	49	27.0	64	Natural as rolled.
0.24	0.72	3.33	0.12	71	100	11.6	36	1600 F. oil.
0.24	0.72	3.33	0.12	92	117	14.5	52	1600 F. water.
0.24	0.72	3.33	0.12	91	116	15.2	57	1600 F. brine 400 F.

Heat Treatment of Alloy Steels

While the best alloy steels are none too good for most of the parts in automobile construction, their qualities will not become pronounced unless they receive proper heat treatment. It is waste of money to buy good alloy steels without knowing how to properly treat them to bring forth their exceptional qualities. For gaging the heat a pyrometer is necessary, but it is too often supposed to take care of itself. The best pyrometer of the thermo-couple type should be regularly inspected. The protecting tubes should be frequently examined and renewed, and the electrical contacts looked over.

The heat treatment operations depend upon established scientific facts, and a lack of appreciation of this causes many people to buy high-priced alloy steels from which they get no better results than from carbon steel properly handled. As an example of the effect of heat treatment may be mentioned a chrome steel which in its rolled condition had an elastic limit of 158,000 pounds, 5 per cent elongation, and 9.4 per cent reduction in area. The same steel, oil tempered and annealed, had an elastic limit of 153,000 pounds, 14 per cent elongation and 52 per cent reduction in area. In other words, the material was transformed from brittle to tough without appreciably affecting its elastic limit. Nickel steel similarly treated will have the elastic limit raised twenty per cent, with its elongation unchanged and its reduction in area improved.

The accompanying tables show typical analyses, treatment and tensile strength of nickel, nickel-vanadium, chrome-vana-

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* Abstract of paper by Mr. John A. Mathews, read before the Franklin Institute, Mining and Metallurgical Section, April 1, 1909.

dium and chrome-nickel steels. Many sources of information have been drawn upon in the compilation of these tables, as, for instance, the data published by the American Vanadium Co., experimental data obtained by tests made by the writer, and the commercial tests made on the steels of many makers. The elastic limit and tensile strength are given in tons per square inch, and the elongations are measured on 2-inch test specimens, ½ inch in diameter. It should be noted that the figures given must be used with some caution. Because a ½-inch test piece, oil tempered and annealed, gives an elastic limit of 75 tons per square inch, it does not follow that a 1½-inch bar similarly treated will have the same elastic limit. The hardening action in quenching does not penetrate very deeply in the large bar, while in a small one it may penetrate to the center.

In the column marked "Treatment" is given the temperature to which the steel is heated before quenching, followed by the liquid in which it is quenched; where a third temperature is given it indicates the temperature to which the steel is reheated to draw the temper or anneal. This will make clear such terms as "1,600 F. oil 600 F."

For springs it seems that no material is better than crucible chrome-vanadium steel. The tempering of this steel is quite simple. The springs made from it should be heated to from 1,675 to 1,700 degrees F. and quenched in oil. The temper is then drawn according to the nature of the spring, and the duty expected. The drawing range is very wide, varying from 600 to about 1,000 degrees F.

Case-hardened versus Oil-hardened Gears

Both case-hardened and oil-hardened gears are largely used in automobile construction. As previously mentioned, the chrome-vanadium, chrome-nickel and silico-manganese alloys are made with both high and low carbon contents. The former contains about 0.45 to 0.60 per cent carbon and enough other hardening elements so that by merely quenching the steel in oil from a bright red heat, surface hardening is produced sufficient for ordinary wearing purposes, while the hardness does not penetrate deeply into the gear, but leaves a tough and strong core. The low carbon alloy steels, with about 0.20 per cent carbon, require to be case-hardened in order to produce sufficiently hard surface for wearing purposes. The writer's observations lead him to prefer the case-hardening gear, the following conclusions being based on the results of direct tests on thousands of gears.

TABLE III. CHROME-VANADIUM STEELS

Carbon	Manganese	Chromium	Vanadium	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.26	0.39	0.78	0.17	41	68	20	64	Natural as rolled.
0.26	0.39	0.78	0.17	103	139	3	8.2	1570 F. oil 400 F.
0.27	0.50	1.00	0.17	33	45	28	62	Annealed 1475 F.
0.27	0.50	1.00	0.17	52	63	21	56	Oil tempered and drawn to various degrees.
0.27	0.50	1.00	0.17	62	65	17	62	
0.27	0.50	1.00	0.17	70	71	17	57	
0.27	0.50	1.00	0.17	100	106	12	51	
0.27	0.50	1.00	0.17	112	116	11	39	
0.40	0.77	1.22	0.19	31	50	26	62	Annealed.
0.40	0.77	1.22	0.19	98	104	10	36	1650 F. oil 840 F.
0.30	0.50	1.00	0.16	71	76	16	56	1650 F. oil 1025 F.
0.38	0.73	1.19	0.18	41	65	22	67	Natural as rolled.
0.38	0.73	1.19	0.18	110	144	10.8	47	1660 F. oil 600 F.
0.38	0.73	1.19	0.18	64	113	12.9	53	1660 F. oil 850 F.
0.33	0.54	1.24	0.20	64	71	15.5	56	1500 F. oil 1125 F.
0.33	0.54	1.24	0.20	95	104	11.0	38	1600 F. water 600 F.
0.45	0.58	2.37	0.30	88	94	13.2	46	1600 F. oil 1125 F.
0.45	0.58	2.37	0.30	138	146	6.0	16	1600 F. oil 430 F.
0.36	0.21	2.78	0.24	60	101	4.1	88	Natural as rolled.
0.36	0.21	2.78	0.24	65	72	20	56	1500 F. oil 1150 F.
0.36	0.21	2.78	0.24	98	104	13	45	1500 F. oil 600 F.

1. The static strength of case-hardened gears is equal to that of oil-hardened gears, assuming that in both cases steel of the same class of appropriate composition has been used, and the respective heat treatments have been equally well and properly conducted.

2. Direct experiments prove that case-hardened gears resist shocks better than oil-hardened.

3. The case-hardened gear resists wear incomparably better, although it is perhaps not as silent in action.

The strong objection to the case-hardening is in nine cases out of ten doubtless due to the fact that the case-hardening operation is not properly understood. The depth of the hard case or covering, the time and temperature required to produce certain results, and the exact control of the conditions, together with an accurate knowledge of the material to be treated, are factors which enter into successful case-hardening.

To obtain the best results in case-hardening ordinary carbon steel, the following rules should be observed. Steel containing less than 0.12 per cent of carbon, and with a low percentage of manganese (less than 0.30 per cent) should be used; the case-hardening should be accomplished by a chemically definite material, such as a mixture of 60 per cent charcoal and 40 per cent barium carbonate, and at a temperature between 1,560 to 1,920 degrees F. The higher the temperature, the more rapid will be the case-hardening. After the case-hardening operation, allow the steel to cool down to about 1,100 degrees F. Then re-heat the work to be case-hardened, and quench it at 1,650 degrees F. This heating and quenching has the effect of toughening the center, but the outside will be coarse-grained and brittle; therefore heat the material a second time to 1,470 degrees F. to render the outside non-brittle.

TABLE IV. CHROME-NICKEL STEELS

Carbon	Manganese	Nickel	Chromium	Elastic Limit, tons	Tensile Strength, tons	Elongation in 2 inches, per cent	Reduction in Area, per cent	Treatment
0.37	....	2.9	1.04	60	78	18.5	61	1475 F. oil 1200 F.
0.37	....	2.9	1.04	77	84	16.	56	1500 F. water 1100 F.
0.45		2.0	1.0	70	90	8.0	20	Oil-temp. and annld.
0.25	....	2.0	1.0	50	65	12.0	30	Oil temp. and annld.
0.25	....	3.0	1.5	57	64	15.0	65	Annealed.
0.25	....	3.0	1.5	110	116	6.0	40	Hardened—oil.
0.50	....	2.0	1.0	33	46	27.0	64	Natural as rolled.
0.50	....	2.0	1.0	72	134	6.0	23	Tempered.
0.30	....	2.0	1.0	35	53	18.0	45	Natural as rolled.
0.30	....	2.0	1.0	68	98	9.0	37	Tempered.
0.30	....	2.0	1.0	45	55	25.0	55	Oil-temp. and annld.
0.40	0.18	2.1	0.80	60	76	12.8	37	Natural as rolled.
0.40	0.18	2.1	0.80	58	66	17.5	40	1500 F. oil 1150 F.
0.40	0.18	2.1	0.80	106	118	10.0	34	1500 F. oil 600 F.
0.40	0.18	2.1	0.80	70	79	15.5	48	Annealed 1150 F.

This procedure is more elaborate than that most commonly used, where pieces are dumped directly from the case-hardening boxes into water. The process, however, can be somewhat modified if one uses a good grade of nickel steel, low in carbon, and after having case-hardened it at the appropriate temperature, permits the material to cool off in the boxes before re-heating and quenching. In this case, if the material is re-heated but once to 1,470 degrees F. the result will be fully equal to or better than those obtained by the most careful annealing and double quenching of ordinary carbon steels. It is, however, better to give a double quenching, as then extraordinary toughness and wearing qualities are obtained.

An ideal way of making a nickel steel gear consists in first annealing the blank than rough machining it approximately to size, and then re-annealing before taking the last finishing cut. The gears are then packed in a mixture as mentioned, heated to a temperature of about 1,625 to 1,650 degrees F., carbonizing to a depth of about 1/64 to 1/32 inch. The gears are then permitted to cool in the boxes, are heated to 1,500 degrees F., and quenched in a hot brine or calcium-chloride solution, and finally re-heated to 1,375 or 1,400 degrees F. and quenched in oil. The temper need not be drawn.

Another important point is that of drop forging small parts which can also be made from bars in automatic machines. No steel is improved by drop forging, although some steels are less susceptible to injury than others. In drop forging work, in order to give plasticity, the material must be heated very hot. An investigation of drop forging and bar cut gears, the former being the product of one of the foremost drop forging companies, showed that under static test the bar cut gears were fully 25 per cent stronger and their resistance to shock was also greater.

THE COMMERCIAL AIRSHIP

C. A. McCREADY*

Broadly stated, there are two distinct systems followed by inventors in their efforts to produce a vessel that can navigate the air. In the first, the vessel is heavier than air, with wings or supporting planes, and equipped with machinery light enough and powerful enough to force it upward and keep it in motion in the air; in the second, it is lighter than air, so that it can of itself rise and carry a definite load. The problem is purely a commercial one, as in transportation on the land and on the sea, and the proper gage of the success of any aerial vessel is its availability for commercial purposes. With commercial success achieved, all other needful purposes can readily be met. As yet we are in the experimental stage, the best results by either system falling far short of commercial requirements. It is well, therefore, to analyze the underlying principles with a view to determining which system offers the best assurance of final success.

The heavier-than-air machines, popularly known as flying-machines, have the advantage of cheaper cost of construction and operation. On the other hand, the construction of such machines is necessarily frail, the risk of being overturned by a sudden change of wind is ever present, they can only rise under favorable conditions, and even under favorable conditions can only remain a limited time in the air. Many improvements can, and doubtless will, be made that will reduce the force of these objections; but even if entirely removed, the further objection still holds that such vessels cannot remain at rest in the air even for a moment, so should any accident befall the propelling machinery, the vessel must descend, whether under control or not, and whether or not there is available a suitable place for landing. The carrying capacity is also limited, and any increase to commercial proportions seems doubtful, since the weight increases as the cube of the dimensions while the carrying capacity increases only as the square.

Of lighter-than-air machines the general public is as yet only familiar with those based on the balloon principle; which means that the air contained in the envelope is forced out and a lighter gas substituted, the difference between the weight of the air and the weight of the gas furnishing the ascensional force, after deducting the weight of the envelope and appurtenances. The advantages of the balloon over the flying-machine are important: it can remain longer in the air, it can ascend higher, and it can carry a greater load. However, the disadvantages are serious, although recent developments have tended to modify some of them. First, the gas—whatever gas is used—is an element of danger. It is also expensive, inasmuch as it must be renewed with each ascension. The process of inflation is likewise bothersome. In a limited sense, the balloon can rise to such altitude as may be desired, yet it can only do this by discarding the ballast it has taken along. It can also descend at will, yet to do so part of the gas which caused it to rise must be released. Neither the ballast nor the gas, once released, can be restored without coming to earth; so the possibilities of the balloon while in the air are limited, and its return to the air is made possible only after delay, inconvenience and extra cost.

The rigid construction of recent German balloons has removed some of the previous disadvantages of this system, and also has permitted making the balloon dirigible, in a modest way, even while carrying a load such as the flying machine could not support; yet little of practical value has so far resulted from the enormous sums spent in experiments. Still enough has been learned to make it clear that it is through the lighter-than-air principle alone that aerial transportation must come, even though balloons themselves, however modified in form, may be incapable of solving the problem.

As already stated, aerial transportation is a purely commercial problem, and to be a success the airship must be capable of meeting the every-day requirements of commercial transportation. It must be able to support and carry a substantial load for an indefinite time without coming to earth. It must be able of itself to rise to such altitude as may be desired, whether it be a few feet above the earth or ten thousand feet or more, and to remain at the chosen level, either at rest or in motion indefinitely. It must be equally able to descend at will, always under the absolute control of the pilot.

All this is possible only on the lighter-than-air principle, yet abundant experience has shown that it is hopeless to expect so much from any vessel which gets its ascensional force from inflation, as with the balloon. There only remains the principle of deflation,—that is, exhausting the air and leaving a vacuum,—and by the proper application of this principle it will be found that all of the above requirements of the commercial airship can be met.

Let us assume a thin steel cylinder of high tensile strength, say 26 B. W. G.,* (0.018 inch) so as to permit of the lightest construction consistent with safety; the diameter to be about 150 feet, and (including cones at either end to facilitate passage through the air) of an extreme length of say 750 feet from apex to apex of the cones; the cylinder and cones to be supported internally by a system of bracing, light in weight but so constructed as to prevent collapse or buckling when the air is exhausted. The natural objection that such construction is impracticable must, for obvious reasons, be passed over for the present without further explanation than that the entire system has been worked out to the final detail, and attested by engineers of national reputation. Such an envelope would contain over 420 net tons weight of air. The weight of the steel cylinder with its internal bracing, including the weight of the attached car, with furnishings and all necessary machinery, would be, roughly, 270 net tons, leaving an extreme lifting force of about 150 net tons with the air entirely exhausted from the cylinder. Leaving say 50 tons of air in the cylinder as a reserve, there would still remain a lifting force of 100 net tons, or 200,000 pounds, the equivalent in weight of at least 1,000 men. If so much lifting force were not required, the surplus would remain as an extra reserve force of air in the cylinder. It is, of course, understood that where no strain appears, the lightest material available, as aluminum, would be used, particularly in the furnishings.

On a small scale the vacuum system is not now practicable; but it becomes proportionately more efficient as the size is increased, which is very important from the commercial point of view. It may be well to note how the vacuum principle as applied to airships will work out in practice. The lifting force itself is the weight of the air withdrawn from the cylinder, after deducting the weight of the cylinder, car and equipment. When the car is loaded ready to be transported, pumps are set to work to exhaust the air from the cylinder, and when the weight of the air exhausted overbalances the weight of the airship and its load, it will rise; and as more air is exhausted, the airship will rise higher until the desired height is reached, whether it be a few feet above the ground or high above the clouds. To descend, it is only necessary to open valves and allow air to enter until the added weight causes the airship to descend. This rising and descending can be adjusted at the will of the pilot, so as to take advantage of whatever atmospheric level is most favorable for navigation; and it is accomplished without difficulty and without cost, by using the very medium in which it floats to increase or decrease the weight of the airship.

The first requirement in aerial transportation, as elsewhere, is safety, and in all calculations concerning the vacuum airship this has first of all been provided for. It must, however, be remembered that while vessels on the sea must at times combat the combined fury of wind and waves, there is one less element of danger in the air; and this danger is minimized in the vacuum airship through its ability to change its specific gravity at will. If storms are raging near the earth, it can rise above them; if the upper air is violently disturbed, it can descend to the quieter level near the earth.

The speed at which this airship can travel must partly depend on the varying conditions met, but a minimum of 100 miles per hour is provided for. Bearing in mind the speed actually attained by the crude devices now on exhibition here and abroad, this estimate for a scientifically constructed air-

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* Address: 301 Produce Exchange, New York.

* The dimension of $^1/_4$ inch, given in the note "Zeppelin's Last Record—The De Bausset Vacuum Airship," July, 1909 issue of MACHINERY, was erroneous.

ship capable of carrying the necessary machinery does not seem extreme. This would permit of a passage across the Atlantic within one and one-half days, or one-third of the time required for the fastest ocean passage yet made. The same rate of speed in a continued trip—which is well within the limits of possibility—would permit of circumnavigating the earth in ten days.

In various other ways the vacuum airship may exert an influence almost incalculable on human affairs. What better health resort can be imagined than the upper air for victims of tuberculosis and kindred ailments? What better method of exploring distant regions, now almost inaccessible, and searching out their hidden treasures? How better could relief be carried to famine-stricken districts, when each day's delay means the sacrifice of many lives?

Unlike the balloons and flying machines of the present, this airship was not designed for war purposes. That it would be useful in time of war is self-evident. But it is hoped that it may be more useful to the world by showing the futility of building and supporting warships and fortifications that could be so easily destroyed, and of maintaining large standing armies that could readily be put out of action by it, and thus relieve the nations of the world of the tremendous burdens they are now compelled to support in time of peace, and perhaps hasten the time when war shall be no more.

In conclusion, it is only proper to state that the vacuum principle as applied to airships is based on the researches and experiments of the late Dr. Arthur de Bausset, a physician by profession, and a scientist of very high attainments; and it is the earnest belief of those most familiar with his work, that when the history of aeronautics is finally written in the light of facts now known only to a few, to him will be given the credit for having made possible the commercial conquest of the air.

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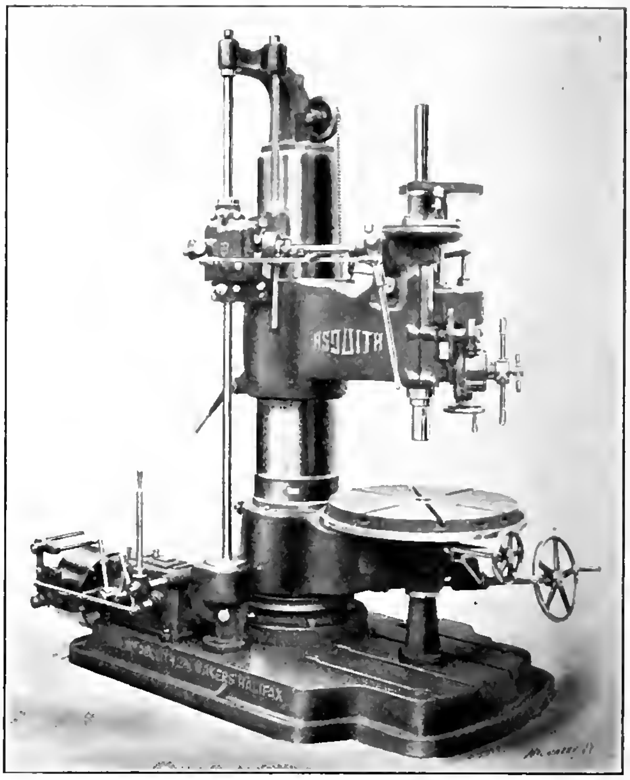
NEW ENGLISH UPRIGHT DRILL PRESS

JAMES VOSE[*]

The firm of Wm. Asquith, Ltd., Halifax, formerly built a wide range of machine tools in conformity with the then common English practice. During the last few years, however, they have specialized in the manufacture of medium and heavy drilling and boring machines, including the radial, upright and horizontal types, and have met with considerable success. We herewith illustrate their most recent design of vertical drill press.

The principal advantages claimed for these machines are an unusual degree of handiness of adjustment, coupled with extreme rigidity and freedom from deflection in the frame or table. They are built in three sizes to admit work up to 36, 48, and 60 inches diameter. The diameters of the driving parts of the spindles are $2\frac{1}{4}$, 3, and $3\frac{1}{2}$ inches respectively, and the vertical feeds for the three sizes are 11, 15, and 18 inches. The 36-inch machine has 8 speeds and 4 feeds, and the 48- and 60-inch sizes have 12 speeds with 4 and 6 feeds respectively. The coarsest feed provided is 1/32 inch and the finest 1/150 inch per revolution of spindle. The maximum distance from spindle nose to the table varies from $28\frac{1}{2}$ to 30 inches in the different sizes, and from spindle nose to the base-plate, from 53 to 57 inches. The heads may be raised or lowered by power within a range of 32 inches in the case of the 36-inch press, 34 inches on the middle size, and 36 inches on the 60-inch machine. As will be noticed, the main drive from the line shaft is through a gear box mounted on the base at the rear of the column. The constant-speed belt, which is 4 or 5 inches wide, runs at from 1,500 to 1,800 feet per minute. The work tables are surrounded by a trough which catches the surplus lubricant, and their working diameters are 30, 42, and 48 inches, respectively, for the different machines. The weights of the machines—which may, of course, be electrically driven if desired—range between 5,500 and 9,500 pounds. Some of the constructional features which may be mentioned are as follows: The high-carbon steel spindles are made larger in diameter where they bear in the sleeves than at the driving parts, and they are rigidly supported by the sleeves even when out at the full length of the traverse. Ball thrust bearings are used, and the spindles have quick up-and-down adjustment with fine hand- and power-feed motions and an automatic trip motion with index dial and safety stops for the prevention of over traverse. The powerful friction feed is also capable of being instantly stopped or applied. For tapping and stud fixing, the reversing motion is worked by the same lever which stops or starts the spindles and controls the vertical motion of the heads, the lever being brought to the front of the head, on which it is carried, for easy access from the operator's working position. The head has no radial adjustment, the present construction being considered more rigid. The standard carrying the head and table is in one piece down to the foundation plate, to which its unusually large base is bolted. Special stress is laid on the assurance thus obtained of practical absence of deflection. The arm carrying the table is very strong and it has a bearing of large diameter and considerable length on the lower portion of the standard. The table can be very easily and quickly adjusted radially by a large hand-wheel (seen in the illustration attached to an inclined shaft), worm and wheel. A fine, accurate and quick adjustment is thus available. The tables also have a rotary motion in the arm bearing through a hand-wheel, worm and wheel, and by this combination of motions any portion of the table can be rapidly brought under the drill spindle. The table, which can be swung entirely clear of the base when desired, is fitted with a foot, as shown, which prevents deflection under any cut which can be imposed. All the driving gears are of steel, and all bearings bushed with gun metal. Particular attention has been paid to the handy locating of locking and manipulating levers and also to lubrication. By way of taking advantage of the satisfactory support afforded the spindle, a very handy attachment is supplied for milling keyways in spindles or shafts. This takes the form of a fixture which is self-setting on the table. The top portion of the fixture can be screw-traversed by hand and it is arranged as a V-block with T-slots on each side for bolting down the work. Generally, the machines are considered by the builders to combine—within their range—the handiness of the best standard radial machines with the rigidity of the best type of vertical drill press. The engraving shows the 36-inch machine.



Rigid Design of English Drill Press

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It is stated in the *Cement Age* that the Pullman Company has completed an all-steel sleeping car with concrete floor laid on steel girders. The new car consists entirely of steel and concrete, with the exception of the upholstery, making it as nearly wreck- and fire-proof as possible.

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[*] Address: 328 Moss Lane, East, Manchester, England.

MACHINE SHOP PRACTICE*

LAYING OUT WORK 1

It is necessary prior to many machining operations to first lay out lines indicating just where the finished surfaces should be, so that when the work is completed all machined surfaces will be in proper relation to one another. Another purpose of such lines, providing they are properly located, is to enable the machinist to remove an average amount of metal from the various surfaces; this is important, for, by way of illustration, if too much metal were removed in facing a boss, it might not be possible to finish another surface to a certain required dimension from the first. In addition, the finished faces are in a more orderly relation with those parts which are left rough, and therefore the work presents a more pleasing appearance. At the present time there is less of this class of work done than formerly, as the numerous jigs and fixtures now used, so locate the work and guide the cutting tools that lines indicating finished surfaces are unnecessary. When the parts are not manufactured in quantity, however, and in small shops where there are few jigs, it is frequently necessary to lay out work.

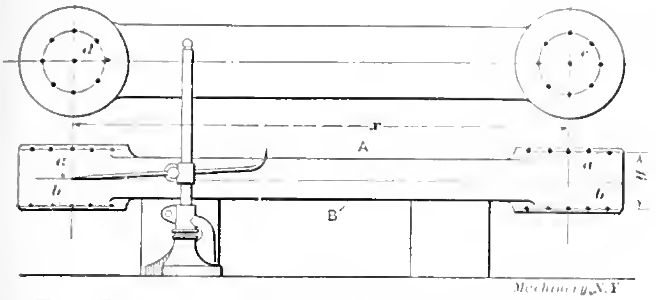


Fig. 1. Example of the kind of Work that is given a Preliminary and a Final Layout

With the exception of certain small parts, a surface plate or other flat surface, such as a planer platen, is almost indispensable for this operation. There are various styles and sizes of laying-out plates, the type depending largely upon the class of work for which it is intended. A table with a circular top which revolves on its base, is very convenient for general work of a light character, and by reason of the movement possible, all sides of the work being laid out may be easily turned toward the workman and also into the best position for light. Large rectangular plates are used in some shops for heavy work, which are sometimes bedded into a firm concrete foundation in order that the weight of the part being operated upon will not spring the surface of the plate. The advantage of placing work on a flat surface is that vertical dimensions, even when they are between points not in the same plane, may be easily laid off, and, in addition, both vertical and parallel lines may be drawn on any part of the work by the use of a square and surface gage. Among the more important tools for this class of work may be mentioned V-blocks, parallel pieces and height blocks of various sizes, surface gage, square, dividers, trammels, scriber, prick-punch and the hammer. As these tools are in common use in every shop, a description of them will not be given.

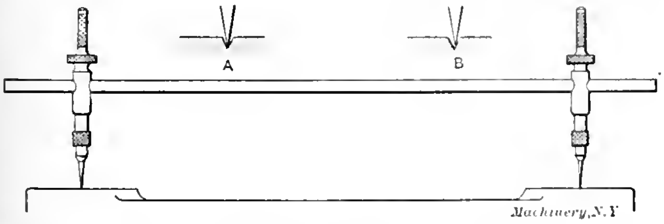
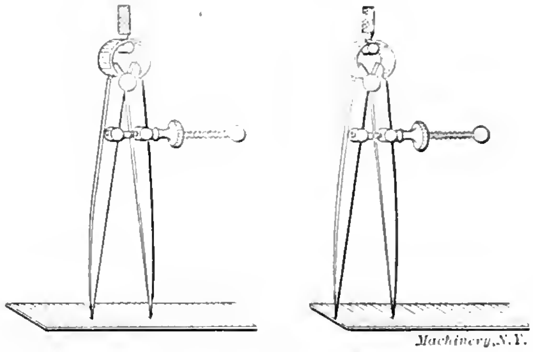


Fig. 2. Testing the Accuracy of the Distance between Centers with the Trammels

Some parts are laid out prior to any machining, but it is often advantageous to first finish some surface, so that lines may be accurately located in correct relation to one another, from this finished part. Upon some work it is not practicable to plane a surface without first laying out the work in a rough way, as it is necessary to secure average allowances in order that other surfaces may be properly trued. A finished surface facilitates lining out to such an extent, however, that this first or tentative lining is often advisable, so that some broad surface, as for example the base of a frame or bed, may first be planed. Furthermore, it is not practicable to lay out most work in one operation, as some of the lines can often be more conveniently and accurately located on previously finished surfaces and, besides, if every line finally required were laid out in the beginning some of these would be removed by the turning or planing tools. Therefore, the laying out of parts is often divided into a preliminary and a final operation.

A simple example of a preliminary and final layout, is shown in Fig. 1. First a center line is drawn central with the sides *A* and *B* and extended to the ends with the surface gage, as illustrated. The lines *a* and *b* are then drawn parallel to and central with this center line and a distance *y* apart equal to the dimension given on the drawing. The faces *a* and *b* are then ready to be machined, and after this operation the lines for the hole in each end of the link are laid out on the finished surface as shown in the plan view.

In order that the lines drawn upon metal surfaces may be plainly visible, some suitable preparation is applied to those surfaces upon which lines are to be drawn. Common chalk or a mixture of whiting and alcohol and water is often used on rough castings, while a solution of sulphate of copper ("blue stone") gives excellent results on finished surfaces. The thin film of copper which is deposited makes it possible to easily see fine lines, because of the difference of color between the copper and the metal beneath. When the latter method is employed it is essential that the surfaces be free from oil or grease. As the lines which are drawn are quite easily obliterated, especially when they are on a chalked surface, permanence is given them by marking their location with small punch marks, as shown in Fig. 1.



Figs. 3 and 4. Correct and Incorrect Methods of Setting Dividers by a Scale

When locating the centers of two circles a certain distance apart it is not advisable to lay off this distance from the edge of a scale, as this can be more easily and accurately done by the use of dividers or trammels. For instance, if the two centers *c* and *d* were to be located, one of them, say *c*, should first be marked lightly with a small center punch. The trammels should then be set to a distance *x* by placing their points directly against the divisions on a scale. Then with one trammel point in the center *c*, an arc could be scribed by the other point upon which center *d* would be located. The accuracy of the distance between two punch marks can be tested by placing the trammel points in them as shown in Fig. 2. If the bottom of each center coincides with each trammel point as shown enlarged at *A*, this will be evident by the "feel" of the trammel and also by the sound emitted as the point is made to strike the bottom. On the other hand, if the centers are, say, too close, one point will bear on the side as indicated at *B*, and the spring necessary to force it to the bottom can easily be felt.

When setting trammels or dividers, the end of the scale should not be used to set one of the points; that is, if a pair of dividers were to be set to say 1 inch, a more accurate setting would be obtained by placing one point in the 1-inch division and the other in the 2-inch division, as illustrated in Fig. 3, than by attempting to use the end of the scale, as shown in Fig. 4.

All parts to be laid out should first be inspected for blow holes or other defects that would render them useless, and

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* With Shop Operation Sheet Supplement.

when a casting is the first made from a new pattern, a rough measurement of some of the more important dimensions is advisable. Then in case a core has shifted or insufficient metal is left at some important point, the casting may be discarded before much time has been expended upon it.

Of course, it is impossible to lay down any fixed rule or give any exact method of procedure for laying out machine parts. We shall, however, in a continuation of this article, endeavor as far as possible in the limited space, to teach some of the underlying principles governing this work by giving a detailed description of the way in which one or two typical parts are laid out.

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MINIMIZING THE TIME OF DRILLING OPERATIONS—2

ALFRED SPANGENBERG[*]

In the previous installment the general requirements of drilling machines and the effect of high speed drills on reducing drilling cost are set forth. In the following the causes of lost time, the requirements of an efficient drilling department, the human element and the wage systems are treated, following which is a summary of the elements which enter into rapid drilling.

Causes of Lost Time

The causes of lost time in a drilling department are located so far back toward the fundamentals of production, and the individual units affording the causes are so seemingly unimportant, and such is the difficulty of recognizing these losses, buried as they are in a busy shop, that they are often overlooked or ignored. This is particularly the case in many large shops where the drilling is done in the various assembling departments. It is interesting to note that where this plan is followed, the drills in one department will be operating at such speeds and feeds as to show a loss of 25 per cent when compared with another department directly beside it but under another foreman; and, at that, both departments will be far below the standard of efficiency they should attain. This condition is due, of course, to the relative efficiency or inefficiency of the foremen. The foremen are not all to blame, however, as they seldom have the time to supervise this work and attend to the other important duties that usually require their attention. When the assembling department is sufficiently large to warrant it, the usual method is to appoint a drill boss who was formerly one of the drill hands, and his experience is limited to the routine practice of the shop. Another nullifying condition is that when the drilling machines are scattered, they cannot always be used to advantage. As an instance of this I recently noticed in one shop a large multiple-spindle drill that was standing idle because there was no work in the department where the machine was installed that could be handled to advantage on it. In the next department work was being drilled on a radial drill that could be handled 400 per cent faster on the multiple drill.

Piece No. Jig No.
Space No. No. of Loose Pieces
Machine
Used for
Drawing No.
Used on
Tools used

Fig. 2. Form of Jig Index Card

It may be objected that some of the holes in various machine elements cannot be drilled until part of the assembling operations are completed, and for this reason it is an advantage to have the drills in the assembling department. I contend, however, that with a proper system of laying out the work, or by the use of drill jigs, all holes that are drilled by a stationary machine can be drilled before any assembling operations are started. All other drilling will permit of being handled more economically by portable air or electric drills. This laying out never should be performed by the assemblers or the drill hands. The economy of having this work done by men set apart for that purpose is due to several reasons. Men become expert and quick at this kind of work; the drills are not idle while the drill hands stop the machine to do the laying out; besides, it can be done on a convenient plate with proper tools, to better advantage than otherwise. These men can also act as inspectors.

In brief, the worst "time wasters" may be classified as follows:

1. Waiting for a new job or because of lack of proper handling facilities. Result, the machine is idle.
2. Measuring up jig bushings to find out what tools are needed. Result, the machine is idle.
3. Getting tools, clamps, jigs, etc., from the tool supply room for a new job. Result, the machine is idle.
4. Excessive time in "setting up" a job, due to lack of suitable fixtures for holding the work, or lack of proper instructions as to the best method. Result, the machine is idle.

Add to these the tremendous loss through failure to use the very best speed and feed for the drills and the result is an output far below maximum efficiency. The important consideration is *time*. Time of the workmen running the drills continuously and efficiently—that is the vital point.

Having these usual defects in system and processes clearly in mind and logically grouped for study, we can easily see the advantages to be gained by having a separate department for the drilling, rigidly supervised by a competent foreman and assistants.

Requirements of an Efficient Drilling Department

The drilling department preferably should be located between the machine and the assembling departments for convenience in routing the work. A proper arrangement of the drilling machines will depend on the character of the work, type of drive, etc., so that no definite plan can be stated which would be generally applicable. It is the general practice to group the machines according to their size and type.

No mention has been made of boring machines for the reason that a proper discussion of them is not within the scope of this article. Before passing, however, it is well to state here that boring operations are so closely associated with those of drilling, that the boring machines are frequently placed in the drilling department. In fact, in many instances boring can profitably be performed on the less expensive drilling machines, especially when boring jigs are used.

The problem of running the drills at the proper speed and feed will be greatly simplified by providing each machine with brass speed and feed index plates. These furnish the drill hands with a standard guide and eliminate all guesswork. A judicious use of the data presented in Table II (July issue) will show surprising results.

The equipment for each drilling machine should consist of an abundance of bolts, straps, adjustable blocking, and other necessary fixtures for quickly "setting up" a job. Work chucks will enable the small work to be clamped very quickly. While this factor of "setting up" is far removed from the single problem of drilling, still it requires a most vital part of the time required to complete a job. The individual equipment should consist of the necessary sockets, bushings, tapping fixtures, wrenches and drifts. The machine number should be stamped on its equipment and a suitable cupboard provided in which to keep the outfit. Suitable work stands are needed for the smaller machines and these should be placed within easy reach of the workmen. For cleaning the chips out of deep holes, a small brass tube fitted with a valve and a dust shield and connected to the air line by a hose, is very useful to have by each machine.

The question of handling heavy work under a drilling machine often becomes quite a problem. For this class of work it will always pay to have good hoisting and handling facilities over each machine. These may take the form of compressed air hoists or an overhead single track carrying an electric hoist serving a number of machines—a very economical arrangement. Of course, where the size of work will war-

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rant it, an overhead electric traveling crane of the bridge type is to be preferred. For handling heavy work under a multiple spindle drill not provided with a work table on wheels, a specially designed jib crane is needed on account of not being able to reach the center of the table with an overhead crane. This arrangement will permit of handling a number of pieces by the jib crane after the work has been placed within its radius.

Drill and boring jigs will, of course, save the expense of having to lay out the work, but where these are not used it is necessary to provide suitable surface plates. Naturally, these will be located near the receiving point for the work so that the work will be laid out before it is sent to the drills. A surface plate with two surfaces, one at right angles to the other, is very convenient, and will enable center lines to be drawn from surfaces at right angles without having to move the work. It may be advantageous to have a style of plate that is not a permanent fixture in any one place, and hence can easily be moved from one part of the shop to another. Ample provision is needed for handling heavy work on these plates.

If the main tool supply room is not convenient to the drilling department, it will pay to institute a separate tool supply room in this department for the purpose of keeping all the tools, jigs, etc., used by the drill hands. A system should be established for taking care of the tools and jigs, keeping them in good condition, and checking up the workmen in regard to those tools in their possession. Some simple system of checking up the men when returning old or broken tools should be kept. This will enable the foreman to locate his careless workmen. The item of broken tools can become a very large one if the workmen find that little attention is paid to this matter.

It is the practice in some shops to supply and keep with each jig a separate outfit of tools. This is an excellent plan but one that cannot always be considered on account of the great expense involved. However, when the tools are in any sense special, such as boring-bars, cutters, special reamers or taps, they always should be kept with the jig to which they belong. A card index of the jigs will be found very convenient. The specimen card shown in Fig. 2 gives an idea of the data required. The cards are indexed according to the forging and pattern numbers. Jig numbers should appear on all detail drawings. The need for an automatic drill grinder already has been pointed out.

Finally, let me urge the necessity of bringing to each drill hand the work and tools for his next job, *before he is ready for it*, and this presupposes a method of removing the work and the tools when the job is completed. Thus will the workman's every duty be eliminated but that of running the drills continuously and efficiently.

The Human Element and Wage Systems

An article on the subject of "Minimizing the Cost of Drilling Operations" would not be complete unless mention were made of the human element and the effect of wage systems on the cost of production. Owing to the simple character of drilling operations and especially when drill jigs are used, it is the custom to have apprentice boys run the smaller machines and to employ drill hands who are handy men, to run the heavier machines. Any foreman who has "been through the mill" will at once recognize the difficulty of securing proper results from these "drill hands" who have been used to the gait of the average shop, especially if they have been accustomed to using the old carbon drills. I have found that the best results are obtained by securing "green men," who are intelligent and active, and train them properly for the work. In this connection the drilling tables and speed and feed index plates mentioned previously will be especially valuable.

The system of pay and character of the reward will depend upon the nature of the work and the method of pay already in use. The principle of extra bonus or the attainment of standard time can easily be applied to almost any system of pay. The determination of standard time should be made carefully, however. If the rates have to allow for the nullifying influences detailed under the subject of "Causes of Lost Time," the firm will be grossly deceived as to the proper output. A proper discussion of wage systems is too broad a subject to be fully outlined here; in fact, that has already been done by a number of able writers. Suffice it to say, however, that the workmen and the foremen should receive a very substantial increase in pay for accomplishing the very desirable results which can be secured.

Summary

Summarizing the elements that enter into the problem of rapid drilling we have:

1. The machine tools.

These must be of a type suitable for the work and must have ample driving power and possess sufficient rigidity; the best type of drive is with a direct-connected variable-speed motor located near the base; the bearings should be self-oiling, and ball thrust bearings should be provided for the spindle; provision should be made for using an abundant supply of lubricant on the drill when drilling steel; there should be a friction drive for rapid power traverse of head on multiple spindle machines and T-slots in the table of multiple spindle machines so as to permit clamping the work.

2. The cutting tools.

High-speed steel drills and cutters are necessary; these must be run so as to secure a maximum output with a minimum expense for grinding; cooling agents are necessary for steel; sockets for driving tools with broken or twisted tangs are valuable; safety tapping devices are needed; improvement in rose reamers to prolong life of reamer is desirable; drill jigs are an important factor in reducing drilling costs; the use of drill tables is recommended.

3. The drilling department.

There is an advantage in having a separate department; machines should be equipped with speed and feed plates; each machine should have its own equipment of fixtures; ample handling facilities are needed; suitable surface plates and men to lay out the work are necessary; it is essential to have a tool supply room in the drilling department and a system for keeping the tools and jigs and giving out the work is needed; the machines should be kept running continuously and efficiently.

4. The human element and the wage system.

The men properly trained are the most efficient; a system of pay is necessary that will reward the extra efforts of the workmen and the foremen.

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A formula for welding cast iron, developed by Messrs. A. Beltzer and C. Delcampe and published in the *Iron and Coal Trade Review*, calls for a flux consisting of 15 per cent lithium chloride, 20 per cent potassium fluoride and 60 per cent potassium chloride. The cast iron surfaces to be welded are preheated, and then covered with the flux powder and heated to the melting point. Additional material is supplied from a rod of cast iron which is also dipped in the flux and presented to the joint where it melts and flows in, filling up the space and making a sound weld. It is claimed that blow-holes in castings may be filled by the addition of cast iron in the above manner and that metal may be added to defective castings to build them up where defective. In short, this can be made a "putting on" process where required. The means for heating are not given, but probably any non-oxidizing flame capable of raising the temperature to the melting point of cast iron, *i. e.*, 2,200 degrees F., can be employed.

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It is expected that the Manhattan bridge over the East River connecting New York and Brooklyn will be ready for traffic about January 1, 1910. This bridge when completed will make the fourth great bridge spanning the East River and the third largest suspension bridge in the world. The contract for the tower on the Brooklyn side was made May, 1901, and the first caisson was put in place February 1, 1903. The first caisson for the New York tower was installed July, 1903, and the foundation was completed in March, 1904, following which the steel towers were soon erected. For further details, see the article on spinning the cables in the October, 1908, number of MACHINERY.

A TWENTY-FIVE DOLLAR TOOL-MAKING JOB

H. J. BACHMANN*

In order to convey somewhat of an accurate idea of the cost of toolmaking, I have here set down in detail the actual amount of money expended on an extension spindle for a drill press, and also the benefits derived from its use.

Having had an excellent demand for our exhaust fans in the smaller sizes ranging from 18 to 48 inches, we found it advisable to facilitate the manufacture of them as much as possible. After a suggested improvement was decided upon, the manager very thoroughly impressed upon the factory the fact that it was a bad time to spend much money, and that whatever was made must be very simple, etc., and the cost must be kept down to about 25 dollars. With this handicap, the fixture was designed with three objects in view, any one of which might ordinarily be considered of sufficient importance to justify the expense of construction. In the first place, it was desired to drill the set-screw holes in the hubs of large pulleys used on the fans, without drilling through the rim. We have a number of these pulleys on fans running at high speeds, in places where the belt must run noiselessly—something it will not do if there is a hole in the rim. Second, it was necessary to drill the holes *D*, Fig. 1, for the bearing adjusting screws in both the cast iron side frames. There are four of these screws on each fan, and, inasmuch as the screws, when adjusted, are held in position by lock-nuts, the former must be square to allow the nuts to set down flat. These holes had previously been drilled in the ordinary way with a long drill put through at a slight angle so that the shank of the drill would clear the edge of the frame as shown at *B*. While it is true that the inclination of the hole from the perpendicular position is very slight, it was found that the high speed of the fan and the consequent vibration would in a short time loosen the lock-nut unless it was properly seated. There was one other operation on these frames which gave us quite some trouble and that was the drilling of the holes *C* in the feet. On all sizes up to 3 feet, the drill press was large enough to allow the holes to be drilled in the direction *x*, but on the larger sizes we had to resort to the same makeshift of tilting the frame and using a long shank drill. With our extension spindle, however, we are now able to drill the foot holes, as shown by the arrow *y*, on all sizes of frames. Drilling in this direction also gives the additional advantage of being able to use a standard counterbore if the hole comes so close to the side of the frame that it is difficult to set down the fastening bolt.

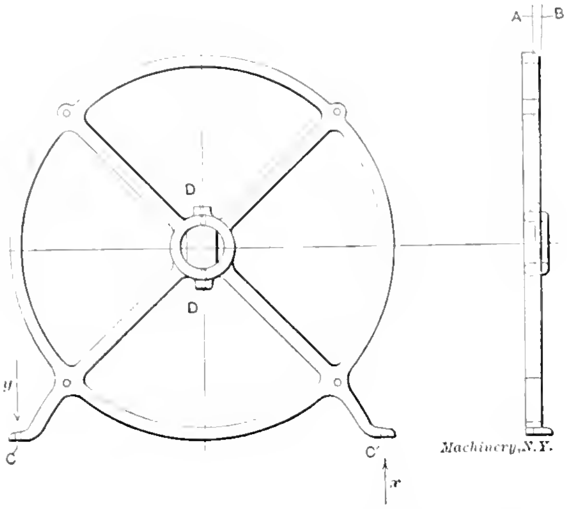

Fig. 1. The Exhaust Fan Frame, which is drilled as indicated by the Arrow y by the use of the Attachment shown in Figs 2 and 3

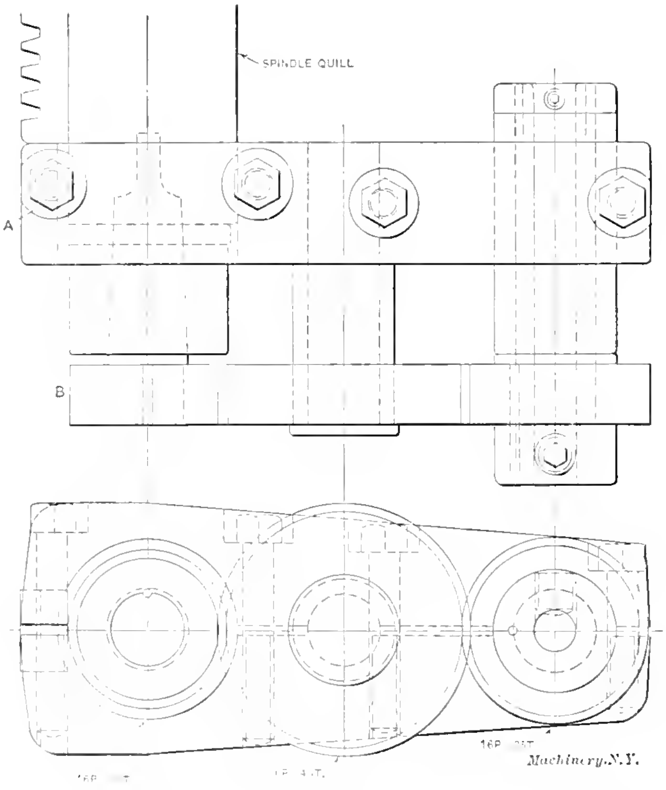

Fig. 2. Extension Spindle and Method of attaching it to the Drill Press

The illustration of the fixture, Fig. 2, will show how well we succeeded in "keeping down the cost." The extension arm was made of two pieces of 1½-inch square, cold-rolled steel clamped together with ⅜-inch cap-screws. A piece of ¼ x 1½-inch cold-rolled steel held between the two larger blocks made it a simple matter to lay out, indicate, bore and ream the three main holes in the arm. This method of making the arm was adopted in preference to using one piece of 1½ x 3-inch stock and splitting with a ⅛-inch saw after boring. By using 16-pitch gears, the center distances, being in sixteenths of an inch, were easily laid out with an ordinary rule and dividers. Finishing the two end holes first, facilitated clamping the work on the face-plate for boring the center hole because the bolts can be put right through the face-plate and the two end holes. The holes for the ⅜-inch cap-screws were counterbored with a ⅝-inch counterbore so as to make the heads come flush with the outside, thereby giving the fixture a very neat and tidy appearance. The heads of these screws fit a standard Williams drop-forged socket wrench, a much better arrangement, taken altogether, than fillister head screws and a screw driver. The outside of the two sections of the steel arm was finished off to the required shape as shown, not by planing or milling, but by standing it upright in the hack-saw vise and sawing a wedge-shaped piece from each side and grinding off the remaining metal on a disk grinder. The time for cutting off 5 inches of 1½-inch steel with the hack-saw running at 110 strokes per minute was

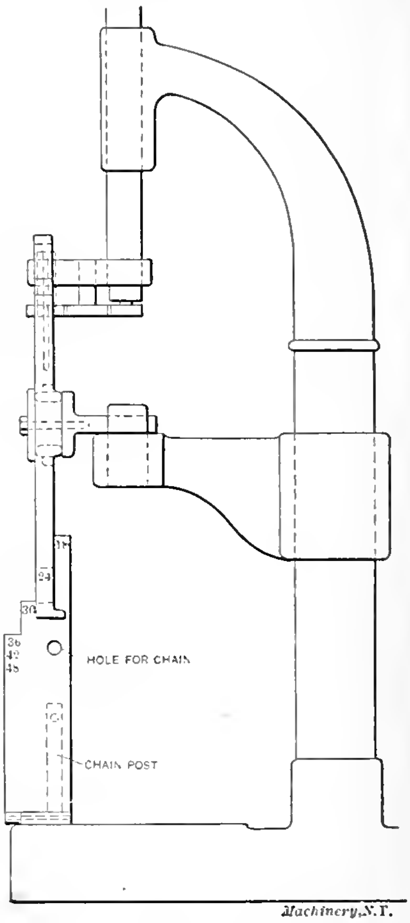

Fig. 3. Drill Prese equipped with Extension Spindle and other Auxiliary Attachments

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25 minutes, or the total time for finishing the outside to size was 1 hour 10 minutes. When all work on the arm was completed the clamping-cap-screws were taken out and the pieces of ⅛-inch packing strip removed. Three of these clamping screws project into the bored holes of the arm, and are used not only to clamp the entire apparatus together, but two of them also act as pins to hold the intermediate gear shaft and the bearing for the outer spindle in position. The other cap-screw behind the quill of the drill press spindle, bears against a flat on the quill, thus holding the extension spindle rigidly in its proper position directly in front of the main spindle. This flat was made on the quill by cutting 1 inch off the blank end of the feed-rack to accommodate the extension.

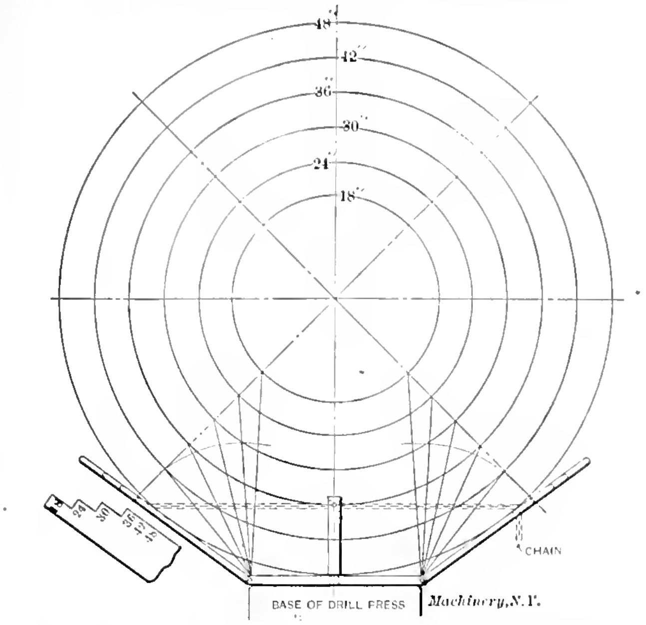

Fig. 4. Layout of a Large Adjustable V-block for Special Work

Not having any facilities for gear cutting it was necessary to buy stock gears. They were fastened to their respective shafts by means of ⅛-inch round pins driven in the ends. The driving gear is fitted to the live spindle with a taper plug in the usual way. The intermediate gear is bronze lined and runs on a shaft having a plain head for an end bearing. The extension spindle has its gear driven against a shoulder, and it runs in a bronze bearing clamped and held in place by the end cap-screw. It is fitted with a fiber washer to take the thrust and a threaded steel collar to take up the end play. A ½-inch reamed hole into which a ½-inch headless set-screw is tapped, serves to hold the drills, the small hexagon wrench furnished with these screws being just the proper thing to use as a key. The drills are the regular twist drills with ½-inch flatted shank, used extensively on blacksmiths' drill presses.

To use the fixture, the end cap-screw *A* is loosened, and the clamping arm is slipped over the driving gear *B* onto the quill, and is drawn into place by tightening the screw *A*. Fig. 3 shows the extension attached to a 20-inch Barnes drill, and also what might be called a few accessories. The fixture did its work so well, ordinarily, that we thought it would pay us to make a complete job of it by adding the two holding devices shown. It is hardly necessary to go into a detailed description of each of these devices, the lower one being simply a sort of a large adjustable V-block (the layout of which is shown in Fig. 4), while that part which is fitted to the table arm is an arrangement made of round cold rolled shafting and used to clamp the frame in an upright position while being drilled. The cost of these was not included with that of the extension spindle, of course.

The following table of the actual cost of the extension spindle alone is figured on the basis of adding 10 per cent of the entire cost to cover the fixed charges, and also on the assumption that none of the material used is kept in stock but must all be bought at retail.

COST OF EXTENSION SPINDLE

1 16-P., 30-T. cast iron gear	$ 0.85
1 16-P., 36-T. cast iron gear	0.90
1 16-P., 48-T. cast iron gear	0.95
11 pounds of square cold rolled steel	0.44
1 ⅜-inch cap screws	0.08
2¾ pounds of Tobin bronze	0.75
5½ pounds of round cold rolled steel	0.22
2 hollow set-screws	0.05
⅛-inch drill rod	0.05
Fiber washer	0.05
Cost of making drawing	5.00
Cost of machine work, 22 hours at 40 cents	8.80
Cost of hand work, 4 hours at 40 cents	1.60
Cost of power, 15 hours, 2 horse-power, at 20 cents	3.00
Total cost	$22.74
Add 10 per cent	2.27
Total cost	$25.01

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SPECIAL DRAWINGS FOR THE PATTERN-MAKER

E. W. MILLER*

It is the practice of many shops in this country to make a working drawing of a casting, which suffices for both the pattern-maker and the machinist. The pattern-maker gets a blue-print and is told to go ahead with the work. From the maze of lines he picks out those meant for him, and makes the pattern, and usually he decides the amount of stock necessary for finish. At the outset, the pattern-maker loses time in distinguishing pattern dimensions from those necessary to the lathe or drill press hand. The time lost here, however, is small compared to that lost by the men who work repeatedly on this piece, and who are compelled to use a drawing bearing a lot of pattern dimensions which cannot fail to confuse. Very often, too, these drawings are made at a reduced scale. This necessitates various radii to insure the correct form for curved surfaces. All this adds to the confusion.

At the works of the Fellows Gear Shaper Company special drawings are made for the pattern-maker. These are full size and the amount of finish is decided in the drafting room. No blue-print is furnished, but a buff paper drawing is made, and when the pattern is completed, the drawing is indexed and placed on file. This method has the following advantages: The full-size drawing gives the draftsman a better idea of proportions. By making the pattern drawing first and using this together with the assembly drawing when making details for the shop, the chance of error is much reduced. This is because a pattern drawing must be more thoroughly developed than a shop drawing. The making of several sections and an elevation or two not necessary to the machinist, often brings to light interferences which would otherwise escape notice.

It might be said that the other method of making combined drawings would accomplish this. It is, however, impracticable to make such pattern drawings as complete as they should be. The difficulties of the machinist increase as those of the pattern-maker diminish, so at best it is a compromise. It is the lot of the pattern-maker to form many irregular curves. When the drawing is full size, he may prick through the paper and define a line on a thin board which, when cut to the line, is a correct templet for the curve. This is easily done, requires little time, and is more accurate than a curve formed by laying out parts of circles from radii given.

* * *

More than 56,000,000 gallons of creosote and nearly 19,000,000 pounds of zinc chloride were used in preserving timber in the United States last year. Small quantities of crude oil, corrosive sublimate, and other chemicals were also used. These figures are based upon reports to the United States Forest Service of forty-four firms which operated sixty-four timber treating plants. Assuming that on an average one gallon of creosote, or one-third of a pound of zinc chloride, will protect a cubic foot of timber from decay, more than 100,000,000 cubic feet of cross-ties, piling, poles, mine, and other timbers were given a treatment that will greatly increase their life and usefulness.

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* Address: Fellows Gear Shaper Co., Springfield, Vt.

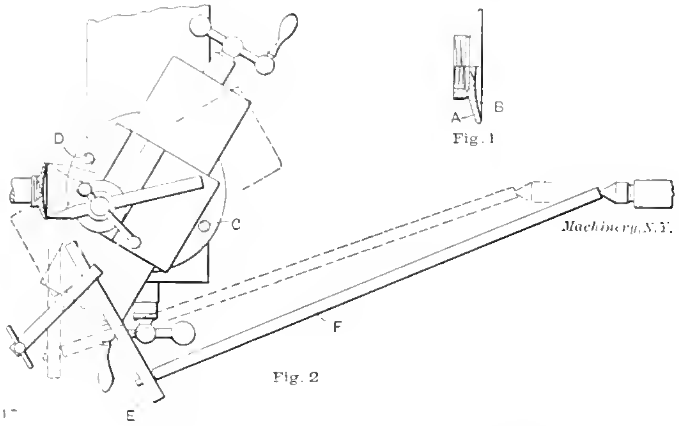
LETTERS UPON PRACTICAL SUBJECTS

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively

SPHERICAL TURNING WITH COMPOUND REST

The brass casting, Fig. 1, is part of an eyepiece for a small telescope, of which a number were to be made at one time. The curved surfaces, *A* and *B*, while not very particular as to shape and size, would look much better if smooth turned, so it was decided to turn these surfaces with a spherical turning rig and let them go with a good tool finish, rather than to turn them with a hand tool and polish with emery paper afterwards.

Fig. 2 shows how the concave spherical surface was turned. The cross-slide of the compound rest was so set that the swivel pin was directly under the line of centers of the lathe, and the rest was set at such a point on the bed that the distance, horizontally, between the swivel pin and the work, was equal to the desired radius of the surface *B*, Fig. 1. Then by slightly loosening the two screws, *C* and *D*, the top slide could be turned on the swivel pin, which would cause the point of the turning tool to travel in an arc of a circle. It was at first intended to simply grasp the top slide in the hands, and turn it that way, but it could not be moved steadily enough, as it would move by jumps, and leave ridges in the work. The square bar *E* was then clamped to the top slide, and the round bar *F* placed between the outer end of *E* and the tailstock center. Then, by turning the tailstock screw, a smooth, even motion could be given to make the point of the cutting tool travel in the arc of a circle, and produce a good finish on the work. The bar *F* has a shoulder turned on one end that fits loosely in a hole in the outer end of *E*, while the other end of *F* is centered in the ordinary manner. This leaves the top slide of the rest free to be used to feed in for the depth of cut.



Figs. 1 and 2. Eyepiece for Telescope, and Lathe arranged to turn its Spherical Surfaces

It is a comparatively easy matter to adjust the cross-slide so that the swivel pin is in line with the lathe centers. If it is too far forward, the tool will not touch the finished surface when moved around towards the back, as shown dotted in Fig. 2, or if the swivel pin is too far back, the tool will jam into the work when moved to the dotted position. A good way to make this adjustment, is to set the swivel pin at approximately its proper position, preferably a little too far back, and take a light spherical cut near the edge of the rim. Then by placing a test indicator in the tool-post, and swiveling the top slide so the test indicator point bears alternately at the front and back, the cross-slide can be adjusted so the test indicator reads the same in both its front and back positions, when the swivel pin will be properly located, crosswise of the lathe, to turn an accurate spherical surface.

The convex spherical surface *A*, Fig. 1, was turned in much the same manner, only a bent left-hand side tool was used, and the top slide of the rest was nearer to the end of its travel. In this case the bar *E* was not necessary, as *F* could then bear directly against the back end of the lathe tool.

As a matter of fact, two clamps were used to clamp *E* to the top slide, but only one is shown to avoid confusion, and also to make it a little easier for the draftsman and the engraver.

WALTER GRIBBEN.

Brooklyn, N. Y.

STRIPPING CUP-SHAPED DRAWN PIECES AND BLANKS THAT ADHERE TO PUNCHES

Die work, as all enterprising mechanics are aware, is to-day playing one of the chief parts in the manufacturing business, and with all its broad possibilities we are continually striving to perfect the most minute, troublesome details to the fool-proof and break-proof basis, thereby bringing out the speed and output, for, as we all realize, every time a stroke of the press is halted there is time and output lost.

In the first place, it goes without saying that in the drawing of all punch pieces there must necessarily be a die-shedder to throw the drafted punchings out of the die, but this is by no means the complete solution of the proposition. Every diemaker or press hand is acquainted with the troublesome, disastrous effect of having the drawn and punched pieces cling long enough to the shedder for the press to come down on a new piece of stock and the punching just made. The outcome is generally a broken die. Of course many thousand may be drawn without any mishap, especially if none or little oil is used on the stock, but without oil the life of the drawing die is soon spent, or in the event of copper or brass being used, the metal amalgamates and necessitates taking down the die to remove the amalgamated stock. In our particular case nothing short of diamond powder would remove the stock from the die and, of course, the cost of this powder all added up in the expense account. When we undertook to put enough oil on the stock to keep the dies in condition, the cups or punchings would invariably adhere to the pushout shedder from oil contact; therefore, we were compelled to punch one at a time, pushing them loose from the shedder each time. After considerable figuring and experimenting, I arrived at a complete solution which has saved us many dollars in die repairs.

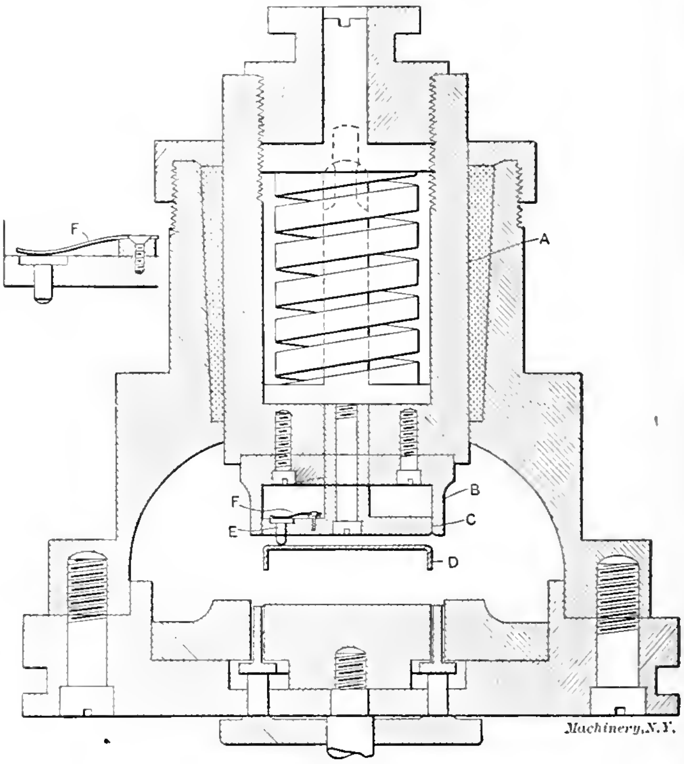


Fig. 1. Sub-press Die equipped with a Secondary Knock-off Pin E

The cast iron piston of a sub-press die is represented by *A* (Fig. 1), while *B* is the hardened drawing die, and *C* the internal die-shedder for pushing the drawn pieces from the die.

Now, as mentioned before, the cup D would cling by oil contact to the shedder C, but by means of the secondary knock-off pin E, with a flat spring F to operate it (see enlarged view), as soon as the cup is pushed from the drawing die the pin E has the tension supplied to it by the spring to break any oil contact that may exist, thereby causing the cup to drop immediately down into the punched hole in the running stock, to be drawn forward out of the way of the succeeding punching. By recessing a spring receptacle, the spring F and pin E consumed no additional space between the die and shedder. This scheme which has just been brought about by me and is truly original as far as we know, has enabled us to increase our speed from 1,500 to 4,500 an hour. The particular punchings in question are of brass and are $1\frac{3}{4}$ inch diameter, $\frac{3}{8}$ inch high, and 0.02 inch thick. We are now running from 25,000 to 35,000 without even touching the dies for repair.

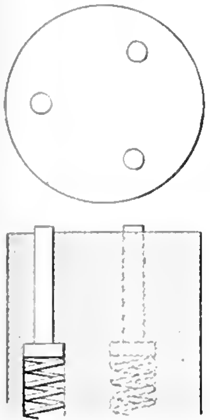


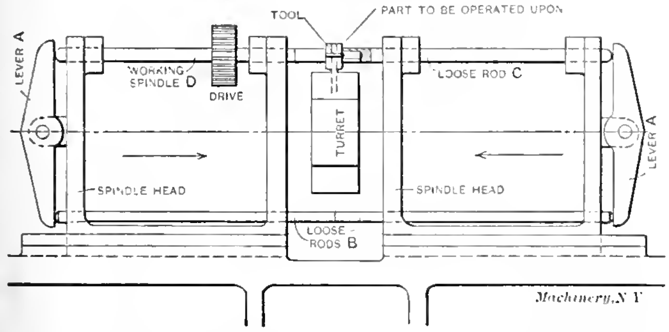
Fig. 2. Punch with Spring-actuated Push-pins to shed Blanks

This scheme has been applied to many flat compound punchings of copper when the center punching has a strong tendency to draw up and stick on the center punch. One instance is that of a copper washer 0.015 inch thick, 1 inch diameter, with $\frac{1}{2}$ inch hole. When blanking sheet copper the die does not seem to be able to shed the punching which invariably comes up after being punched; this, of course, puts two thicknesses of metal between the dies for the succeeding punching, then, by running both punchings, three deflecting pins in the punch with coil springs back of them, as shown in Fig. 2, end the trouble. C. HOWELL DICKSON.

Springfield, Ill.

PRESSURE COMPENSATING DEVICE FOR AUTOMATIC MACHINE

When a fixture cannot be built strong enough to resist the pressure of the cutting tool, or when the surface of the part to be operated upon cannot be properly supported, the compensating device, shown diagrammatically in the engraving, may be used to advantage for equalizing the pressure on the part, due to the thrust of the cut. This illustration represents an unusual arrangement of an automatic turret machine. At either end there are levers A, fulcrumed in the center as shown, which can be put into any position. The levers A are so arranged that they are in line with the work-spindle D, the rod C, and the two lower rods B. As the spindle heads move toward the work, there is no appreciable pressure upon the latter when the spindle D or the rod C comes into contact with it, until rods B meet as shown in the illustration. Then the work is subjected to the pressure of the tool, but the former is supported on the other side by rod C with the same amount of pressure as that due to the thrust of the cut. There are doubtless a large number of cases in which this system of equalizing levers can be used to advantage, particularly when the same part is being manufactured in large quantities, such as small rods, links of threshing machines, small parts of sewing machines, etc. Of course, these parts would first be roughed off on the sides by planing or milling. All other operations such as drilling, finish facing, counterboring, counter-sinking and reaming can be accomplished by using the device here illustrated. Other parts such as fly wheels, valve seats, etc., which cannot be securely fastened by their peripheries, can also be drilled, chamfered, reamed, counterbored and even ground and polished by the use of the equalizing levers.



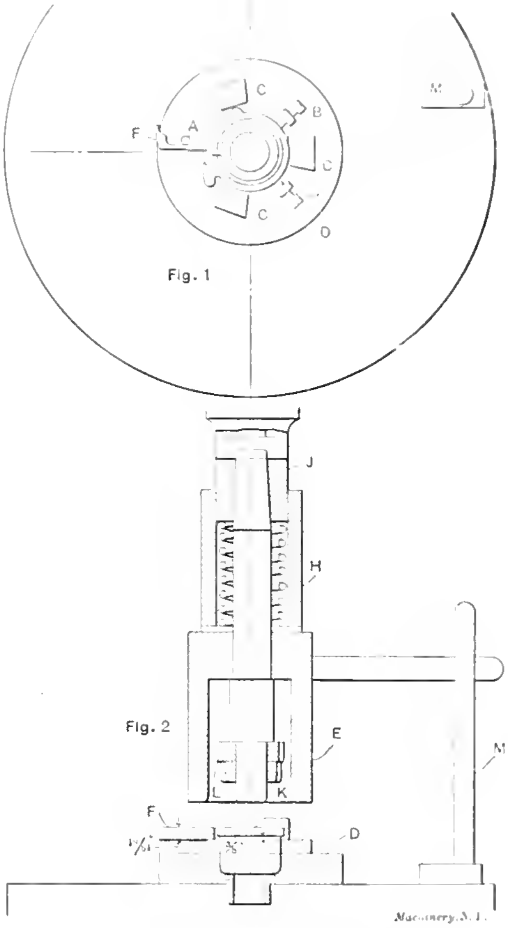
A Device for Automatic Machines, designed to equalize the Pressure, due to the Thrust of the Cut, upon Work which cannot be properly supported

Elizabeth, N. J. PETER ZELINSKI

COMBINATION LOCATING, CLAMPING, DRILLING AND COUNTERBORING TOOL

I have noticed in my travels among the manufacturing plants that many are wasting time by using poor jigs and fixtures. Some will acknowledge that they use poor tools, and the excuse offered is that there is not enough time lost to pay for better ones, but this is rather a poor argument.

The plan view of the drilling fixture shown in Fig. 1 is one that I saw on one of my recent visits to New York City, and this fixture is a fair illustration of the point in mind. The locating of the work was accomplished by the two screws B and the pin A, and the three clamps on pads C held it in place.



A Tool for the Drill Press which locates the Work and then holds it for the Drilling and Boring Operations

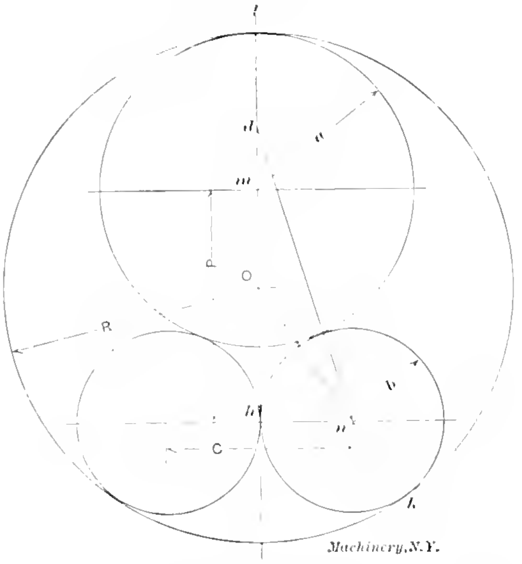
With this fixture the operator machined about 300 finished castings per day. With the improved tool shown in Fig. 2, some 1,000 finished castings constituted a day's work—a gain that well paid for the building of the improved device. This is a combination tool for locating, clamping, drilling and counterboring the work. In constructing this tool the old fixture minus the clamps was retained. This part is located in a central position on the top of the drilling press table, and the three locating points B are used to center the casting with the sleeve E that surrounds the counterbore, which is held in the spindle by its taper shank. This cylindrical bushing E is bored a little smaller in diameter than the outside of the casting F, and the mouth of the bore is flared out in a bell-shape as shown. The lower face of the sleeve is cut away in places in order to clear the projections on the casting to be machined. The top part of the sleeve is bored to a running fit for the shank of the counterbore in order to bring it into alignment with the cutters. A machine steel pin prevents the bush-

ing from revolving out of position. Within the tube *H*, which is a sliding fit on the spindle *J*, there is a steel wire spring which keeps the bushing *E* against the shoulder on the end of the counterbore. This spring also holds the casting down in the jig when the cutters are at work. On the end of the counterbore there is a pilot which enters the bushing which is placed in the center of the fixture *D*, just before drilling takes place, and keeps the counterbore rigid. The casting *F* is drilled and counterbored in one operation by two cutters *K* and *L*. Cutter *K*, which bores the through hole, has a rounded end, while the cutter *L*, which does the counterboring, has a square end. When using this tool, the drill-spindle handwheel is equipped with a long lever, which enables the operator to move the tool rapidly to and from the work. In the face of the drill press table a vertical stud *M* is placed, which acts as a stop and prevents the locating and clamping bushing from moving past its correct position. F. W. HALL.

Berlin, N. J.

DETERMINING THE DIAMETER OF A CIRCUMSCRIBED CIRCLE

On the "How and Why" page of the May number of MACHINERY, the problem given by "J. F. P." of finding the radius *R* (see diagram) when distances *P* and *C* are given, has a different solution from the one that I recently worked out for a similar problem, which is as follows: First find the radius *a* by the method given in the solution referred to; as there stated $a = mn - b$, but $mn = \sqrt{mh^2 + hn^2} = \sqrt{P^2 + (\frac{1}{2}C)^2}$.



The Problem is to determine the Radius R when the Dimensions P and C are given

Next, lay out a distance *ld* equal to the radius *b*. Then *dh* equals $mh + md$ or $P + md$. (md equals the difference between *lm* and *b*.) Tangent angle *hdn* equals $\frac{hn}{dh}$. Angle *hOn* equals 2 × angle *hdn*. *On* equals cosecant angle *hOn* × *hn*. Then *R* equals $On + nk$.

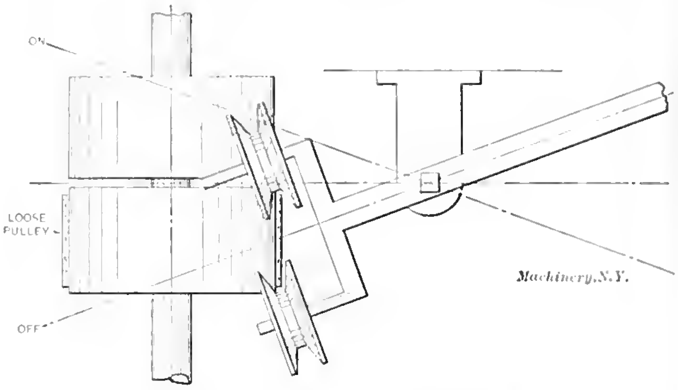
This solution, dealing with trigonometry, may not be as readily understood by some as the one given in the May number, but to one working with angles every day it is much simpler than the one using the algebraic equation.

Ilion, N. Y. A. C. JOHNSON.

IMPROVED FORM OF BELT SHIFTER

A 4-inch crossed belt driving one of our grinders annoyed us by turning over when shifted, and remaining so until, after half a dozen twists were in, it had to be run off the pulleys and straightened. In its twisted condition, the belt was more or less unevenly strained, and when the joint passed through the fork additional chafing was produced that not infrequently pulled out the hooks and disconnected the belt. The grinder was of the type built with the counter-shaft on the base at the rear and served by a shipper-lever that reached forward to a position convenient to the foot. An ordinary iron fork straddled the belt, and, as the machine was started many times an hour by the "approved" method of starting, which was to give the lever a vigorous kick, the time spent in keeping the belt in shape can be surmised.

To "cut out" all this waste time, a new fork was made having turned ends on which were mounted deeply grooved guide rollers between which the belt ran. Thus protected, no amount of kicking at the lever could twist the belt which, being in contact with rolling surfaces only, was not abraded. It will be noticed from the engraving that the rollers never lie in the same plane except when the belt is half on each pulley; they are confined on the forks only by the belt with which they are free to move endways, stop collars not being necessary. These rollers are made of maple, treated to two coats of filler, it being considered better to replace a pair of such inexpensive rollers once a year than to use metal ones which would demand careful lubrication.

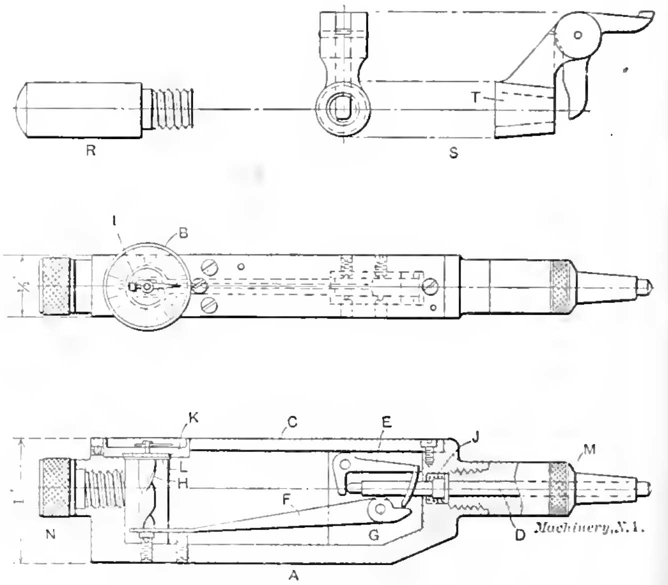


Belt Shifter which will not turn the Belt when operated quickly

Middletown, N. Y. DONALD A. HAMPSON.

COMPACT FORM OF DIAL INDICATOR

A compact form of dial indicator for use on external and internal work is shown in the accompanying engraving. The working principle of this tool, which was also illustrated in the April number of MACHINERY, is as follows: The rod *D*, which is in contact with the work being tested, when forced back strikes the lower arm of lever *E*, while at the same time the upper arm of this lever, in which there is an elongated slot through which rod *D* passes, strikes the fork lever *F*, which causes it to swing on the fulcrum pin *G*. On the long end of this lever there is likewise an elongated slot, that is an exact sliding fit on the flat of the spiral leadscrew *H*. This screw is supported at the upper and lower ends similarly to the pinion shaft of a watch, and rotates on its centers freely without any perceptible jar or friction. As the slotted end of the fork lever *F* is raised it engages with the spiral or thread of the screw *H* and causes it to revolve. At the top of screw *H* is fastened pointer *I* which gives the reading.



Section and Plan showing the Construction of a Dial Indicator

To bring the levers, screw and rod *D* back to their original position, there is a fine wire spring *J* in the head of body *A* that rests against the shoulder on rod *D*, and there is also a watch hair spring *K*, one end of which is fastened to spiral screw *H* and the other end to the dial *B*. Underneath this spring there is a copper washer *L*, which prevents lever *F* from striking the spring. Both of these springs should be so adjusted as to bring back their respective parts to the normal position without any further unnecessary tension, because if these springs are made heavy and a high tension put on them, it will be found that the bearings, etc., of the different levers will soon wear, and therefore the accuracy of the indicator will be lost.

The body *A*, dial *B* and cover *C* may be made of some good grade of cold drawn steel, and all other parts of a high grade tool steel, and hardened. When filing the end of lever *F*, extreme care should be taken in forming it to the proper curve, to compensate for the loss and increased movement at the point where lever *E* bears against it. It is very important that all levers have a free oscillating movement, that all pinion screws are carefully adjusted and that they are a snug fit in their respective tapped holes.

The part *R* is a tail piece or an extra attachment to go with the indicator; this is used to take the place of part *N* when it is found necessary, for instance, to use the indicator in the lathe, in which case it can readily be caught in a boring tool holder. The part *S* is also an extra attachment, and it can be readily attached to the taper end of nose piece *M*. This attachment is used when it is desired to use the indicator to obtain inside measurements. The taper hole *T* should correspond with taper on the nose piece *M*, which is about 1½-inch taper per foot. The lever should work freely without any perceptible vibration, and should be hardened.

Buffalo, N. Y. Lucien Haas.

AIR BLAST ON THE PUNCH PRESS

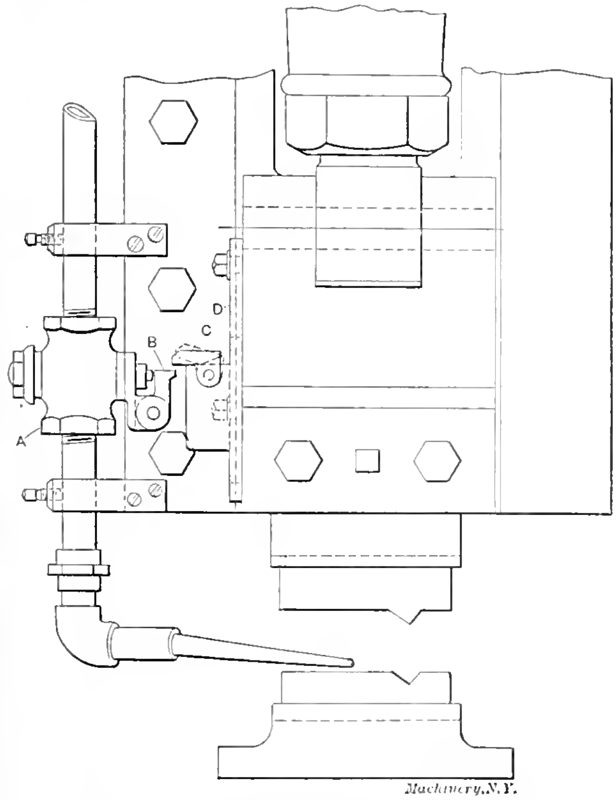
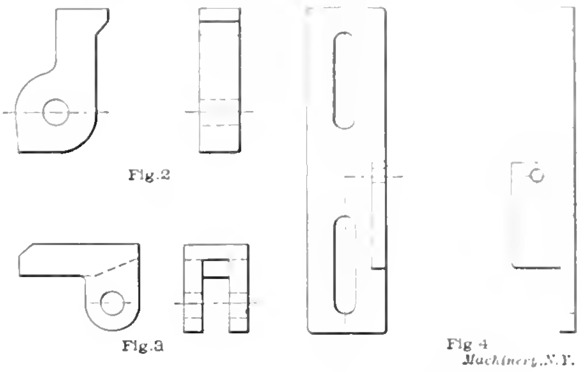


Fig. 1. Pneumatic Punch Press Attachment which automatically removes the Work

An arrangement for blowing work from a forming die in a punch press, by means of compressed air, is shown in Fig. 1. It is simple and durable, and is used on about forty presses in a large plant, with satisfactory results. The engraving shows a plain forming die in position under the plunger of a press, while at the left of the plunger is the air valve *A* with its attachments. This valve is a Lunkenheimer whistle valve. It is held by the pipes which are screwed into each end, these pipes being held by the brackets which are screwed to the frame of the press. Below the valve there is a union and some other connections, and a bent tube which may be turned so as to apply the jet of air most advantageously. In some cases two unions are used to facilitate the adjustments. The lever of the whistle valve has been removed and in its place the trigger *B*, which is shown in detail in Fig. 2, is mounted. This trigger is so designed that it remains vertical when not in action; it is seen in position against the plunger of the valve. The trigger is operated by the pawl *C*, shown in detail in Fig. 3, which is mounted on the bracket *D* shown in Fig. 4. The bracket is made of angle iron and is provided with two long slots for adjustment when the dies vary in thickness. It is held by two screws which are tapped into the plunger.



Figs. 2 to 4. Some of the Details of the Attachment

As the plunger descends, the end of the pawl *C* rises, as shown by the dotted outline, and passes below the head of the trigger *B*. On the upward stroke the end of the pawl engages the cam on the end of the trigger and thus operates the valve. In this way a jet under full pressure is suddenly directed against the work, blowing it out of the operator's way before the plunger reaches its highest position. When we realize that more time is usually consumed in removing the pieces by hand, than in placing them in position, the saving of time is appreciated.

The same device may be used to advantage for removing dry chips from a vise on a milling machine when doing light work. Often the operator wastes more time in brushing away chips than in doing the actual work. The valve may be clamped to the column of the machine and operated by a slight extra movement of the table. The writer has also adapted the scheme with success to a drill press used to drill wood, on which the table moves.

Camden, N. J. Herbert C. Barnes.

WHAT WOULD JIM HAVE SAID?

The answer given "F. O.," who asked for a general rule for locating a driving and driven pulley on shafts not parallel, in the May number of Machinery, brought before my mind an incident that occurred when Jim and I were employed in a small shop a few years ago. We had a superintendent whose load of wisdom was manifestly all he ought to carry, and no one who knew him would willingly attempt to add to his burden in that line. It was desired to move a machine around at an angle to the main shaft, so the "super" squinted around a little and told Jim to stand the counter on some marks on the floor which he had made. The belt ran off as fast as they tried to put it on, and after that the "super" kept Jim pinching that heavy counter-shaft around the floor for two days trying to find the place where it could be located and have the belt run on the pulleys. Meanwhile the rest of us, who worked by the piece, were waiting for the stock to be put through that machine. Now the "super" (who had brought up one family) had just taken unto himself a new wife and she used to send for him to come home and see her once or twice every day. It was one of these absences that gave us a chance to use the rule given us by an old millwright for belting a machine that was placed at an angle with the line shaft. So when the word went around that the "super" had had a "summons," we went out to see if we could not get that machine to run without his knowing how we did it. Jim's disgust was apparent on his face and more so in his remarks, but he was good for one more try.

and when we said, "Plumb the centers of the delivering faces," Jim understood, and we stayed with him and helped lace the belt so that the "super" would think it just happened to come right.

The answer given "F. O." made me wonder what Jim would have said if someone could have handed him that rule. I imagine he might have read as far as the word tangent and then said, "Tangent to your grandmother," or something more forcible, and then gone on pinching that counter-shaft around to the next trial location. The rule referred to is complete and not very obscure, but I will venture to assert that not one in ten of the better class of men in the shops will understand it without some help. I suppose there are a great many homely rules, which were used before the present generation of mechanics came on the stage, that are just as easily understood as the one given in the foregoing, and if they could be rounded up and written down, would help some one over a hard spot. Who has another? C. A. H.

SOME MILLING MACHINE DETAILS

Times were bad—nothing doing—and our equipment of milling machines was nearly as bad as the times, so we decided to build a couple of millers for our own use. Drawings and patterns were made, and the machines pushed on as rapidly as possible. The drive, as originally designed, was by a three-speed cone, back gears, and a two-speed counter giving twelve speeds to the spindles. After careful consideration and a little figuring, we decided to alter the drive to double back gears. Unfortunately, before we arrived at this decision the body castings had been made so that we had to be content with a two-speed cone in place of the three-speed one, but as this (with the double back gear and two-speed counter) also gave us twelve spindle speeds, we were quite satisfied, though we had to do a moderate amount of extra chipping, facing, etc., to get the new arrangement into the place designed for the old one.

One of my reasons for writing this is to show what a great advantage double back gears have over the ordinary single back gear. Perhaps some readers who are concerned with millers or other cone and single back gear machines will be tempted to alter their drives to the double back gear type—at any rate I should certainly advise them so to do—for in my opinion double back gears are only slightly removed from the constant speed or gear box drives now coming into use and are not by any means so expensive.

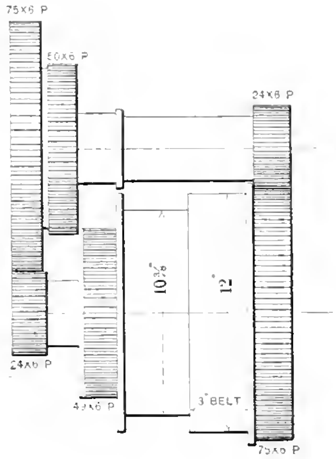
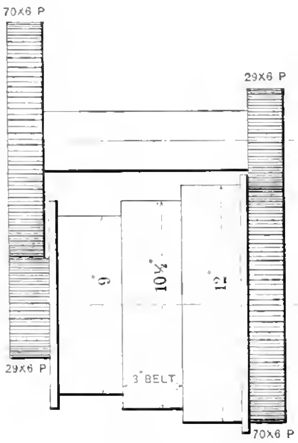


Fig. 1

Fig. 1 Double Back Gear



Machinery, N.Y.

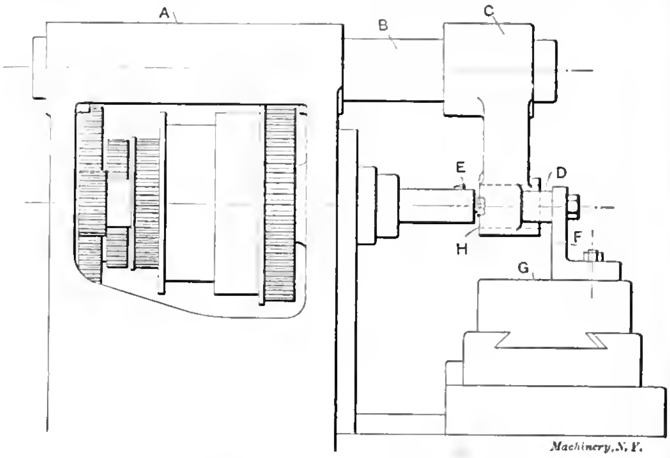
Fig. 2

Fig. 2. Single Back Gear

Fig. 1 shows diagrammatically the two-speed cone and double back gears, and Fig. 2 the three-speed cone and single back gears which were discarded. There are two methods by which we may compare the power of the two arrangements: First by finding the average horse-power transmittable by the cone belt, and second by comparing the average belt and gear purchase. As the first is the shorter method we will apply it here. In any cone drive the horse-power transmitted by the belt varies through more or less wide limits, because as the speeds are varied the belt is working on a larger or smaller step of the counter cone, with the result that the horse-power varies as the diameters of the cone speeds and also (in the case of a two-speed counter) as the counter speeds vary. If, then, we find the horse-power for each belt speed and divide the sums of these quantities by the number of belt speeds, we shall have the average horse-power. The formula for obtaining the horse-power transmitted by a belt is $H. P. = \frac{D \times \pi \times W \times S \times 40}{33,000}$, where D = diameter of pulley in feet, $\pi = 3.1416$, W = width of belt in inches, S = revolutions per minute of pulley, 40 = pull of belt in pounds per inch of width.

It was found that the average power transmitted by the double back gear drive was 30 per cent more than for the single gears. By comparing the two by the second method, that is, by the average belt and gear purchase, the double back gears make a still better showing.

The formula for this method is $D \times R \times W$, where D = diameter of cone step, R = ratio of gears, W = width of belt. Since in this case W is the same for both examples, it may be left out and $D \times R$ used as the formula. If this is worked out for each spindle speed and the average taken as before, we find that the double gear arrangement is more powerful by 40 per cent.



Machinery, N.Y.

Fig. 3. Method of Boring Overhanging Arm

Another valuable feature of double back gears is the comparatively high spindle speeds obtainable through the gearing; this is a very important item in these days of heavy cutting at high speed.

With each machine there is a blue-print table, which gives the spindle speeds, how each speed is obtained, feeds and how obtained, suitable sizes of cutters for each spindle speed at various cutting speeds, and feed per minute for each speed at any one of the fifteen feeds. By this means the operator knows exactly what he is doing; or, what is perhaps even more important, how to get what he wishes to get without any reference to a stop-watch, cut meter or other similar instrument.

I might say in concluding this rather long eulogy of double back gears that we have taken a cut ⅜ inch deep off a piece of cast iron 3½ inches wide at a cutting speed of 50 feet and a feed of 3 inches per minute. The cutter was 8 inches in diameter and was screwed onto the spindle nose, which had eighteen inserted high speed steel cutters.

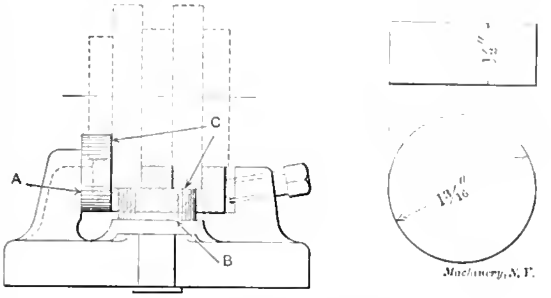
One little detail of construction may prove of interest and that is the method we adopted of boring the arbor bearing in the outer support. This had been previously bored in the lathe, but when we tested it we found that the bearing was considerably out of line with the spindle, so, to insure an accurate job, we rebored it by the method shown in Fig. 3. The outer support C was firmly clamped to the overhanging arm B and the latter was adjusted to its bearing A (by means of the clamp bolts), so that it was a close sliding fit.

The angle plate F was bolted to the table G and also to the brace lug D, care being taken to have the bearing H as nearly in line with the spindle as its inaccuracy would permit. A boring tool E mounted in the taper hole of the spindle completed the outfit, the bearing H being trued up with one roughing and one finishing cut with the regular automatic cross feed for feeding. This made a very good job and one that couldn't

be anything else but accurate. Another method of overcoming error in the bearing of the outer support is to make the bush which fits the hole *H* slightly eccentric so that it may be adjusted to the proper center; but our method is thought to be much better as the bush is then a plain straightforward job easy to replace when worn. RACQUET.

LOCATING TOOLS AND CUTTERS IN PLANING AND MILLING FIXTURES

As one who has had considerable experience with fixtures for planing and milling, I would like to condemn the common practice of providing fixed locating faces, to which tools and cutters should be set directly when machining the pieces held in the fixtures. My experience has shown that sooner or later these locating faces become damaged by contact with the tools, through carelessness or otherwise. A much better practice is to provide locating faces set back from the line of the tool point or face by a certain amount, say ½ inch, so that a standard height block can be inserted between this locating face and the tool. The block is held by hand when setting the tool or fixture until it just touches both the locating face and the tool. By this means a very sensitive adjustment can be made and the locating faces preserved. One of the height blocks, and also its method of application, is shown in the accompanying engraving, in which *A* and *B* represent two locating faces, and *C* the ½-inch blocks locating a milling cutter sideways and for height. HEIGHT BLOCK.



Method of Locating Cutters in Correct Relation to Finished Surfaces on a Fixture

TWO BENDING DEVICES

In the manufacture of gasoline lamps on a small scale, a jobbing shop uses two bending jigs that may be of interest. The upper part of the framework of the lamp is made of rather heavy brass tubing about a quarter of an inch outside diameter, bent as shown in Fig. 1. This tubing is bent with the tool shown at the left in the engraving. When in use it is screwed flat on the bench, near one corner, where the handles may be easily worked. The levers *A* and *B* and the attached roller are slipped off the pivot pin and a piece of tube of the proper length is passed between the roller on lever *C* and the first former, through the hole in the post *D* and against the stop shown. The lever *C* is then pulled around, bending the tube over onto the second former. The levers *A* and *B* are then slipped on and the final bend is finished. The two levers *A* and *B* are used for adjusting purposes. The tubing is heavy enough to bend nicely without filling, the rollers being of course, grooved the size of the tubing.

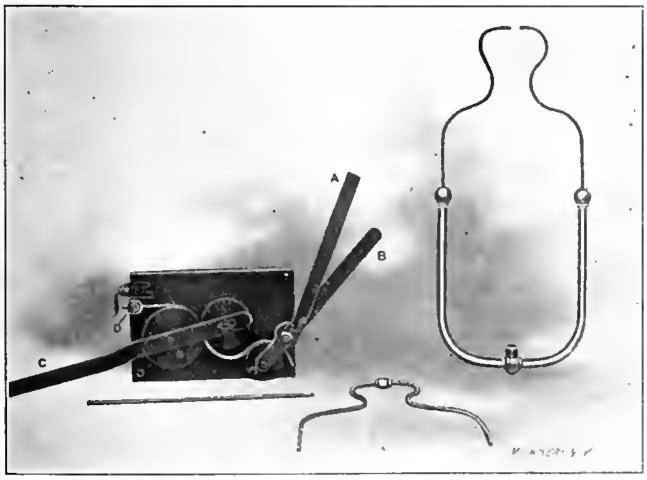


Fig. 1. Tool of Simple Construction for Bending Brass Tubing

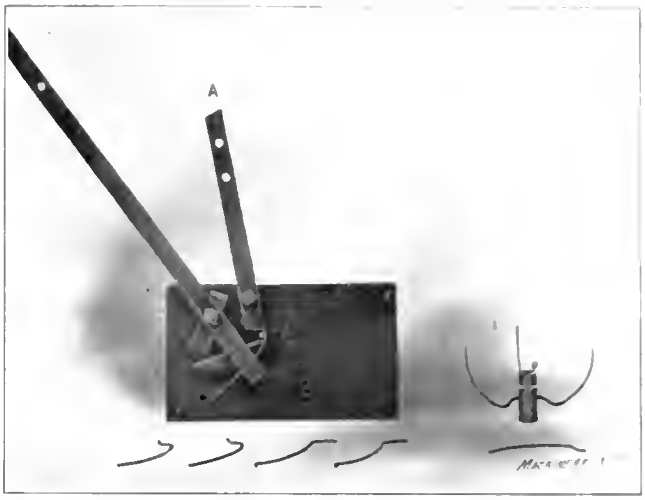
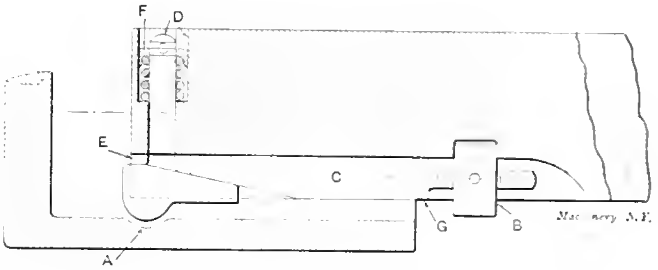


Fig. 2 Device for Bending the Wires shown in the Illustration

Fig. 2 shows the tool for bending the wires used to hold the glass globes in place. In order to get the little kink in the end of the wire, a hole is drilled in the end of lever *A*, into which the end of the wire is slipped while the end of the other lever is up as far as possible. Lever *A* is then pulled up against the stop-pin and held there while the bend is finished with the other lever. E. V.

ADJUSTABLE BORING TOOL FOR TURRET LATHE

To effectively accomplish all the work of the turret lathe with the general line of tools with which a machine is equipped is impossible; some form of boring-tool which can be adjusted without altering the position of the turret head will often be of value. There are many types of this class of tool, some of which are altogether too flimsy to be used when heavy cuts are necessary. The tool illustrated herewith is stiff and rigid, and, consequently, it can be used on heavy cuts. The illustration shows a part section of a casting, the bore of which was first machined with the bars in the turret. The special adjustable boring-tool is used to form the recess shown at *A*. The tool is adjusted to the proper position in the bore as shown, and then it is fed into the metal by turning the feed-nut *B* which forces the wedge-shaped feed bar *C* under it, thus giving steady feed.



Recessing Tool which may be fed into the Work without Changing the Position of the Turret

When making a bar of this type care should be exercised when fitting the cutting tool, as it should be a close sliding fit in the hole *D*, and, at the same time, have a good bearing on the sides of the slot *E*. The spring shown should be strong enough to keep the tool rigidly on its seat. The cap *F* retains the spring and prevents any dust or borings from getting to the spring and tool-shank. The cutting tool is made of high-speed steel, and the feed bar *C* of mild steel with taper end case-hardened. That part of the tool-shank which passes through feed bar *C* is flattened in order to reduce the width of the slot in *C*. A thread of fine pitch on the end of the feed bar provides a slow feed to the cutting tool. The slot at right angles to the bar which receives the feed-nut *B* should

be circular, so as not to weaken the section of the bar more than is necessary. Obviously, any shape or form of cutter can be used for various classes of work, such as clearing out the cast recess in the combustion chambers of automobile cylinders, etc. Needless to say, the slot and feed bar must be long enough to allow the feed-nut to be outside the bore of the work being operated open, so that the nut can be turned readily. Lines can be scribed on the edge of the feed-bar slot, as at *G*, to indicate the exact position of the cutting tool and when the required depth of cut has been reached.

CONTRIBUTOR.

SHEARING PUNCH AND DIE

We received an order in a tool job shop to make about fifty shearing punches and dies that were required to make about as many different size blanks. Extreme accuracy as to dimensions was not specified or necessary, but nicely cut laminations were insisted upon. The design submitted had been carefully worked out for a tool that would last a long time and produce an immense number of punchings before having to be replaced. The first consideration, that will be apparent to all, in the design of this die is rigidity. The die-holder, it will be noticed, is massive and well laid out to firmly support the steel members and lessen the liability of springing during the action of cutting and causing premature wearing away of the cutting edges. The stock used for the lamination is 1/64 inch sheet iron, of a brittle quality, and covered with scale that is detrimental to a keen-edged tool or sharp corners. For this type of die, in order to obtain the most satisfactory results, extra hard steel is of special importance, while for the piercing punch, hardness should be combined, as far as possible, with toughness, to insure the acute edges standing up.

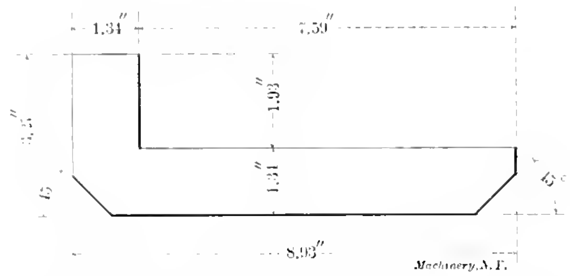


Fig. 1. Blank produced by the Punch and Die shown in Figs. 2 and 3

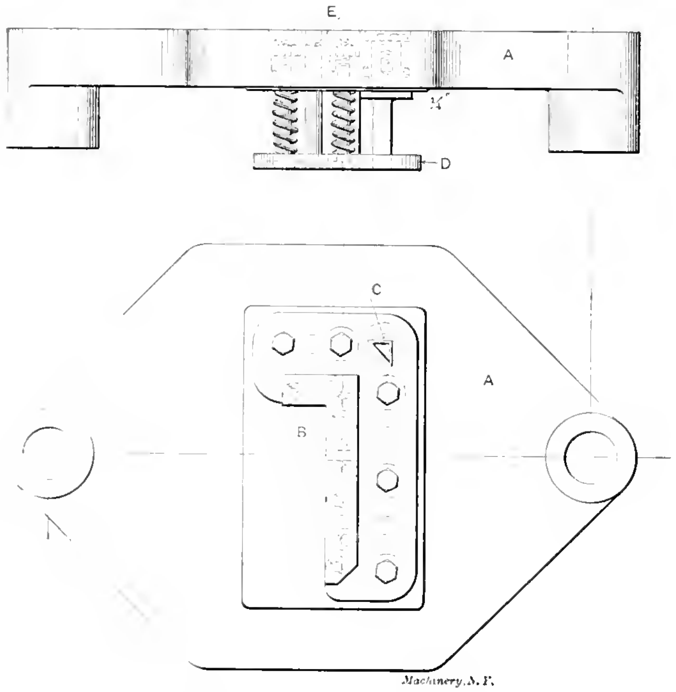


Fig. 2. Punch for the Die shown in Fig. 3

The outline of the blank is shown in Fig. 1, and the punch and die are illustrated in Figs. 2 and 3, respectively. By careful reference to the drawings, the construction will be understood. In Fig. 2, *A* represents the cast-iron punch holder; *B* the shearing punch secured to the holder by screws and pins; and *C* the piercing punch that cuts away the corner of the lamination. The combined stripper and stock-holding plate *D*, made of machine steel, is moved downward by compression springs and maintained in place by screws and nuts as shown. Pins *E* are provided to steady this plate, as it is not very closely fitted to the punch. A clearance of 1/32 inch is given around the piercing punch to avoid springing this member, should the stripper cramp.

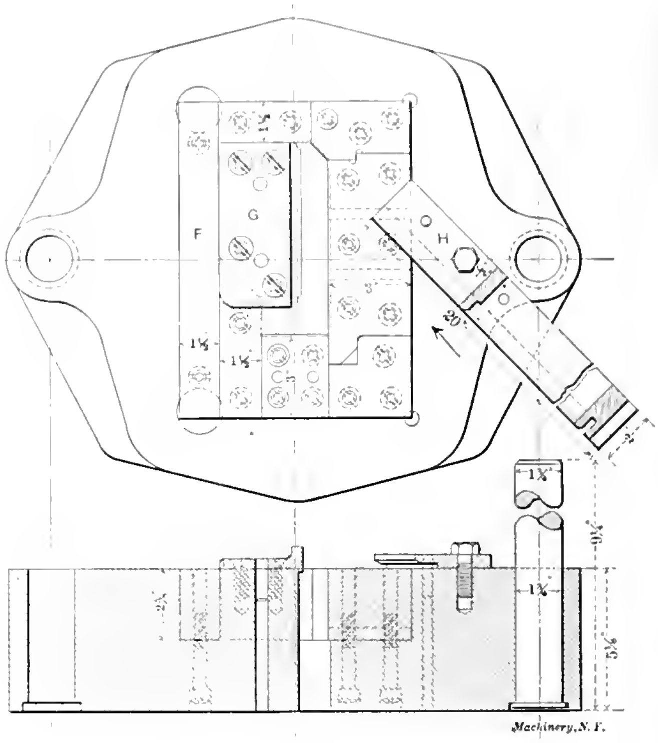


Fig. 3. Section and Plan of a Die for producing the Blank, Fig. 1

In Fig. 3 the manner of arranging the parts is clearly shown. The box-shaped holder is carefully planed to receive the six steel sections that, when assembled as indicated, comprise the working parts that do the piercing of the stock and the shearing away of the blank. The machine steel bar *F* fills in a cavity that is first machined out to allow clearance for the planer tool when working out the inside. The backing plate *G*, as will be seen, is secured to the face of the holder by screws and dowels; this member acts as a stop for the stock and also supports the punch and prevents it from springing away from the cutting edge of the die. A machine steel guide *H* for the stock is fastened to the die, and like the backing plate, has to be removed when sharpening is necessary. The punch and die are sub-pressed with 1¾-inch pins, for without these die-aligning studs the setting of such heavy tools in a press becomes a time-consuming operation, while with them it is only a matter of a few minutes. No clearance is given in the die, except on the three sides of the piercing hole, the blanks being almost free as soon as they are forced down in the die beyond the overhanging edge of the backing plate. The springing of such thin plates eliminates friction at the ends and permits them to drop out of the die.

Under working conditions, preparatory to shearing the blanks, the stock which rests against the back guide *H* is fed from right to left in the direction indicated by the arrow until it butts against the backing plate *G*. On the first stroke of the press, a portion of a blank is cut and a hole pierced; the second stroke either cuts off a perfect punching or a nearly complete one, according to its length. The only waste is that on the end and sides and the small triangular piercing. Owing to the shape there is considerable loss at both ends, hence sheet stock of longest length is provided. Twenty-five thousand is the average run per day, and between sharpenings fifty thousand clean cut plates free from burrs are sheared.

It may be well to call attention to the fact that the accurate size and location of the piercing punch is of utmost importance. Should this be at all out of place, notches on the inside of the laminations or sharp points at the angles will be manifest.

TOOLMAKER.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary

TWO USEFUL BLACK-BOARDS

In connection with the instruction of mechanical drawing, it was necessary to use the black-board frequently, and, as the scale of the drawing was then enlarged, much mental calculation was necessary. The drawing sheets used were 13 × 17 inches, so it was thought a good plan to divide the top edge of the board, which was 48 inches in length, into 17 divisions, and a space along the left-hand edge into 13 equal divisions. These divisions were then, in turn, divided so as to represent half inches. All sketches were then easily drawn to scale, the trouble of figuring the proper black-board dimensions was eliminated, and, incidentally, many questions were not asked which would have been otherwise. There is space still left at the bottom of the board for any explanatory work. Fig. 2 represents a black-board well adapted for the engineer's office. The factory grounds and buildings are permanently drawn on the board with white paint. Any suggestions regarding the changing of or additions to the plant can be conveniently sketched in, and altered without injury to the original plans. C. E. J.

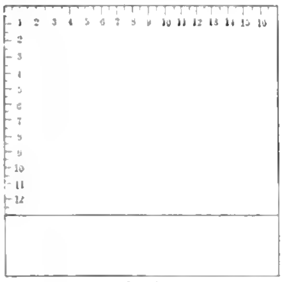


Fig. 1

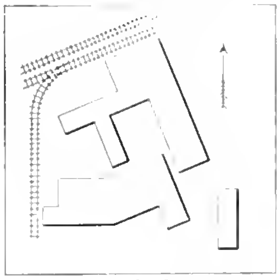
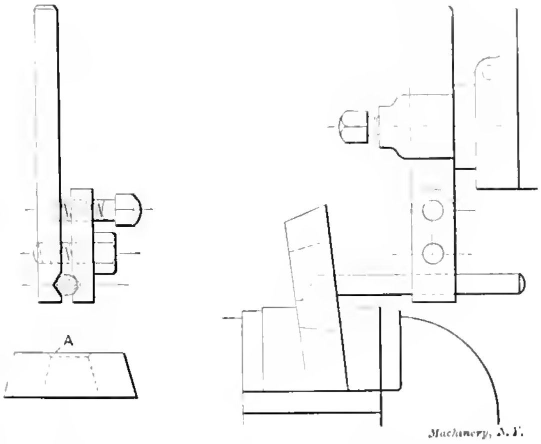


Fig. 2

Machinery, N.Y.

ADJUSTABLE SHAPER TOOL

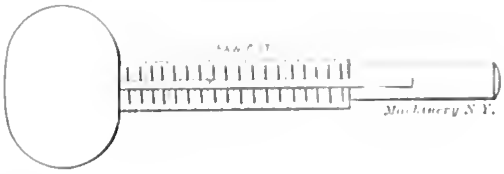
The tool-holder for the shaper described in the February issue of MACHINERY is very similar to one I saw a few years ago, the sketch of which is shown herewith. The tools generally used were a half inch in diameter, although larger or smaller sizes could have been used as well, as will be evident by referring to the engraving. Primarily, this holder was made for planing out blanking dies, the dies being held in the vise in the manner shown. After the core was taken out, the top edge of the blank was beveled as shown at *A*, to prevent the metal from breaking out beyond the finish line.



Stamford, Conn. J. PRICE.

A THUMB-SCREW THAT WON'T JAR LOOSE

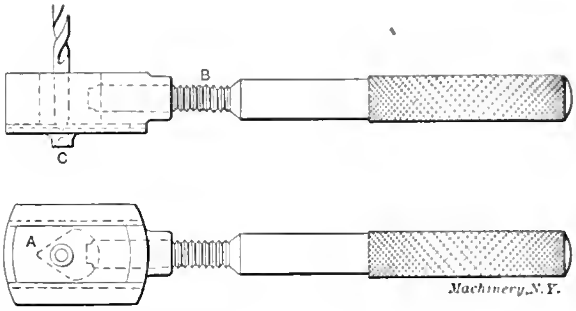
It is sometimes necessary to have a thumb-screw which can be used for adjusting purposes conveniently, that is to say, so it can be used without having to manipulate a lock-nut or other retaining device. The sketch shows a style of thumb-screw which is effective. The saw cut is put in by milling from both sides after the thread is cut, then a die is run over the threads to remove the burrs, after which a narrow thin wedge is driven into the slit which widens the threaded portion at the center. It is obvious that a screw of this kind can be easily put into place as the end is not distorted appreciably, and the compression is gradual. Ordinary malleable iron thumb-screws have enough spring to them to act well. More or less tension can be obtained by making the distortion to suit. H. R. ASH.



Chicago, Ill.

HOLDER FOR SMALL DRILLS

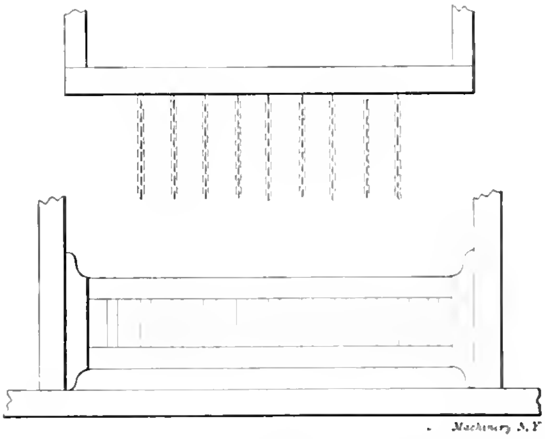
The tool for holding small drills, which is shown in the engraving, is very handy and convenient when small holes are being drilled in the lathe when the tail-center is used to support and guide the drill. The pointed end of the drill is placed in the center in the sliding plate *A* as shown. The screw *B* is then tightened, and the plate follows the drill. As the center *C* is in line with the one on the inside of the plate, the result is practically the same as if there were a center in the drill. W. W. COWLES.



Poughkeepsie, N. Y.

FOREWARNING THE LOWERING OF AN ELEVATOR

Perhaps the cheapest and most convenient device used for forewarning the lowering of an elevator is shown in the engraving. A number of small chains about two feet long are hung from the bottom of the cage. If the elevator is coming down, and an attempt is made by the user to look up from the gate when the elevator is within a short distance from his head, he will have time to avoid a serious, or perhaps fatal, accident because of the warning given by the lowering chain. [Of course it will be understood that the height of the gate is often limited by the distance between the floors.—EDITOR.] This device is in daily use in at least one factory, and doubtless if it were installed in many more, a large number of elevator accidents could be prevented. C. E. J.



HOW AND WHY

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

ALLOWANCE FOR "SET" OF LOCOMOTIVE PISTON RINGS IN TERMS OF DIAMETER

B. L. H.—What is the proper amount of excess diameter allowance to make in turning locomotive piston rings of the concentric and eccentric types? The chief engineer of our road claims that 1/32 inch allowance per inch diameter is right, but others say that this amount is excessive. The rings are 22 to 23 inches diameter, 11 16 inch wide, and 3/4 inch thick. The cast iron is of medium grade.

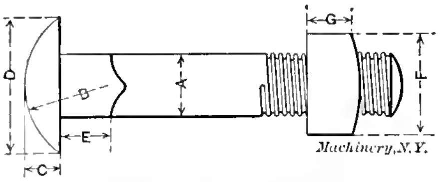
A.—The allowance for "set" made in the ordinary snap or Ramsbottom piston rings, varies considerably according to different authorities, the range being from 1 to 3 per cent of the cylinder diameter. Common practice points to about 1½ to 2 per cent in the case of narrow rings of the concentric type. In the case of a 22-inch cylinder, this would mean that the rings would be turned about 5/16 to 1/2 inch larger than the bore of the cylinder. Eccentric rings should be made with practically the same allowance but more can be given if they are sprung together after the excess is cut out and the outside turned to the cylinder diameter while held in a suitable chuck. In general there is no gain in making the allowance greater than one-half the ring depth, that is the radial dimension, for the ring will be practically worn out before the wear has equalized the "set" to the cylinder diameter.

CARRIAGE-BOLT HEADS, SHANKS AND SCREW THREADS

C. H. T.—For some time I have been searching for data on the dimensions of heads and shanks of carriage bolts, but have been unable to find any information, although I have looked over a great many standard mechanical hand-books and textbooks. Kindly publish in an early issue a table giving these dimensions; also data on carriage bolt screw threads.

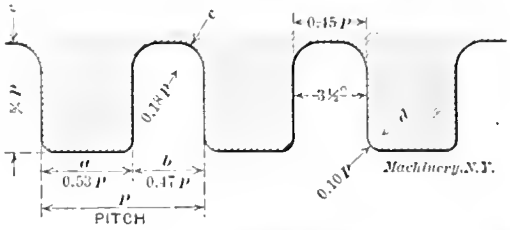
A.—The accompanying table giving the dimensions of heads and shanks and number of threads per inch of carriage bolts from 3/16 to 3/4 inch diameter inclusive, was supplied by the Michigan Bolt & Nut Works, Detroit, Mich., and gives the standards of this company. There is no recognized standard of carriage bolt thread. The tendency is for users to demand the United States standard thread and pitches. The typical carriage bolt thread is a sort of compromise between the Whitworth and a screw thread, but up to a few years ago hardly any two makers of carriage bolts used the same shape thread or number of threads per inch. When a manufacturer wanted new taps or dies it was necessary for him to send samples to the tap and die makers to insure perfect duplication. Some years ago the J. M. Carpenter Tap & Die Co., Pawtucket, R. I., reduced the conflicting shapes to a standard governed by the pitches of the thread, which they were able to duplicate whenever necessary without the trouble of referring to samples. This standard has been adopted by several large manufacturers of carriage bolts, but as previously stated, the tendency of users is to use the established and readily duplicated United States standard thread and pitches. The second table gives the shape and dimensions of the Philadelphia carriage bolt screw thread, which is typical of carriage bolt screw threads in general.

CARRIAGE-BOLT HEADS, SHANKS AND SCREW THREADS



A	B	C	D	E	No. of Threads	F	G
3/16	3/16	3/32	7/16	3/16	24	3/8	3/16
1/4	1/4	1/8	9/16	1/4	20	7/16	7/32
5/16	7/16	3/16	11/16	5/16	18	1/2	1/4
3/8	9/16	7/32	7/8	3/8	16	5/8	11/32
7/16	21/32	1/4	1	7/16	14	11/16	3/8
1/2	3/4	5/16	1 3/16	1/2	13	13/16	7/16
5/8	29/32	11/32	1 7/16	9/16	11	1	9/16
3/4	1	13/32	1 5/8	5/8	10	1 3/16	5/8

PHILADELPHIA CARRIAGE-BOLT SCREW THREADS



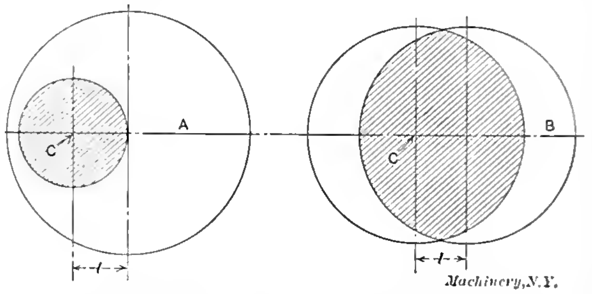
Threads per inch	e	f	a	b	c	d
26	0.024	0.03846	0.0204	0.0181	0.0069	0.0038
24	0.026	0.04167	0.0221	0.0196	0.0075	0.0042
20	0.031	0.0500	0.0265	0.0235	0.0090	0.0050
18	0.0347	0.05556	0.0294	0.0262	0.0100	0.0056
16	0.039	0.06250	0.0331	0.0294	0.0113	0.0062
14	0.0445	0.07142	0.0379	0.0335	0.0129	0.0071
12	0.052	0.08333	0.0442	0.0391	0.0150	0.0083
11	0.0568	0.09091	0.0482	0.0427	0.0164	0.0091
10	0.0625	0.1000	0.0530	0.0470	0.0180	0.0100
9	0.0695	0.11111	0.0589	0.0522	0.0200	0.0111
8	0.0780	0.1250	0.0663	0.0587	0.0225	0.0125

Contributed by "A."

ECCENTRICS AND CRANKS

R. A. B.—What is an eccentric, and when does an eccentric become a crank?

A.—An eccentric is defined as an enlarged crank-pin that encircles the shaft. There are intermediate conditions, however, that make the distinction between an eccentric and crank not always easy. In the illustration, *A* clearly is an eccentric, and *B* may be named either an eccentric or a crank without exciting violent protest. The following points may be considered in analyzing the matter as distinguishing an eccentric from a crank: 1. Relative diameter of crank-pin and shaft. 2. Ratio of throw to diameter of shaft. 3. Whether the function is that of converting rotary action into rectilinear motion, or *vice versa*. The defining line between an eccentric and crank-pin might be assumed to be where the periphery osculates the shaft, all forms being considered eccentrics which completely encircle the shaft and all whose peripheries at any point lie between the shaft surface and its center, as being cranks. In the last, our notion would be to always limit the diameter of the crank-pin to a size not larger than the shaft and to limit *l* (one-half the throw) to not less than one-half the shaft diameter. Then, if the diameter is larger than the shaft, and *l* equals or is less than one-half its diameter, we would call it an eccentric; if the size of crank-pin is less than one-half the shaft diameter, and the throw equals or is greater than one-half the shaft diameter, we would name it a crank. According to this rule both examples shown in the illustration are eccentrics. If the function is that of converting rotary to rectilinear motion, cranks close to the limiting conditions set forth in the foregoing might be preferably named eccentrics, or, conversely, eccentrics may be called cranks. The throw of an eccentric or crank is the stroke, and is 2*l*.



SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

INK FOR WRITING ON CELLULOID

Ink for writing on celluloid triangles, etc., can be prepared by dissolving a tar dye stuff of the desired color in anhydrous acetic acid. JOHN B. SPERRY.

Aurora, Ill.

POLISHING WOOD

A very nice polish on wood is obtained by using the following mixture: ½ pint of alcohol, ¼ ounce of shellac, and ¼ ounce of resin. Dissolve the shellac and resin in the alcohol; then add ½ pint of linseed oil, and shake the whole mixture. Apply with a sponge, brush or flannel. Rub the wood thoroughly after the application. E. W. NORTON.

RECOLORING BRONZE

Bronze may be renovated and recolored by mixing one part muriatic acid and two parts water, and applying the diluted acid to the bronze articles with a cloth. Before applying the acid the articles should be cleaned thoroughly from all grease. After having applied the acid let the article dry, and then polish with sweet oil. E. W. NORTON.

SOLDERING PASTE FOR COPPER WIRES

Soldering paste has come into extensive use in electrical work as a flux for soldering, and the following recipe will be found useful in soldering copper wires when the use of an acid would be objectionable. This paste will not spatter or corrode, and the proportions are as follows: Saturate solution chloride of zinc, one dram; vaseline, 1½ ounce.

Philadelphia, Pa. WILLIAM DAVIS.

TO COVER IRON PULLEYS WITH RUBBER

Thoroughly clean the surface of the pulley; if the pulley has just been turned in the lathe, so much the better. Give it a thorough wash in muriatic acid and let stand over night. In the morning give the iron and rubber a good coat of heavy yellow shellac varnish and apply the rubber and clamp. Let stand until thoroughly set. E. B. GAFKEY.

Lakewood, Ohio.

SOLDERING ALUMINUM AND COPPER

It is often stated that aluminum cannot be readily and successfully soldered to other metals. I have, on numerous occasions, successfully and easily soldered aluminum to both copper and brass by the following method: First tin the aluminum and the copper, or brass, using stearine as a flux; wipe off clean, then use zinc chloride as flux, with solder composed of: tin 67 per cent, lead 33 per cent. T. ILES.

Manchester, England.

CEMENT FOR FIXING LEATHER OR PAPER TO PULLEYS

Soak six pounds of carriage glue over night; then heat until thoroughly dissolved and add six pounds of white lead ground in oil. Reduce the mixture with oil until it is of a free working consistency. Now add one ounce of nitric acid and stir until thoroughly mixed. The pulley surface should be made thoroughly clean and should be warmed to about 125 degrees F. Then apply the cement and clamp on the leather and let stand twelve hours before using. If the job is done right, the leather will have to be turned off in a lathe in order to remove it. E. B. GAFKEY.

Lakewood, Ohio.

SPOTS ON BLUE-PRINTS

We were bothered for some time with peculiar blue spots on our tracings, which were next to impossible to remove, and which caused spotted blue-prints. The office receiving these prints finally requested us to remove the ink blots from our tracings. The trouble was finally located in connection with the blue-printing. The one doing this work had a habit of making one print, washing it at once to prove the color, and then printing the entire lot. Now after washing the first print, he did not thoroughly dry his hands, and on placing the next print, the paper was moistened and the exposure "fixed" some of the blue clear through the tracing cloth.

HOWARD D. YODER

BATH FOR HARDENING HIGH SPEED STEEL.

An excellent bath for hardening high speed steel consists of a mixture of table salt and paraffine oil, in the proportion of one pound of table salt to each gallon of pure oil. The steel is heated to a lemon color, and plunged into the bath, being kept in motion until it has thoroughly cooled. The steel should come out of this bath gray in color, and nearly free from black spots. The bath referred to can be used for almost all brands of high speed steel, with good results. It has been used to great advantage for the Midvale steel, and also on a large number of tools made of Novo, Simeteora, Rex, Jessop high-speed, and Blue Chip steel. On all these, good results have been obtained, but it may be added that this bath seems to give the best results with the Midvale steel.

H. S. STEEL.

FOR HOLDING LEATHER ON IRON PULLEYS FOR BAND SAWS

First soak twelve ounces of good glue in cold water. Put four ounces of boiled oil and four ounces of turpentine into the glue pot, and in this dissolve three ounces of resin. When the resin is dissolved, add the glue. The resin and glue should be well stirred while dissolving.

Before applying the leather cover to a pulley have it warm and dry, and scrape off all matter that may have accumulated on its face. Then, with a swab, apply muriatic acid (full strength) to all parts of the face of the pulley. When dry, wipe gently with waste. Cut leather lengthwise of hide, and a little wider than the face of the pulley. Have the cement melted in the glue pot, apply it across the face of the pulley, with a brush, for about six or eight inches, lay on the end of leather and rub it down hard with the corner of a piece of wood. Fold back the leather and continue to apply cement until the pulley is covered. Two thicknesses of leather are used. Make the first thickness a butt joint, and the last a scarf or lap joint of about three or four inches long. Make the laps on the driven pulleys the way they run, and on the drivers the opposite way. Pulleys should be cleaned by holding a piece of coarse sand paper against them. R. F. WILLIAMS.

Montreal, Canada.

HOW TO SAVE UNDERPRINTED OR OVERPRINTED CONTACT COPIES

Blue-prints are never so over-printed that they cannot be reduced to a suitable depth by a slightly alkaline bath of borax, bicarbonate of soda, washing soda, or ammonia. Black-line, or "ink" process paper, is usually lost if slightly over-printed; if under-printed it develops too gray all over its surface to be of use for tracing or for reproduction photographically. In the winter-time, when prints from thick paper drawings are apt to be under-exposed, I treated a number of such apparently useless prints with a lotion for throat troubles—the first "tonic" available—with excellent results, the invisible lines developing out a strong black on a gray ground. The mixture was tannin-and-glycerine solution to about 20 parts of water. When using this solution it is safer to under-print rather than to over-print, with the resulting weak or broken lines.

Sepia prints, when much over-printed, can be saved by washing in a very weak solution of hyposulphite of soda, which bleaches away the image before it can become fixed by the usual preliminary wash in plain water. The hyposulphite solution is so energetic that it will bleach down the darkest of sepia prints if not previously put in water. Purple tones are obtained, after washing, by treating with any gold-toning bath. CHARLES R. KING.

Staple Hill Park, Bristol, England.

NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

THE LODGE & SHIPLEY "MARVEL" LATHE

A new type of lathe has recently been brought out by the Lodge & Shipley Machine Tool Co., of Cincinnati, O., which in many respects differs from the ordinary types, and which possesses many valuable features which are entirely original. The prime object in the design of the lathe has been to produce a machine suitable for the rapid production of duplicate parts made from bar stock cut to the required length. One tool in conjunction with a number of automatic stops will turn any number of diameters on any number of pieces to the same dimensions, providing the number of diameters does not exceed the number of stops furnished. The distances between the shoulders on the turned pieces can also be made exactly the same on any number of pieces by using the automatic longitudinal stops provided. As these features are original with the Lodge & Shipley Company, patents have been applied for, covering all of the new devices embodied in this type of lathe.

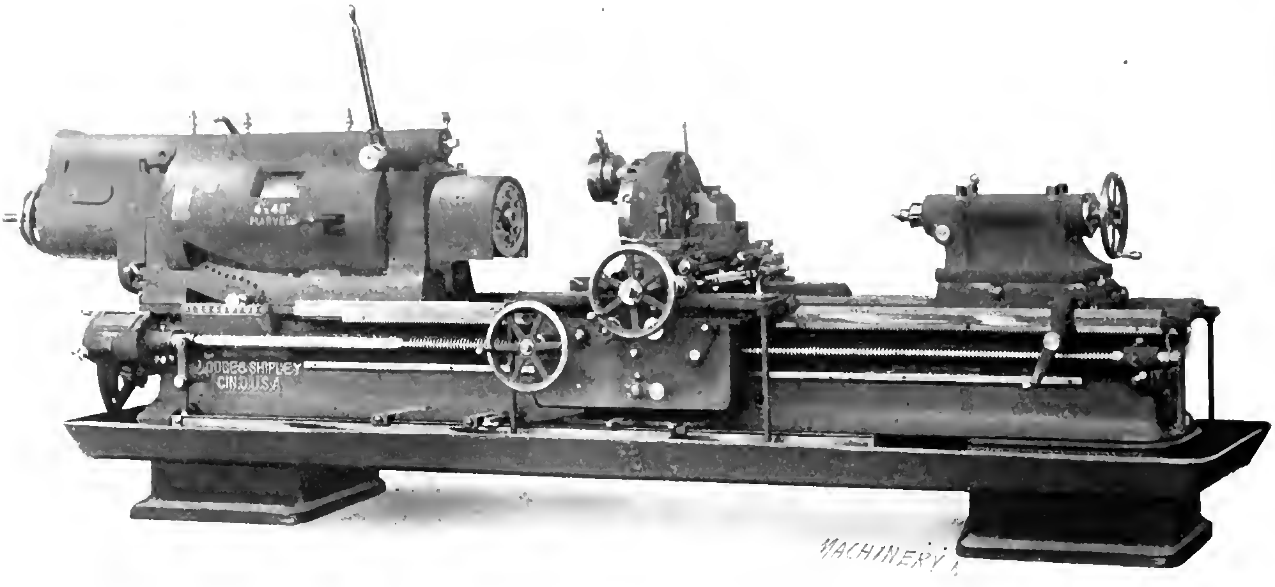


Fig. 1. The Lodge & Shipley 4 by 48-inch Marvel Lathe

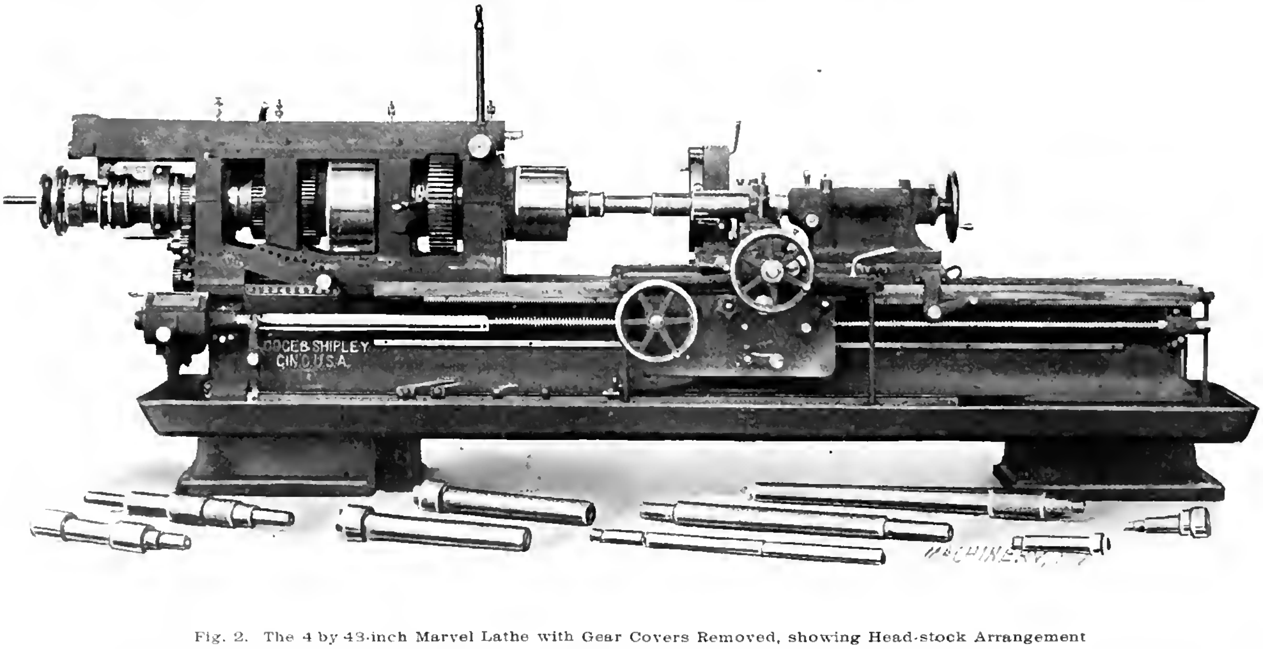


Fig. 2. The 4 by 43-inch Marvel Lathe with Gear Covers Removed, showing Head-stock Arrangement

The machine is built in three sizes, known, respectively, as the 2 by 24, the $2\frac{1}{2}$ by 36, and the 4 by 48-inch, these dimensions referring to the maximum diameters of the stock and the maximum length which can be turned. In Fig. 1 is shown the 4 by 48-inch machine complete, and in Fig. 2 the same machine with the gear guards in the front of the head-stock removed. In Fig. 3 is shown the $2\frac{1}{2}$ by 36-inch size with all parts in place, and in Fig. 4 the same machine with the gear guards at the end of the head-stock removed. In Figs. 2 and 4 the machines are shown in operation, and samples of work are also shown in the same engravings. Figs. 5 to 8 show various details of the machine. Before dealing directly with the operation of the lathe, it will be necessary to give a general description of the design of its various parts.

The Head-stock and Chuck Mechanism

A side view of the head-stock is shown in Fig. 5; the front end is shown in larger scale in Fig. 6, and a view from the front end in Fig. 7. The head-stock is of the same design as that used in the regular Lodge & Shipley patent-head lathe with double back-gears and single pulley drive, the pulley being carried in bearings independent of the main spindle, thus relieving the spindle and its bearings of all belt pull. The main spindle, which is exceptionally large, is bored out to receive a hollow tube, called the draw tube, the bore of which

determines the diameter of the bar stock coming within the capacity of the lathe. The end of this draw tube at the front end of the spindle is threaded, and an adjustable collet fitted to it, the thread furnishing the means for adjusting the collet to any diameter of bar that any one set of jaws will take. The rear end of the spindle projects beyond the end of its bearing, and carries a stepped collar which slides on the spindle. Between the stepped collar and the rear main spindle bearing is another collar backed up by a nut threaded on the spindle. (See Fig. 5.) In this collar are pivoted two steel levers, the outer ends of which are provided with two hardened steel rollers which rest on the inclined faces of the stepped collar. The inner ends of the levers engage a collar fastened to the rear end of the draw tube, the levers passing through a slot in the spindle. On the extreme rear end of the spindle a threaded collar is placed as a stop for the sliding stepped collar. This threaded collar also serves as an abutment for a compression spring acting against the rear end of the draw tube.

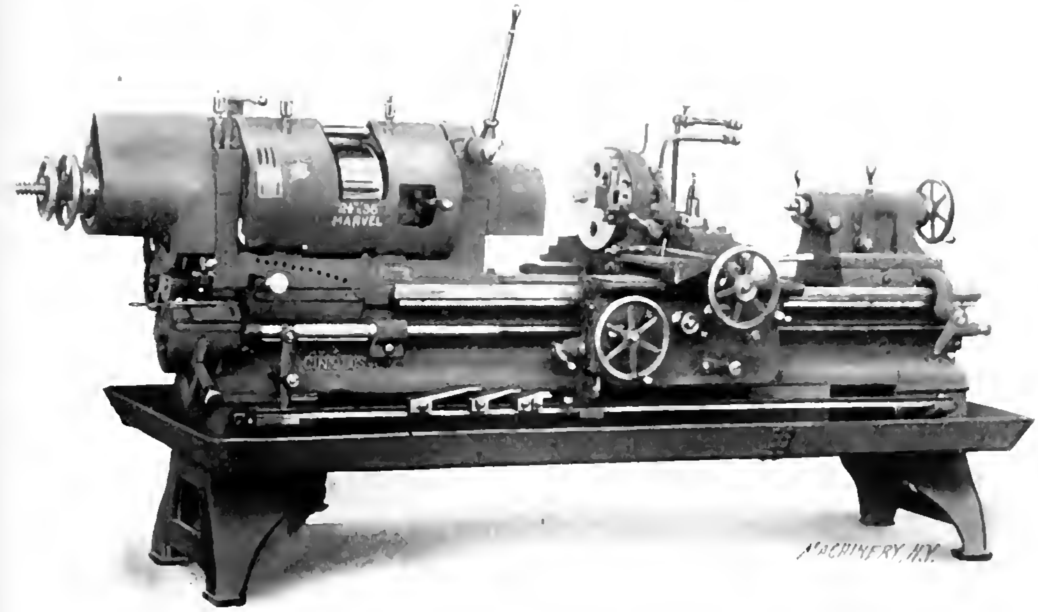


Fig. 3. The Lodge & Shipley 2¼ by 36-inch Marvel Lathe

Directly above the main spindle a guide shaft is placed on which slides a yoke engaging the stepped collar. To this yoke is attached a bar which extends immediately over the guide shaft (and over the main spindle gears and pulley) to the front end of the headstock. On the front end of this bar a rack is cut on the under side. This rack engages with a pinion fastened on a shaft at right angles to the main spindle, the end of which projects out on the front side of the machine. On the extreme outer end of this shaft a clutch is placed, the teeth of which engage another clutch which is loose on the shaft and to which is attached a hand-lever, as shown at the right in Fig. 5. The loose clutch is kept in engagement with the one fastened to the shaft by means of a light spring, which can easily be compressed by hand so as to throw the clutches out of mesh.

The chuck on the front end of the spindle consists of an outer shell or hood threaded on the nose of the spindle. In this hood is secured a hardened conical steel ring. The collet body is carried in a taper bushing in the end of the spindle, the inner end being threaded to receive the draw tube as before mentioned. In the collet body are cut radial T slots into which are fitted hardened and ground steel jaws which bear against the conical steel ring in the shell. Springs are inserted in each jaw to keep them in contact with the conical ring.

When operating the chuck, the hand lever before mentioned (shown to the right in Fig. 5) is pulled forward thereby drawing the stepped collar forward and forcing the lever arms at the rear end of the spindle outward. As the inner ends of the levers bear against the collar at the rear end of the draw tube this latter is forced backwards together with the collet body, and the radial jaws are caused to slide on the conical ring in the shell, thus gripping the stock. When relieving the grip, the hand lever is reversed, thereby withdrawing the stepped collar from between the lever arms and allowing the spring which acts against the rear end of the draw tube to force it and the collet body forward. The springs in the radial jaws force these out against the conical ring in the shell, thus releasing the stock.

A coarse pitch screw acting as a stock stop passes through the center of the draw tube and is supported at the front end by a collar which is a sliding fit in the bore of the draw tube, and on the rear end by a nut secured to the extreme rear end of the main spindle. Mounted on the screw immediately behind the nut are two hand-wheels, the inner one of which is keyed onto the screw by a key movable longitudinally in a spline, and the outer one threaded and operating as a lock-nut. When the inner hand-wheel is revolved, the screw revolves with it, and is caused to travel through the nut secured to the main spindle, thus giving end adjustment. The screw can be locked in any desired position by the outer hand-wheel. The front end of the screw is arranged to receive either a small center or straight stop bar.

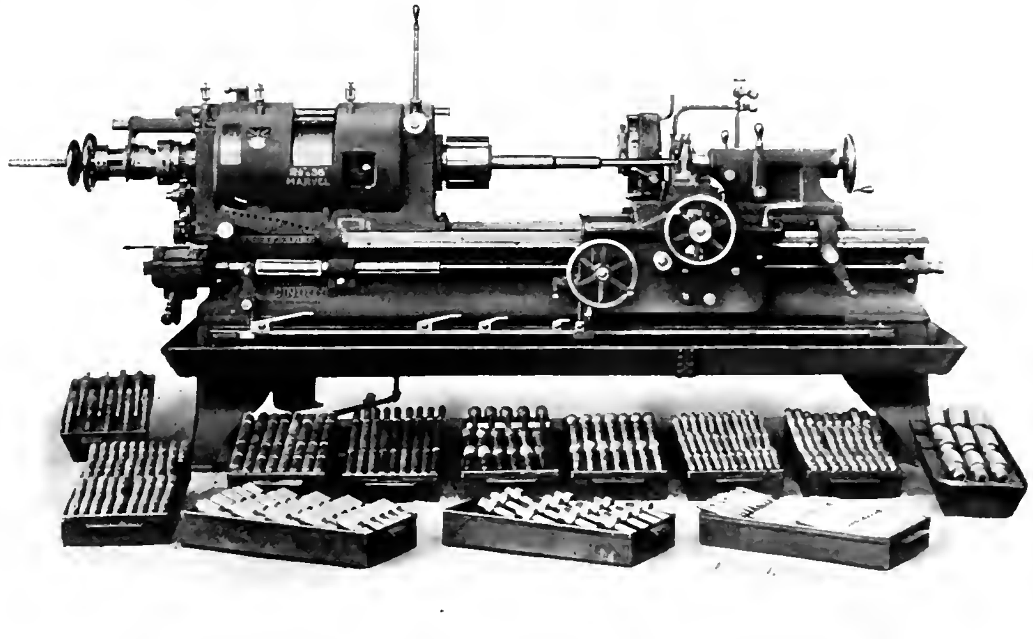


Fig. 4. The 2¼ by 36-inch Mervel Lathe with Covers Removed showing Chuck-operating Mechanism

Carriage and Tool-posts

The arms of the carriage bear on two outer V's of the bed. The bridge also has a bearing on the top and inside

of the flat track of the front shear. The bridge of the carriage is exceptionally wide and, as will be seen from Figs. 7 and 8, is extended beyond the back of the carriage. Two independent transverse dove-tails are planed on the bridge, the one on the right-hand side (looking at the machine from the front) being raised considerably above the other and extended the entire length of the bridge and its rear extension. The other dove-tail extends from the rear of the bridge extension a little past the lathe center. The right-hand dove-tail is fitted with a slide which carries the front and back tool-blocks. The front tool-block consists of a slide fitted in a dove-tail parallel with the main spindle, for the purpose of providing a longitudinal screw adjustment for the front tool; when adjusted, this tool-block is locked in position by a clamp screw. A large longitudinal T-slot at the top receives the usual form of tool-post and step washer. The rear tool-block has transverse hand adjustment and is clamped by two T-bolts in a T-slot planed in the main slide. This block also has a large transverse T-slot for receiving either the usual form of tool-post or a tool-holder of the European type, shown in place in Figs. 6, 7 and 8. Due to the separate adjustment, the tools in the front and rear tool-blocks can be set in any required relation to each other and can be rapidly, independently and accurately adjusted.

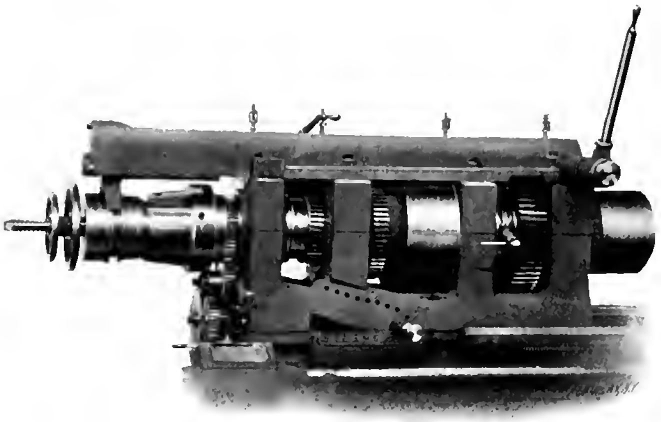


Fig. 5. The Head-stock of the 4 by 48-inch Marvel Lathe with Covers Removed showing Details of Head Construction

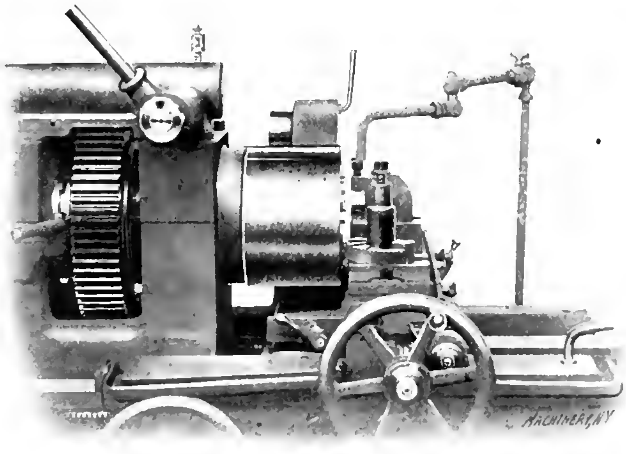


Fig. 6. Front End of Head-stock of 4 by 48-inch Marvel Lathe, showing Chuck, and Lever for operating Chuck Mechanism

In the left-hand dove-tail of the carriage is fitted a slide which carries a rotating tool-holder, a kind of vertical turret. In the face of this tool-holder which is turned toward the head-stock are reamed four holes to fit various tool shanks. (See Fig. 8.) The holes are so placed that when the tool-holder slide is locked to the carriage by means of a spring plunger provided for the purpose, each one of the tools in the face of the revolving tool-holder can be brought into a position so that its center coincides with the axis of the main spindle. The revolving tool-holder is locked to its slide in each position by a spring plunger. Tools of various types, such as centering tools, die holders, etc., may be placed in the holes in the revolving tool-holder, and necking tools, cutting-off tools, and turning tools may be carried in holders bolted to the face of the revolving tool-holder, so that their cutting edges project beyond the edge of the tool-holder itself. These tools, then, can be used for turning operations. An adjustable stop is provided in the carriage for use in connection with turning and necking tools, so that they may repeatedly be brought into exactly the same position relative to the main spindle center, thus insuring exact duplication of work without measuring each piece. A single lever operates this stop and also the spring plunger, which locks the revolving tool-holder slide to the carriage. A similar lever also operates the plunger which locks the revolving tool-holder to its slide. Both these levers are shown in Fig. 8, one at the end of the slide, and the other on the side of the projecting housing. The right-hand slide carrying the front and back turning tool and the slide carrying the revolving tool-holder are traversed back and forth by the same hand-wheel at the front of the carriage; but, at the same time, the movement of each of these slides is entirely independent. This is accomplished by means of a friction or slip member inserted in this hand-wheel.

Automatic Stops

One of the most important and noteworthy features in the design of the carriage is the automatic stop used in connection with the front and rear tools carried on the right-hand slide, by which a number of different diameters can be rapidly and accurately turned on a number of duplicate parts. The construction of this stop is as follows: Along the side of the bridge of the carriage next to the tail-stock, and journaled in two hubs cast on the front and rear arms of the carriage, as shown in Fig. 7, is a heavy bar with T-slots milled lengthwise through that part of the bar which is between the arms of the carriage. The bar is reduced at one end for a certain distance to a diameter just below the bottom of the T-slots, so as not to interfere with the insertion of the T-bolts into the slots. The bolts secure small steel stops in any desired position on the slotted bar, as clearly shown in Fig. 7. On the front end of the bar means are provided for taking up end wear, so that a snug running fit may always be maintained. On the outside of the rear bearing is secured a steel clutch, the teeth of which correspond to the T-slots in the bar. Engaging with this is another clutch keyed to the rear end of the slotted bar, and kept in engagement with the stationary clutch by means of a spring. On the outside of the clutch on the bar are cut spiral grooves corresponding in number to the number of slots in the slotted bar. On the edge of the tool-block slide next to the tail-stock are two hubs, the front one being cast solid with the slide, while the rear one is adjustable longitudinally by means of a T-slot and T-bolt. In each of these hubs a shaft is journaled parallel with the slotted bar; to the inner ends of the shafts steel fingers are secured. In the ends of these fingers and also parallel with the slotted bar, two screws are threaded and provided with means for locking them in

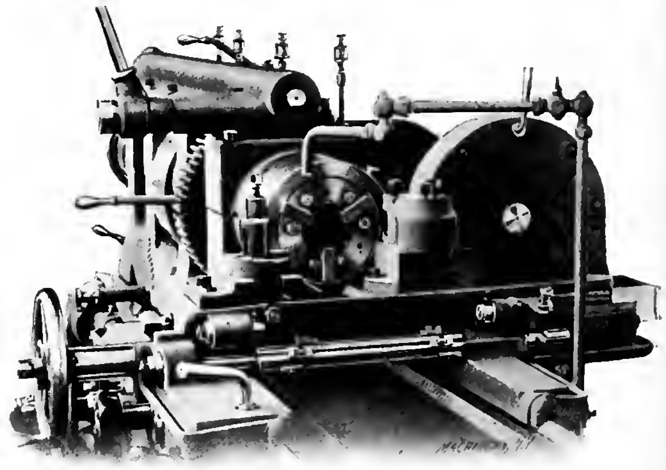


Fig. 7. Front View of Head-stock and Side View of Carriage of 4 by 48-inch Marvel Lathe showing Automatically-revolving Stop Bar

position when adjusted. The fingers each have two positions, one for engaging the stops on the slotted bar and the other for allowing the fingers to pass over the stops. These positions are both maintained by means of a spring latch.

The slotted bar has two sets of stops as shown. One set engages the screw in the steel finger on the front end of the slide and is used in connection with the front tool. The other engages with the steel finger carried by the adjustable block on the rear end of the slide and is used in connection with the rear tool. In the rear hub there is also a spring pin, the end of which engages with the spiral grooves cut on the outside of the clutch keyed on the end of the slotted bar. These grooves are so formed that the forward movement of the slide will cause the end of the spring pin engaging the spiral groove to compress the spring which keeps the clutches in engagement. This action continues until the clutch teeth are disengaged, at which time the slotted bar will revolve by the continued movement of the slide, the end of the spring pin traveling in one of the spiral grooves. The length of the spiral grooves is so determined that when the slotted bar has revolved sufficiently to bring the next set of stops into position, the end of the spring pin passes out of the groove and at this time the clutch teeth come into engagement, the clutch being actuated by the spring previously compressed. The movement of the slide is then continued until a stop is reached. On the return movement of the slide the end of the spring pin will again enter the same groove, but instead of any movement being imparted to the clutch, the groove is so formed that the spring pin will ride over the top of the spiral and drop into position in the next groove in the clutch. It is obvious that by means of this automatic stop arrangement a number of various diameters, not, however, exceeding the number of stops on the slotted stop bar, can be rapidly turned on a number of similar parts.

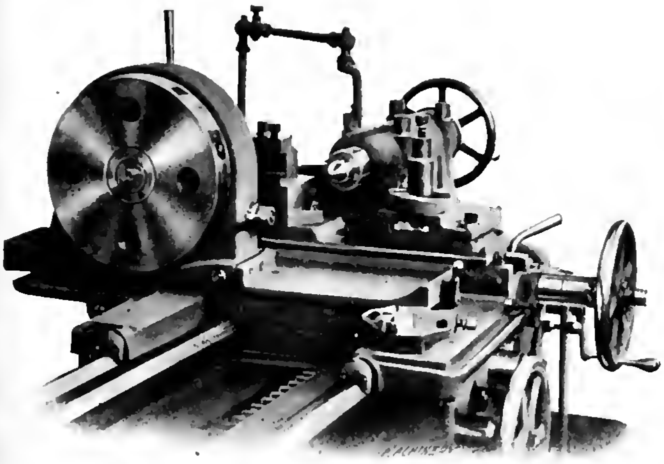


Fig. 8. Side View of Carriage of 4- by 48-inch Marvel Lathe, looking toward Tail-stock, showing the Rotating Tool-holder

The longitudinal stops provided on this lathe are of the same type as those described in connection with the Lodge & Shipley crank-shaft lathe in the June, 1909, issue of MACHINERY and will be but briefly referred to here. Along the front of the bed just below the apron is placed a rectangular bar, which slides in brackets bolted to the bed. The top of the bar is planed in the shape of a dove-tail, and telescoping stops adjustable the entire length of the bar are screwed to it by means of clamp bolts. The head end bracket, holding the bar, carries a spring and solid abutment which limits the sliding movement of the stop bar. The lead-screw is divided at the front of the head-end box, thus making two separate parts; on the right-hand end of the short piece in the box is formed a clutch, which engages with a sliding clutch keyed to the end of the lead-screw. This clutch is connected to the stop bar along the front of the bed by means of a lever pivoted to a stud as shown in Figs. 1 to 4. When actuated the bar has just sufficient movement to disengage the clutch.

At the bottom of the apron, as shown in Figs. 1 to 4, is bolted a bracket with a pivoted arm which engages the stops on the sliding bar. When engagement takes place, the bar slides with the carriage until the clutch on the lead-screw is drawn out of mesh, thus stopping the feed. At the same time the bar comes against its solid abutment at the head end of the bracket. The pivoted arm may be raised out of engagement with the stop, at which time the spring previously compressed by the movement of the bar will force the bar back to its former position and re-engage the clutch thereby again starting the feed.

The previous description of the main features of the machine will make a concise description of the operations performed on the machine possible.

Operation of the Marvel Lathe

The stock to be operated on is delivered to the operator of the machine cut in pieces to the required length. The advantages of this procedure over that of using the stock in a bar passed through the spindle are marked. A considerable amount of floor space is saved, and no stock projects beyond the back end of the machine. The stock is more easily handled, and when the machine is in operation there is no vibration and no noise from a long bar, seldom quite straight, revolving in loose supports. The vibration caused by parts revolving in this manner also greatly impairs the accuracy of the work and the smoothness of the finish.

In the Marvel lathe the piece to be operated upon is inserted in the front end of the chuck and is gripped so that sufficient stock is left for the operation to be performed. The gage screw inside the draw tube is brought against the stock and is then locked. Now the revolving tool-holder carrying a centering tool is brought into position and the projecting end of the piece is centered. The revolving tool-holder is then returned to its rear position, and the tail center is inserted into the center just made in the work and is then clamped in place. The first cut is now started with the tool in the front tool-post and the first stop on the diameter stop bar at the rear of the carriage is clamped in position to give the diameter required. The cut is then allowed to travel the required distance, and the shoulder stops in the front of the machine are set in position. The tool is then withdrawn and the back tool is used for squaring the shoulder, its stop being properly set. The forward movement of the slide for the next cut revolves the diameter stop bar and brings the second stop into position, and the second diameter and shoulder are then turned in the same manner as the first. When the turning of the piece is completed, it is removed from the chuck, but if the piece is of such a nature as to require an operation on the end gripped by the chuck, the finished end is inserted into the chuck and the rough end permitted to project sufficiently to complete the work to be done. When the piece is gripped in the chuck, the projecting end is centered in the same manner as before and the tail-stock center inserted, the following operations being the same as already described.

It is evident that in this manner any number of pieces can be turned rapidly and accurately to the same dimensions. On one of these machines in the Lodge & Shipley shops, any twenty-five pieces taken from a lot have been found not to vary over 0.002 inch either in diameter or length between shoulders. The method of holding the work insures the greatest possible accuracy, in addition to which some operations impossible on the ordinary turret lathes and screw machines are easily performed.

BESLY DOUBLE SPIRAL DISK GRINDER

The accompanying half-tone illustrates a new grinder brought out by Charles H. Besly & Co., 15-21 So. Clinton St., Chicago, Ill., and manufactured at the company's works at Beloit, Wis. The machine is known as the No. 26 Besly double spiral disk grinder and embodies the same general features as to construction, power, rigidity and accuracy, which have previously been referred to in these columns in descriptions of the Besly grinders.

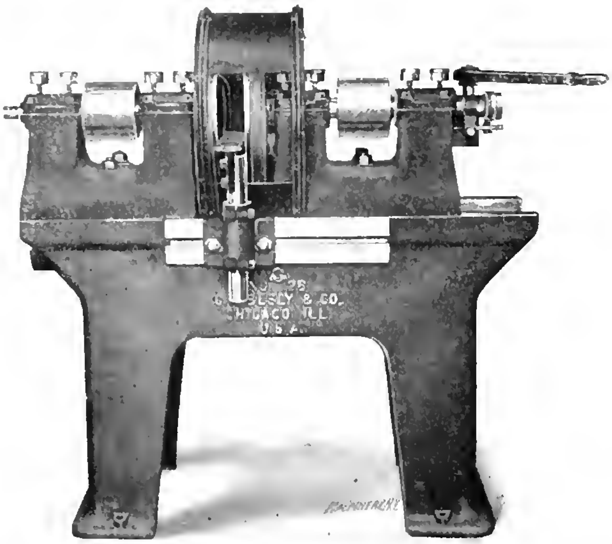
The bed and legs of the machine are cast in one piece, and the bed is provided with a T-slot pad in the front, as shown. The work-rest carriage is attached to the machine by means of two bolts fitting into the T-slot. Seven work-rests are fur-

nished with [illegible] each one varying in width from 7/16 inch up to and including 2 7/16 inches. The heads of the machine are carefully fitted to the top of the bed casting, and are bored and reamed to receive bearing bushings. These bushings are made in halves with the exception of the long rack or lever bearing at the right-hand end of the machine, which is 10½ inches long and made in one piece. The end thrust is taken up by hardened and ground steel collars of large area, and ample provision is made for taking up all wear. Over the bushings are fitted removable caps into which the oil cups are screwed; particular attention has been given to the lubrication of all the parts of the machine.

A dust hood of special construction encloses the disk wheels. This dust hood is built on the telescoping plan, so that the opening between the edges of the dust hood are never greater than the width of the pieces being ground. The top of the hood is hinged and can be thrown back instantly to give free access to the wheels. An opening is provided below the wheels for attaching a 5-inch exhaust pipe.

An interesting feature in the design of this machine, to which attention should be called, is the provision made for a third wheel and rocker shaft, which can be attached to the left-hand end of the machine at any time. On this shaft can be mounted either the geared lever feed table or the swinging or tilted tables made by the company.

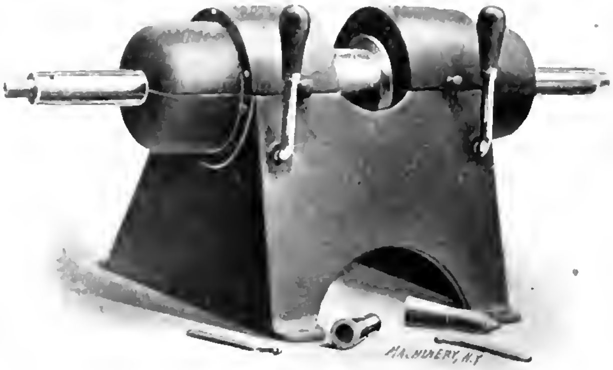
The operating floor space required for the machine is 5 by 10 feet, the floor space of the machine itself being 20 by 44 inches. The height from the floor to the center of the spindle is 42 inches. The disk wheels used are 18 inches in diameter and 5/8 inch thick and run at a speed of 1,650 revolutions per minute. The maximum opening between the disks is 10½ inches. The spindle pulley is 6 inches diameter with 5¼-inch face. The counter-shaft should run at 618 revolutions per minute in order to drive the disks at 1,650 revolutions. The driving pulley and drum pulley are 16 inches in diameter for 5-inch belt, and the tight and loose pulleys 10 inches in diameter for an 8-inch belt. The weight of the machine complete with counter-shaft, not crated, is 2,100 pounds.



No. 26 Besly Double Spiral Disk Grinder

DUPLEX INDEPENDENT END BUFFING LATHE

One of the inconveniences of the ordinary double end buffing lathe used by jewelers, silversmiths and others for polishing, is that it is necessary to stop work on both wheels when one wheel is changed, due to the fact that both polishing wheels are fastened to the main shaft. As the wheels have to be changed frequently, and as it requires some time to change a wheel, the loss of time is considerable. To overcome this difficulty, single end lathes are sometimes used, but the comparative unsteadiness with which they run makes it impossible for an operator to perform good work, and the extra amount of space required for an equal number of operators is considerable. For this reason, A. B. Nutting & Co., Amesbury, Mass., have brought out a new double polishing lathe where the polishing wheels can be independently thrown into or out of engagement with each other by means of simple friction clutches, operated by the hand levers in the front of the machine shown in the accompanying illustration. A slight movement instantly throws one wheel into or out of action without shifting the belt or interfering with the running of the other wheel.

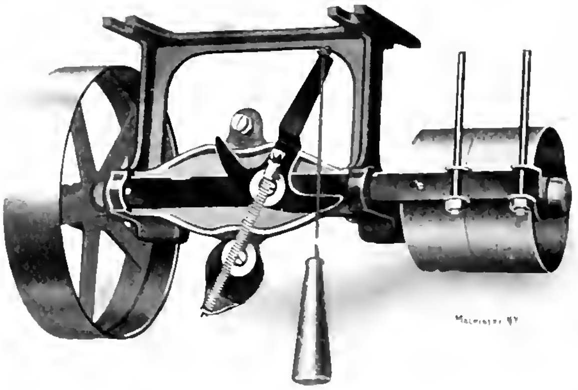


Nutting Duplex Independent End Buffing Lathe

The frame of the machine which occupies a bench space of 12 by 17 inches is made in box form and is provided with dust-proof casings covering the bearings and working parts completely. The bearings are cast to the frame so that they are always in alignment and the journals are constantly flooded with oil. The spindles and the main shaft have a special adjustment to compensate for the end thrust wear. The ends of the spindles are detachable and any length or form can be substituted, making it possible to use the machine for all classes of work. The drive is by means of a 3 by 3-inch pulley running between the bearings as shown and belted from above or below. All the running parts are balanced and can be run at a rate of 3,500 revolutions per minute without causing difficulties.

PULLET BELT SHIFTER AND COUNTER-SHAFT

A decided improvement on the old wood shipper for shifting the belts on counter-shafts is shown in the accompanying half-tone, illustrating the Pullet belt shifter and counter-shaft brought out by the L. & D. Co., 88 Broad St., Boston, Mass. The construction of this shifting device is as follows: An oscillating lever to which a pull cord is attached is mounted on a sliding shifter bar and is kept in position by a compression spring which also locks the shifter bar at each stroke. The pivoted spring support always keeps in line with the direction of the push of the spring. When the handle attached to the cord is pulled, one wing of the oscillating lever engages a pin fixed in the base-plate. This pin then acts as a fulcrum so that the shipper bar is forced to the left (assuming the parts to be in the position shown in the illustration). The initial pull on the pull cord forces down the shipper bar so that the notch in it no longer engages the frame casting, thereby permitting the bar to move.



The Pullet Belt Shifter and Counter-shaft

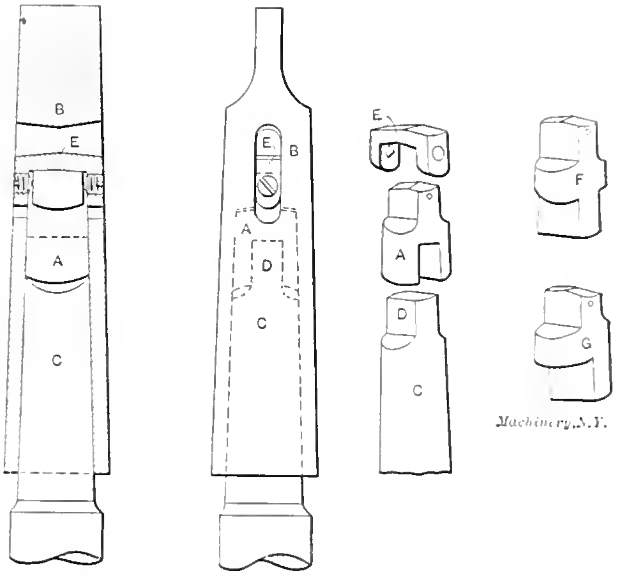
At the end of a stroke, however, the notch at the other end engages a stop on the base-plate, and as the center of rotation of the oscillating lever is now on the opposite side of the vertical center line, the spring throws it into a position the reverse of that shown in the illustration, from which it is ready to be shifted back by a new pull on the cord. Thus a pull on the cord will shift the belt in either direction.

One advantage of this shifter is that the handle can be located directly over the work. By clamping the base-plate upside down and running the cord over pulleys, the machine can be stopped and started from any point. The shifter can be applied to any ordinary counter-shaft by clamping it to a pipe screwed into a flange in the ceiling, thus making it adjustable vertically. In the illustration, however, the special Pullet counter-shaft is shown, provided with a frame to which the shifting device is directly attached. While the hanger and shifter support are complete in one casting, the shifting device can be quickly inverted, so that a pull cord can be run over pulleys as already mentioned.

There are three sizes of the Pullet shifters, each size being adjustable for two lengths of throw (two widths of belt). For instance, a shifter for 1½ and 2-inch belt, respectively, can be used for the one or the other, simply by turning over the shifter bar so that the respective notches are brought into use. The shifters have the further advantage that they cannot easily get out of order. They make the shop look neater and more pleasant than when full of wooden shippers, and the simplicity of construction brings the cost to a very reasonable figure.

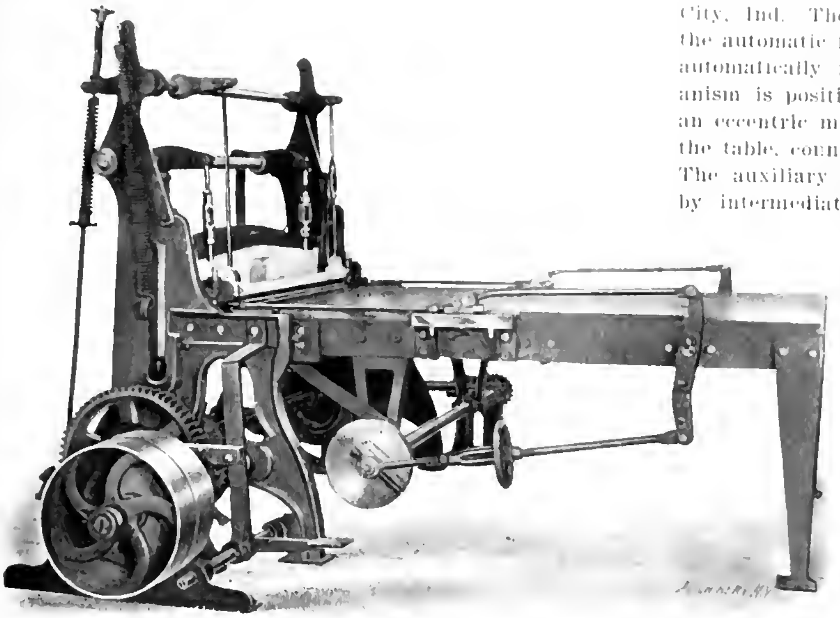
GROSS & GROSS INTERMEDIATE DRILL SHANK TANG

The device shown in the accompanying line engraving is an improved method of driving twist drills and other tools provided with an end tang for driving, and is the invention of Messrs. Gross & Gross, 1616 No. 4th St., Harrisburg, Pa. In order to overcome the common occurrence of the tangs of twist drills becoming distorted or broken off on account of being subjected to too great a stress, an intermediate driving block *A* has been provided which may be placed in the socket *B*, and it is only necessary to form a new tang on the drill shank *C*, after the original tang has been broken off. Any torsional stress on the drill shank and tang will be transmitted to this intermediate tang, which will break before the new tang *D* on the drill shank *C*. If the intermediate tang *A* breaks, a new one can readily be substituted for the broken one at a cost which is comparatively slight as compared with the cost of a new drill. In operations where a frequent change of drills is not required, the intermediate tang *A* is used without the part *E*, but in operations where it is required to change the drill often, the intermediate tang is used in connection with a holder *E* to prevent the falling out of the intermediate tang from the socket at the time of removal of the drill; this holder may also be conveniently manipulated to disengage the drill in the socket. The intermediate tang *A* may be used for any make of socket. At *F* and *G* are shown modified forms of the intermediate tang.



A New Device for making possible the Use of Broken-off and Re-tanged Twist Drill Shanks in Regular Drill Sockets

BERTSCH AUTOMATIC FEED SHEAR



Automatic Feed Shear built by Bertsch & Co.

In the accompanying illustration is shown a new shear recently designed and built by Bertsch & Co., of Cambridge City, Ind. The most prominent feature of this machine is the automatic feed mechanism whereby the sheet to be cut is automatically fed in between the blades. This feed mechanism is positive and works very accurately. It consists of an eccentric mounted on an auxiliary shaft suspended under the table, connecting rods and levers, and a clamping device. The auxiliary shaft is driven from the main driving shaft by intermediate gearing. The clamping device consists of two plates or jaws which at the proper time grip the sheet and automatically move it towards the blades. At the moment when the feeding mechanism has placed the sheet in the required position to be sheared, the regular "hold-down" descends ahead of the top knife and holds the sheet in place during the shearing operation. While the shearing is being done, the plates or jaws of the feeding mechanism release the grip, and move away from the blades into a position where they are ready to grip and feed the sheet for the next cut. The jaws gripping the sheet are opened and closed by means of an eccentric on the main driving shaft, which actuates the connecting arms and rods shown in the illustration above the clamping device. The feeding mechanism can be so adjusted that it will automatically shear the sheet into uniform strips of any width from 1/16 inch to 12 inches. Either a single sheet of any desired width up to the capacity of the machine, or several narrower sheets placed side by side can be automatically fed in this manner. Owing to the fact that the feed mechanism is designed as an independent device attached to the machine, it can be applied to any standard shears built by the makers.

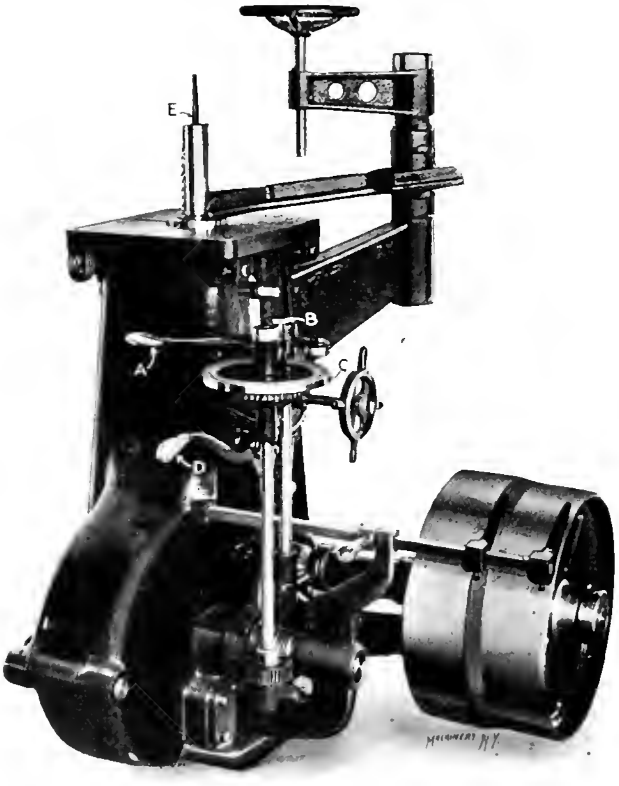
An automatic feed arrangement of the type shown adds considerable to the usefulness of the shear, and makes possible a marked increase in the output, at the same time as accuracy of the product is much more easily obtained.

LEES-BRADNER AUTOMATIC GEAR-CUTTING MACHINE

The accompanying illustration shows a general view of a machine designed by Mr. E. J. Lees of the Lees-Bradner Co., 923 Schofield Building, Cleveland, O., and intended for hobbing spur, spiral and worm gears and also for threading worms. The machine has a capacity of cutting spur and spiral gears of up to 14 inches in diameter and four diametral pitch; worm gears of the same diameter up to one inch circular pitch; and worms of one inch pitch and any lead, up to 8 inches long and 8 inches in diameter. The machine works on the generating principle, using hobs for cutting gears. For worms, however, a single cutter is used, the machine working in a manner similar to a thread milling machine.

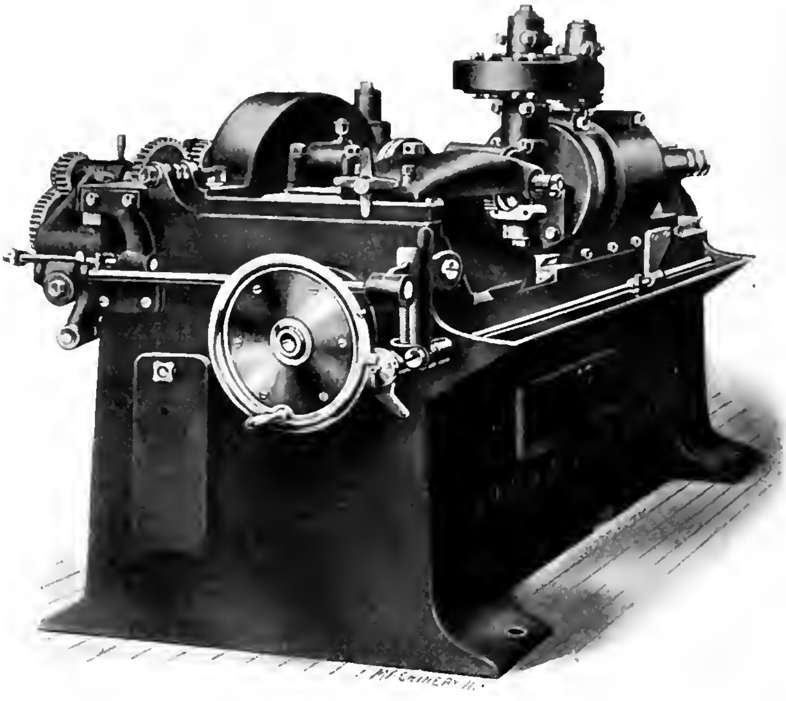
The drive of the machine is by belt on a three-step cone, and the machine is back-geared in the ratio of 8 to 1. The swiveling head can be moved 180 degrees and has no over-hang. The swiveling mechanism consists of one pair of bevel gears inside of a large cylindrical head, which in turn fits into another cylindrical bearing on a slide. The mechanism is rigidly locked to the slide by bolts on either end. All movements are in one direction in all operations, so that back-lash is entirely eliminated. The screws used for feed and head slides operate with a draw pull and not with a pushing action.

The work-spindle and arbor are horizontal, and the arbor is rigidly supported at both ends, which is highly important, especially when cutting the teeth in spiral gears. Provision has been made in the design so that the larger the diameter of the gear to be cut, the closer the cutter is brought to the original point where the power to the cutter spindle is delivered. As the work-spindle has a three-inch bore, gears made in one piece with, or placed on, a shaft can be either held in the spindle with a draw-in collet or can be held between centers.



Lapointe Vertical Key-seating Machine with Automatic Feed, Release of Cutter and Stop

A micrometer is provided for gaging the depth of the cut with graduations on a disk 6 inches in diameter, which is locked at zero with a thumb-screw when starting to take the reading. This provides for an easily adjusted and quickly operated micrometer for duplicate work. When operating the machine the necessary depth is obtained by adjusting the head at the same time the micrometer is set, after which the work is fed across the cutter head. At the completion of a cut the main drive is automatically thrown out and all mechanisms stopped simultaneously. This is a necessary requirement in cutting spiral gears and relieves the operator of constantly watching the machine in order to stop it at the right moment. When setting for the depth of cut, a stop rod collar is adjusted, and an original feature introduced permits the slide to be backed away to any distance and yet returned to its original setting to a positive stop without attention to graduations; although, if the operator wishes to set the cutter in or out a few thousandths inch, the original reading is visible on the disk and can be worked from.



Lees-Bradner Machine for Cutting Spur, Spiral and Worm Gears and for Threading Worms

A feature of interest in the machine is that it can cut worms advantageously. When cutting or threading worms a single cutter is used running from 75 to 117 revolutions per minute. The cutter head is very rigid in order to eliminate any possibility of lack of uniformity in the worm thread. The worm can be mounted on an arbor held either between centers or in a draw-in collet, the other end of the arbor being supported either on a center or in a bushing.

All the mechanism is in one horizontal plane, and, therefore, all parts can be readily reached. Adjustments are provided where required for taking up back lash. The chips are disposed of without coming in contact with any of the moving parts and are removed by taking out a pan located directly back of the door in the frame of the machine. The chip pan and the receptacle for oil are the only parts inside of the frame. The oil pump is located on the outside and below the oil supply, which obviates the necessity of priming the pump.

LAPOINTE VERTICAL KEY-SEATING MACHINE

The machine illustrated in the accompanying half-tone engraving is designed and built by the Lapointe Machine Tool Co., Hudson, Mass. It is intended for general key-seating, and is provided with automatic feed, automatic release for the cutter, and automatic stop for any depth of keyway desired. The work to be operated upon in the machine is first put onto a bushing fitting the hole in the work, and is fastened by means of a clamping arm, one end of which rests on the work and the opposite end on a post adjustable to the height of the work; the clamping arm is held down by

means of a screw provided with a hand-wheel. The machine is then started by means of the operating handle *A* and the depth of cut required is determined by means of the depth regulator *B*, which can be set in any of the holes in the index plate *C*. When the machine is in operation, the index plate revolves, and in due time the depth regulator or finger comes in contact with a cam on the operating lever, thereby stopping the machine. The index plate is provided with forty holes, the distance between each hole being equivalent to a depth of 0.010 inch in the keyway.

The cutter consists of a broaching bar provided with ten teeth, each cutting its proportionate part at each stroke of the bar. The fact that the bar is provided with a series of teeth reduces the number of strokes necessary for cutting keyways as compared with the time required when using a bar with a single cutter. The feeding of the cutter is accomplished by means of a wedge *E* sliding on the back of the bar, automatically advancing at every stroke, and automatically released on every return stroke by allowing the wedge to drop back half the distance of its advance, so that the cutter is prevented from rubbing against the work on the return stroke. The machine is provided with quick return for the cutter bar.

The machine has a tilted table used when cutting tapered keyways, and is also arranged for hand operation when required, the feed being disconnected by the feed-key releasing handle *D*. The drive is by means of a tight and loose pulley, so that it can be belted directly to the main shaft, thereby making a countershaft unnecessary. The loose pulley is provided with a self-oiling arrangement and will run for at least a year without attention.

THE CHICAGO DUPLEX HAND MILLING MACHINE

A number of improvements have been introduced in the new design of the Chicago hand millers, manufactured by the Chicago Machine Tool Co., of Chicago, Ill., the most important ones of which are illustrated in the accompanying half-tone engravings. The machine is of the "Duplex" type, the name being derived from the fact that a vertical attachment is furnished with each machine. The combination of both vertical and horizontal spindles on the same machine together with an exceptionally large range for a hand miller, adapts it to a large variety of work. The machine illustrated is known as the No. 3 Duplex miller, and is shown in Fig. 1 with the vertical attachment in place. This attachment is one of the most important features of the machine, as it makes it particularly adapted to tool-room work and also makes it valuable in the manufacture of small parts for locks, typewriters, guns, sewing machines, etc. In Fig. 5 is shown a front view of the machine with the vertical attachment in place. It will be noted from these two illustrations that the machine is of a particularly rigid design. The table has a very wide bearing on the saddle in order to insure rigidity, which is an essential feature in any type of milling machine. A taper gib is provided for taking up the wear; this gib is easily adjusted when required.

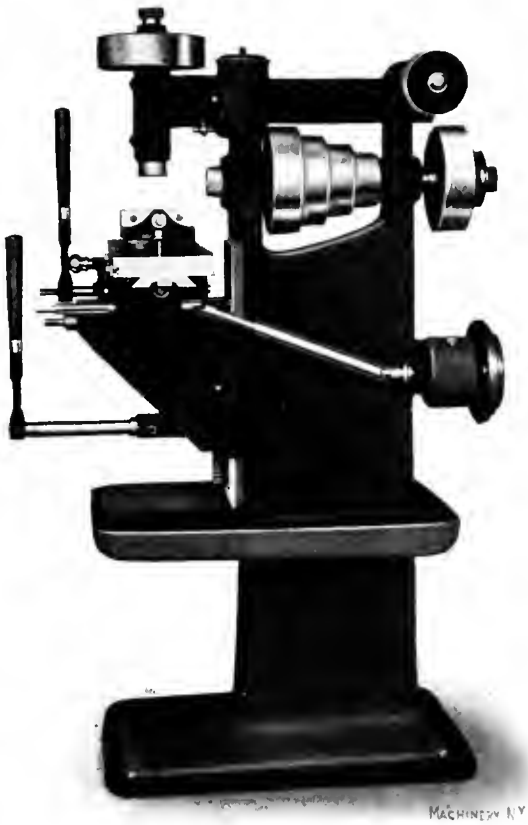


Fig. 1. Chicago Machine Tool Co.'s No. 3 Duplex Hand Milling Machine with Vertical Attachment

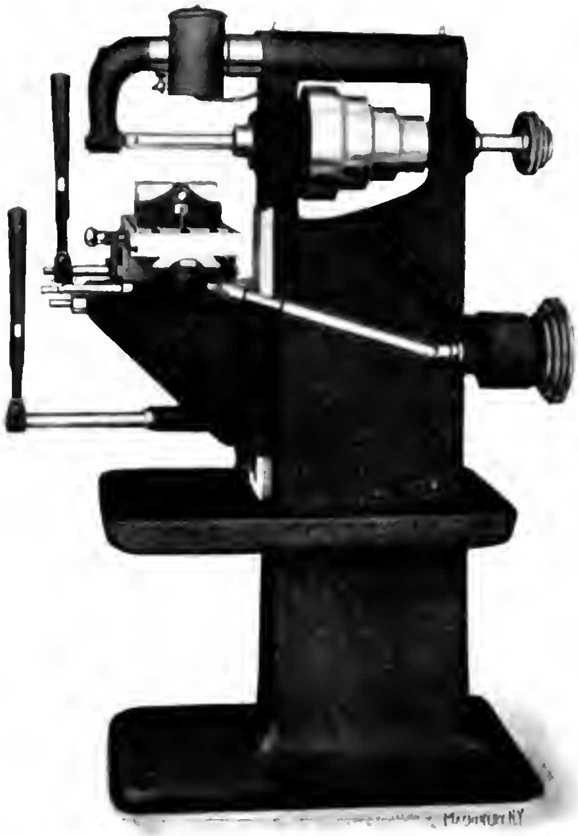


Fig. 2. The Chicago Duplex Miller with Overhanging Arm, ready for Horizontal Milling

Fig. 3. Parts of Vertical Milling Attachment

The saddle is so proportioned that the overhang of the table is minimized even when feeding the work to the limit of the capacity of the machine. The design permits the application of automatic feed at any time, if required. The knee is of box construction, and having no opening at the top, there is no tendency to spring it when the saddle is clamped. It will be noted in Fig. 1 that the knee has a long bearing on the column in order to give the required stiffness. The machine has a crank feed for the table as well as a hand lever

feed or hand feed. The hand lever can be used to good advantage for quick return of the table after a cut has been taken. A hand lever feed for the vertical movement of the knee is also provided, as shown in Fig. 5. This hand lever is fastened to a shaft carrying on its other end a pinion meshing with a rack, secured to the column. A bracket which carries the nut for the transverse feed-screw is fastened to the saddle and extends into a slot cast in the side of the knee. This arrangement protects the feed-screw and prevents chips or dirt from falling inside the knee.

Fig. 4. Part of Column for Hand Miller, showing Oil Reservoirs

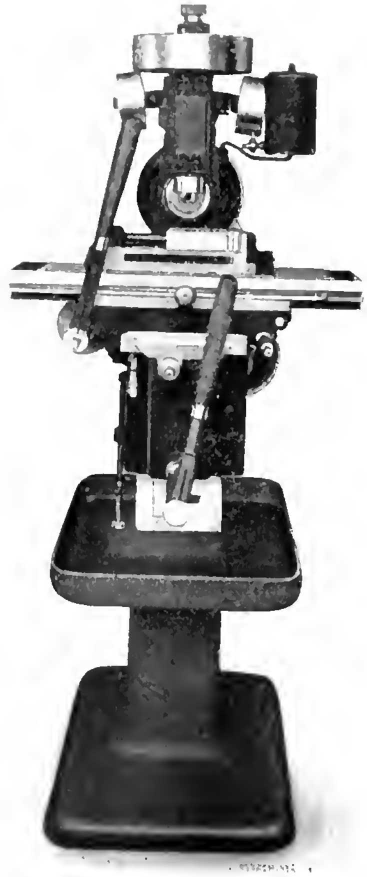


Fig. 5. Front View of Chicago Hand Miller with Vertical Attachment

The Vertical Attachment

One of the main features of the vertical attachment is that there are no gears in connection with its drive, it being driven by a belt from a pulley on the rear end of the horizontal spindle, as shown in Fig. 1. The belt runs over idler pulleys shown at the top of the machine. In Fig. 3 are shown the main parts of the vertical attachment. The spindle *A* is bored to receive a No. 9 Brown & Sharpe taper. This spindle runs in the split bronze bearing *B*, a slot in which runs the entire length of the bearing and in which is laid a wick for lubrication. The casing *C* which contains the spindle bearing, spindle and other parts, is also split and provided with screws for taking up any wear that may occur in the bearing. In this casing an oil reservoir *D* is provided, this being cored out in the casting. The ends of the wick previously mentioned are dipped into this reservoir which contains enough oil for the running of the machine for a full year. The arrangement insures perfect lubrication of the bearings, eliminates wear, and makes smooth running possible. The same illustration also shows the draw bar *E*, the sleeve *F* and the collet *G*. End mills are held in place in the vertical attachment by the draw-in collet, this latter being interchangeable on the vertical and horizontal spindles.

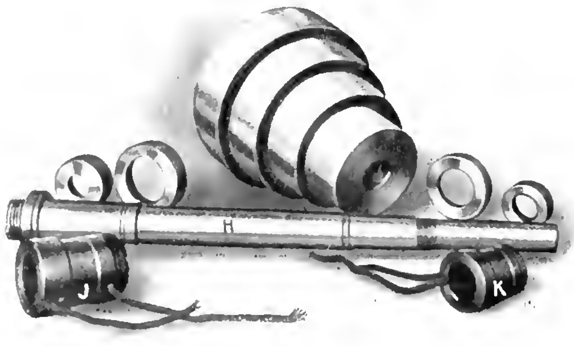


Fig. 6. Horizontal Spindle and Bearing Bushings

The Machine Used as a Horizontal Miller

In Fig. 2 the machine is shown with the vertical attachment removed and the overhanging arm in place supporting the outer end of the arbor. It takes but a few minutes to change over the machine from vertical to horizontal. The horizontal spindle of the machine is bored to receive a No. 9 Brown & Sharpe taper shank.

The respective parts of the horizontal spindle are shown in Fig. 6, in which illustration *H* is the spindle proper, and *J* and *K* bronze bearings fitted to tapered bores in the column. Adjusting collars are provided for taking up the wear occurring in the bearings. The wicks provided for the lubrication are also shown and a good idea of the novel arrangement provided for the oiling of the bearings may be obtained from Fig. 4. Two reservoirs *L* and *M*, cored out in the casting, are provided in the column under each bearing; these are filled with cotton and oil and furnish sufficient lubrication for a full year by means of the wicks in the bronze bearings laid in a groove cut for the purpose. The machine may thus be run at high speeds without danger of heating the bearings.

The Power Feed

The power feed of the machine is taken from a cone pulley at the rear end of the spindle to a three-step cone pulley on the rear of the gear box, as shown in Fig. 1. From the gear box the drive is through the universal joint shaft to a pair of 45-degree spiral gears in the saddle. As shown in Fig. 7, a worm is fastened on the same shaft as one of these spiral gears and the whole mechanism is held in a rocker which throws the work in and out of mesh with a rack in the table. The worm has at all times five teeth in working contact with the rack.

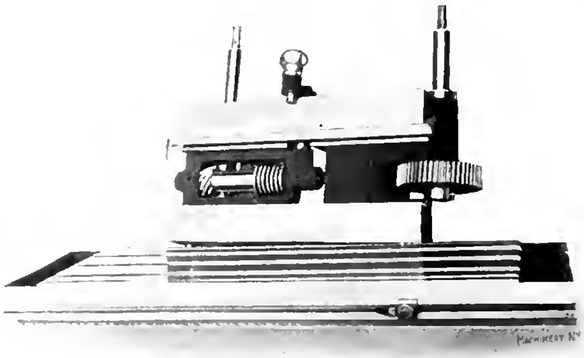


Fig. 7. Table and Saddle of Chicago Hand Miller

The design of the gear box is shown in Fig. 8. The feed gear mechanism consists essentially of a set of planetary gears contained in a compact case. Through this set of planetary gears the desired reduction of the spindle speed is obtained to give the proper feed for the table. The feed mechanism is

extremely simple and yet very effective. The cone pulleys which transmit the power from the spindle to the feed gear box are interchangeable, so that six changes of feed are obtainable.

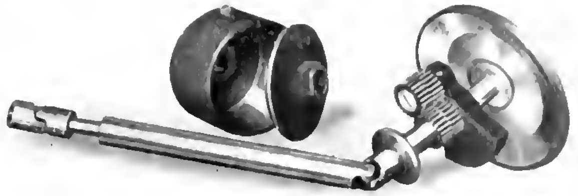


Fig. 8. The Simple Gear-box Parts of the Chicago Hand Miller

The counter-shaft furnished with the machine has self-oiling shaft bearings and it is not necessary to refill the oil chambers more than once a year. This feature alone is of great importance as it eliminates the usual counter-shaft troubles.

Messrs. Hill, Clarke & Co., of Chicago, Ill., are the selling agents of this machine and it may be seen in operation in the demonstration shops of this concern.

ATTACHMENT FOR CUTTING HELICAL STEEL GEARS

In the April, 1909, issue of MACHINERY an article was published entitled "Cutting Helical Gears on the Brown & Sharpe Automatic Screw Machine." This described the tools and methods employed in the unusual operation of cutting helical gear-teeth in the screw machine. As will be remembered, this was done by running a revolving gear, having teeth of such shape as to mesh properly with the finished work, over the revolving blank; the face of the gear was ground, and set in the same plane with the axis of the work, thus providing a cutting edge which formed the teeth in the blank. The tool illustrated herewith, made by the Brown & Sharpe Mfg. Co., Providence, R. I., works on the same principle, as will be understood from the following description. Certain very interesting changes have been made in its construction, however, to fit it for heavy cutting in steel, the former tool being better adapted to work on brass and similar materials.

In the original attachment, the cutter was driven from the work by a three-cornered center, which was forced by spring pressure into the bore of the blank. For cutting steel it was found unsafe to trust this, so another, and very ingenious, expedient was resorted to. On the rear cross-slide in Fig. 1 is shown mounted a milling attachment. Just previous to the tooth-cutting operation, the work spindle is stopped, and the revolving cutter of this attachment [illegible] up [illegible] the outer end of the unfinished blank, milling a keyway [illegible] not quite to the center, as shown in Fig. 2. The milling attachment is then withdrawn, the work spindle is started up and the tooth cutting tool is brought into action. The point of the driving spindle A, Fig. 4, enters the bore of the work. To A is pinned the clutch B having a single tooth, which engages the cut or recess in the work, and thus drives the spindle A and the connected train of gears. After the cutting of the teeth, the hub of the work is faced off as shown to the right, Fig. 2, thereby removing the milled recess. This method gives a drive strong enough for the heaviest duty, up to the point of breakage.

The principle of operation is the same as in the case of the original tool. As the attachment is fed onto the work, the spindle A (Fig. 4) is driven by the means just described, clutch B being held in engagement by the pressure of a long spring in the shank of the tool. A long worm D, keyed to the spindle A, and moving longitudinally with it, engages a worm wheel E, which is keyed to an arbor carrying driving gear F (Fig. 3) at the outer end. This latter, through idler G, drives gear H, which is keyed to the cutter spindle. The cutter J is thus driven in synchronism with the rotation of the work.

As described in the previous article, provision is made for keeping the cutter and work in step with each other during the longitudinal feeding of the turret slide. As the attachment is pushed over the work, spindle A, clutch B (in engagement with it), and worm D are pushed back against the pressure of the spring in the shank of the tool. This backward movement, through the axial movement of D, rotates worm-wheel E in just the right ratio to keep the cutter in step with the work. The cutter J and the work are thus always in step with each other, whatever the rate of rotation of the work, or the feeding movement of the attachment. The slow forward feeding of the latter over the work thus causes the hardened and ground face of the cutter J to form teeth of the desired shape in the work.

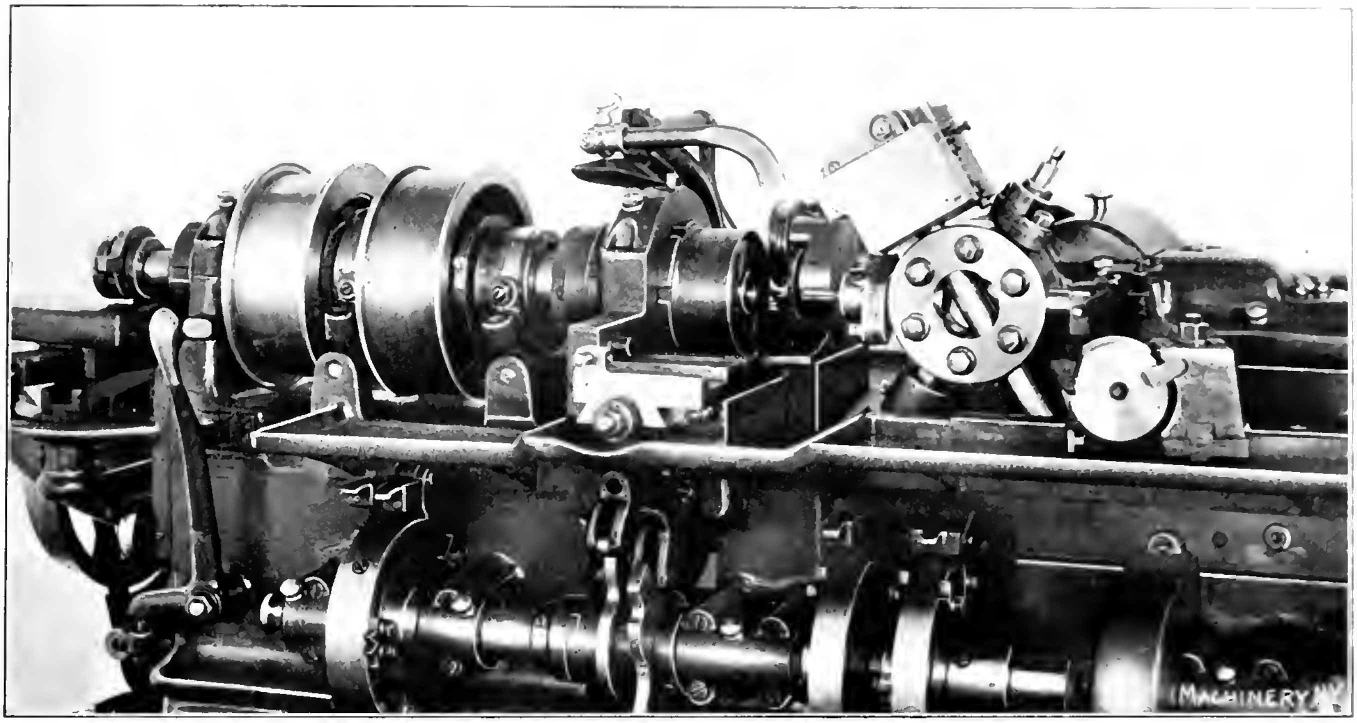


Fig. 1. Automatic Screw Machine with Attachment for Cutting Helical Steel Gears

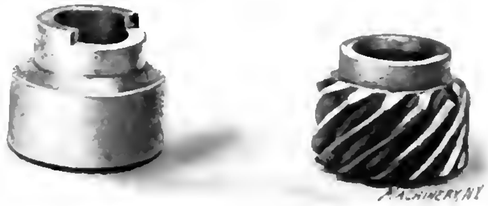


Fig 2. Blank with Recess for driving while Teeth are cut, and Finished Gear

A number of adjustments are provided in this improved attachment, which tend toward increased convenience and accuracy. The spindle of worm-wheel *E* and gear *F* is mounted in an eccentric sleeve, which may be rocked by suitable adjusting screws to take up all back lash between *D* and *E*, and still leave a running fit. Sector *K* is pivoted to a hub on this eccentric sleeve, so that *G* is always in proper mesh with *F*, and so that it may be adjusted to properly mesh with *H*. A screw locks this adjustment.

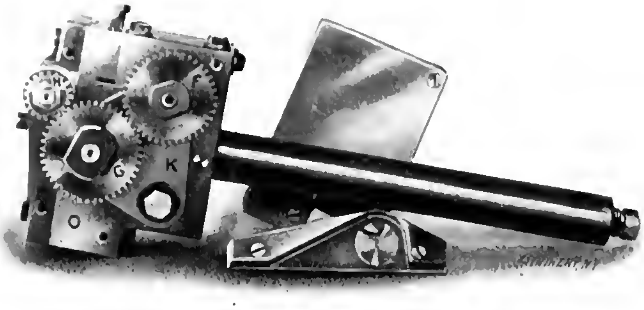


Fig 3. Front Side of Spiral Gear-cutting Attachment for Steel Gears, showing Gearing

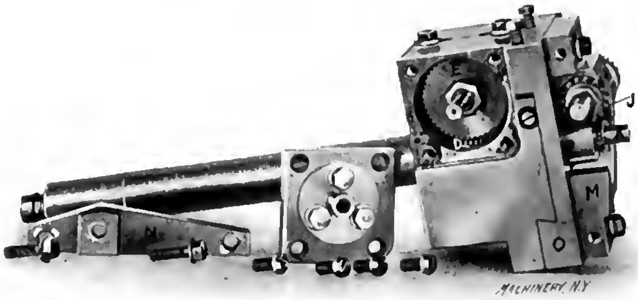
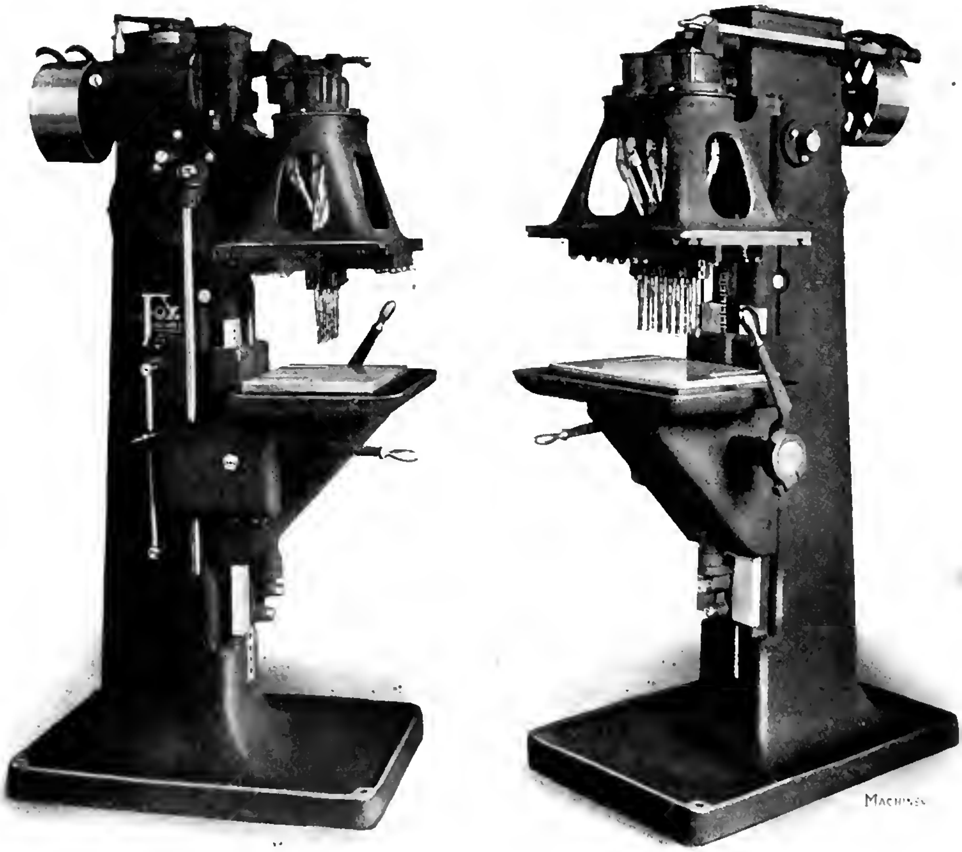


Fig 4. Rear View of Attachment showing Driving Clutch, Worm-gear and Tooth-cutting Tool

The cutter spindle is mounted in a slide *M*, which is adjusted vertically to give the desired pitch diameter for the finished gear teeth. The overhanging end of the spindle is supported by the outboard bearing *N*. Slide *M* is supported, in turn, on cross-slide *O*, which may be adjusted horizontally to bring the face of the cutter in the same plane with the axis of the work. Both the vertical adjustment for diameter and the horizontal adjustment for centering the cutter are effected by fine pitch adjusting screws; when made, the adjustments are firmly held by clamp bolts.

FOX ADJUSTABLE MULTIPLE SPINDLE DRILL

The accompanying illustrations show two views of the No. 2 Fox universally adjustable multiple drill, a description of the various features of which is given below. This machine is built and placed on the market by the Fox Machine Co., 815-825 N. Front St., Grand Rapids, Mich.



Figs. 1 and 2. Fox Universally Adjustable Multiple Spindle Drill

The machine is intended for drilling any number of holes up to sixteen, simultaneously. Each drill is driven through a universal joint, the drill spindles proper having an independent vertical adjustment of two inches, so that even though the drills may be of different lengths, they may be all set so as to start at the same time. The spindles are driven entirely through gears, four speed changes being obtainable. The main drive consists of a loose and tight pulley having a 4-inch belt. The pulleys are 14 inches in diameter and are so placed on the machine that a convenient arrangement for motor drive can easily be made.

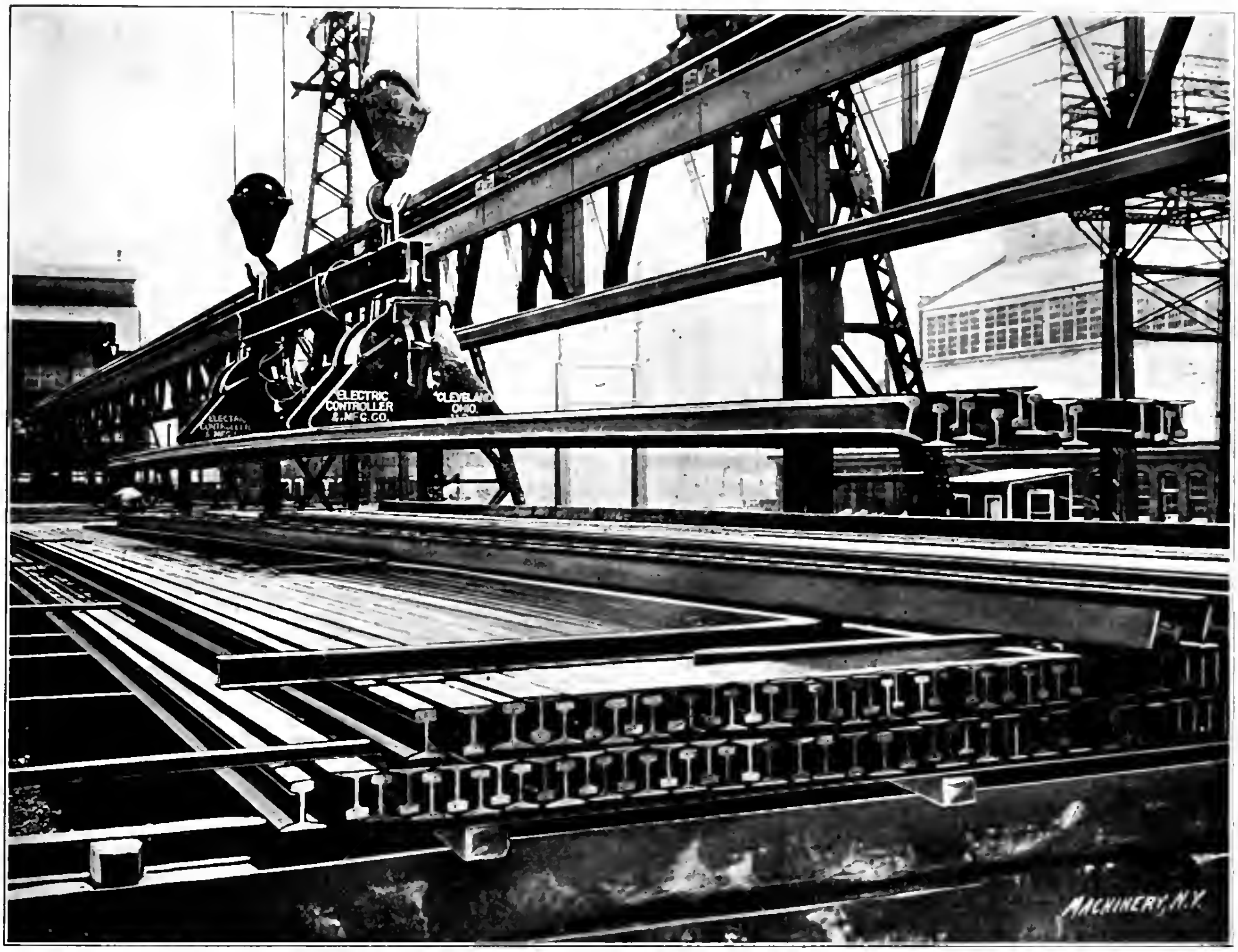
The drill head is bolted solidly to the column and the feed is accomplished by raising the knee of the machine while the drills remain stationary in the longitudinal direction, capable only of the vertical adjustment, already referred to. The standard drill head is adapted for drilling holes within a rectangle 8 inches wide by 14 inches long, but the head may be varied somewhat to meet special conditions. The main driving shaft runs at a constant speed and the feed mechanism is operated directly from this shaft. Five changes of feed are obtainable, and as the whole feed mechanism is operated by means of gearing, it is entirely positive in its action. An automatic trip is provided so that at the proper time the feed is thrown out, and then the table returns automatically to its lowest position. An adjustable buffer is provided so as to eliminate the shock when the table descends to the required position on the machine. The knee may be operated either by hand or power feed through a steel pinion meshing with a wide steel rack bolted to the face of the column. This latter is of a cored-out box section and is provided with a very substantial base having an oil pan along the edges; the table is also provided with very liberal oil channels along its outer edges. The knee is made of a full box section to insure sufficient strength and eliminate vibration. The entire machine is constructed on the unit system, each of the various units being attached to the main frame.

Spindles, shafts, etc., are all finished in the grinding machine. All sliding bearing surfaces are carefully scraped, and the drill spindles are made of high grade steel running in bronze bearings. The gears are all made of steel or bronze, and the principal steel gears are case-hardened.

The machine, as regularly furnished, will drive from 1/16 to 3/8-inch drills. The latter size drills require somewhat heavier spindles and universal joints than the former. The machine may, however, be furnished for special requirements to drive sixteen 3/8-inch drills, twelve 1/2-inch drills, ten 5/8-inch drills, and eight 3/4-inch drills.

RAIL-LIFTING MAGNETS

An improved design of rail lifting magnets brought out by the Electric Controller & Mfg. Co., of Cleveland, O., was illustrated and described in detail in the December, 1908, issue of MACHINERY. The same company has lately completed some very large lifting magnets for the handling of the entire output of the rail mill of the United States Steel Corporation's plant at Gary, Ind. This rail mill is of the most modern design in every respect and electric power has been used throughout for driving purposes. It was therefore a logical development to handle the finished rail by lifting magnets, provided a successful magnet could be designed. The difficulty met with in the design of the magnet was that, while it was desirable from the standpoint of rail mill and railroads alike to ship rails in locked sections, this arrangement of the rails made it particularly difficult to handle them with a magnet, the difficulty arising from the fact that the top layer of the rails practically short circuited the magnet field, and the magnets had to be very powerful and carefully designed in order to have sufficient strength to lift the bottom layer. Successful magnets were, however, furnished by the Electric Controller & Mfg. Co., and in the accompanying illustration one of these magnets is shown in operation. The magnets are capable of lifting locked sections of both 33- and 60-foot rails having an aggregate weight of 15 tons.



Electric Controller & Mfg. Co.'s Rail-lifting Magnets in Use lifting 60-foot Rails

The advantages of using lifting magnets for work of this kind may be summed up as follows: Sufficient labor can be dispensed with to make the application commercially profitable as regards cost; a large saving in time of handling is effected, and as there is no possibility of bending the rail when loading by magnets, loss on this score is eliminated.

MACHINE FOR HOBBING TAPS

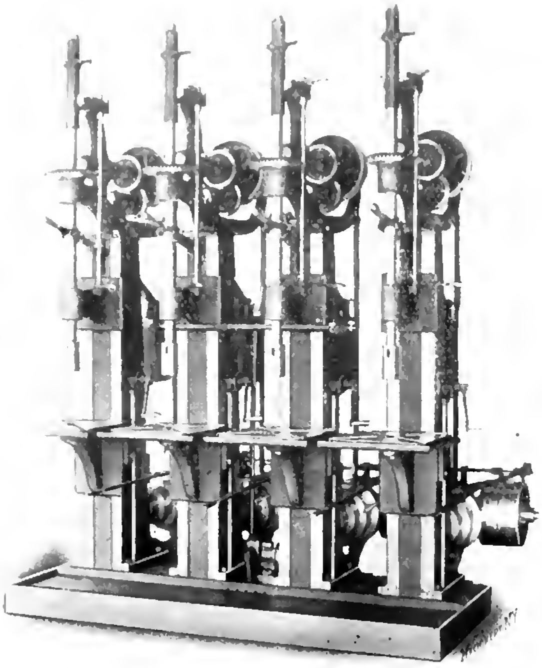
A new type of drill press, specially designed for use in the manufacture of taps, is shown in the accompanying illustration. The machine is built by the Hoefer Mfg. Co., Freeport, Ill., and embodies several interesting features which, together with the simplicity of action of the machine, ought to make it valuable for the purpose for which it is intended.

The machine resembles in many respects an ordinary drill press, but it differs notably in that the automatic feed is obtained by means of a lead-screw on the upper end of the spindle, which for this purpose is extended through the crown gear. The upper end of the spindle is turned down to a smaller diameter, and the lead-screw, consisting of a threaded sleeve, is fastened on the spindle by means of a lock nut. The lead-screw is removable, so that in each case it has the same lead as the tap to be threaded.

The tap blank is inserted in the vertical spindle in the same way as the tap itself would be inserted in a drill press used for tapping, whereupon the blank is driven through a die bolted to the table below. The tap blank passes through two dies, one for roughing and one for finishing. When the threaded portion of the tap blank has passed through the die, the special fixture or chuck holding the tap blank releases its hold on the shank, and the tap drops through a hole in the table. At the same time an adjustable dog clamped on and revolving with the threaded sleeve or lead-screw throws out of mesh the nut which engages the sleeve, whereupon the spindle returns to its original position, automatically, actuated by a counter-balance weight. The machine is then ready for another blank. The nut engaging with the sleeve is again thrown in mesh by means of a hand lever on the side of the lower spindle bearing.

The lower end of the spindle is provided with a Morse

upper end which is fitted a special fixture for holding the shank end of the tap blanks. An interesting feature in connection with the spindle end is the special method employed for cutting the slot required for removing the Morse taper shanks. Most manufacturers make slots for drift pins by drilling three holes through the spindle and then working out the remainder of the metal by means of a chisel. In the present case, however, the slots in the spindle head are milled out on a machine made for that purpose with two milling cutters working one from each side simultaneously. This results in a central and smoothly finished slot.



Hoefer Mfg. Co.'s Machine for Threading Taps

The machine as shown in the accompanying illustration is provided with four spindles and thus provides for two sets of dies. One man can easily operate a machine of this type. Each of the spindles is attached to an independent column, and is equipped with its own independent driving mechanism, although all four columns are bolted to the same baseplate. As will be seen from the illustration, the columns supporting the spindle heads and driving mechanism are of the box type, in order to provide strength. The upper head is fitted with an additional brace supporting the outer end of the cone pulley shaft. One oil pump supplies oil to all the four spindles, and drainage is provided from the tables to the oil pan base so that the oil can be used over and over.

Due to the fact that the threading of tap blanks does not require high speed, the back-gears are designed to be left permanently in mesh and changes of speed are made only by shifting the belt on the cone pulleys. Each lower cone pulley is driven at right angles from a shaft having a loose and tight pulley, so that each spindle can be stopped independently by means of the belt shifting levers projecting through under the tables. Each table can also be raised and lowered independently of the others by means of a screw passing through a nut attached to the table and provided at its upper end with a bevel gear drive and crank.

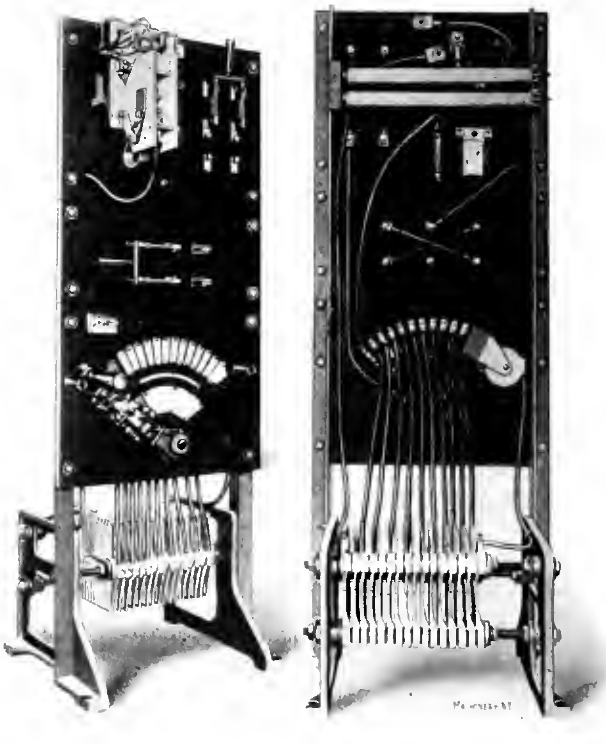
A NEW LINE OF MOTOR STARTERS

A new line of motor starters has been brought out by the Electric Controller & Mfg. Co., of Cleveland, O., one example of the new type being shown in the accompanying half-tone, where both a front and rear view are illustrated. The new design has been brought out on account of the demand for a motor starter of rugged construction. The improvement on previous types is embodied in the following features. The magnetic switch can be closed only by bringing the arm to the "off" position, thus preventing injuries and overloads to the motor upon the return of voltage after voltage failure. The magnetic switch can be held closed to the arm on any accelerating step only by holding in a push button; this prevents any of the starting resistance being permanently left in the circuit and thereby burning out the resistance. Finally, the magnetic switch will maintain itself closed only when the arm is at the "full-on" position.

The new line of starters is essentially of the mill type design. They are made in panels having supporting feet, as shown, and are completely self-contained; the dimensions of the different types vary only in height. Nothing projects beyond the slates, so that adjacent starters may be placed side by side, forming a continuous control board.

Experience has shown that the no-voltage protection secured by a spring return arm is open to the objections that the spring is likely to be either broken or weakened, so that upon voltage failure the arm does not return to the "off" position; in the second place, the contacts may become so roughened that the spring is not powerful enough to move the arm. Besides, an ignorant operator may block the arm in the "off" position, so that it is impossible for the spring to properly perform its function. If the arm is not returned to the "off" position upon voltage failure, the motor will be subjected to a damaging overload upon the return of the voltage. In this line of motor starters, therefore, the spring is eliminated, and the no-voltage protection is secured by a magnetic switch which opens upon voltage failure. The same magnetic switch in connection with an overload coil is used for securing overload protection. The feature for securing overload protection thus possesses the same arc breaking ability as a circuit breaker.

The resistance fingers, contacts, etc., used in these motor starters are of the same design and material as used in the builders' controllers for heavy service. The starters are furnished in several forms, beginning with a very simple type, and elaborated on to embrace such features as no-voltage release, overload protection, and separate and different overload protection for accelerating, the last-named feature allowing more current to flow through the motor during starting than during running. Since starting is relatively infrequent, the motor will not be injured by employing a starting current in excess of the running current. This feature is of particular value when the motor is connected to loads having great inertia, such as a hot saw or press with a heavy fly-wheel, where the mere acceleration of the load demands a considerable expenditure of work. By allowing more current to flow through the motor during starting, the starting time will be materially reduced, which in many instances is of particularly great importance.

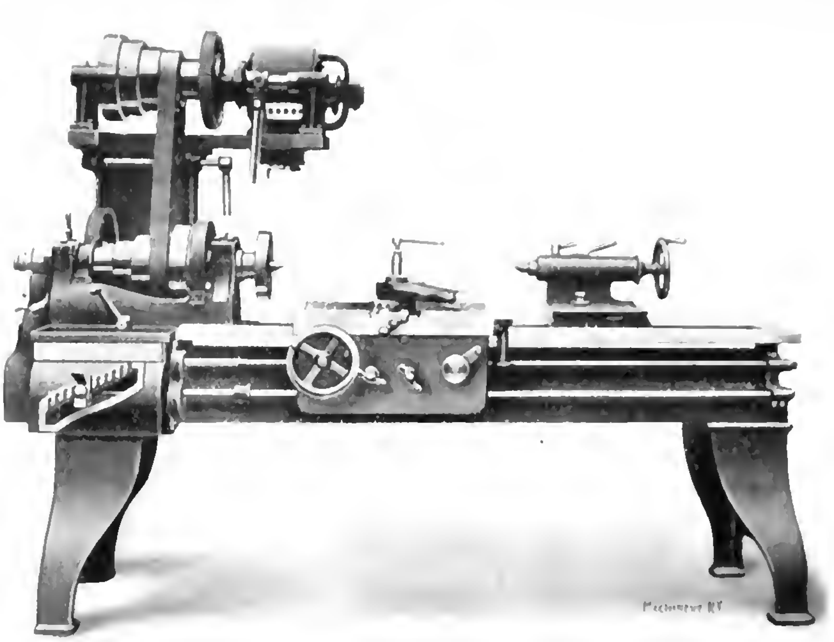


Front and Rear Views of the Electric Controller & Mfg. Co.'s Mill Type Motor Starters

DAVIS 16-INCH ENGINE LATHE WITH MOTOR ATTACHMENT

In the July issue of MACHINERY, reference was made to a 14-inch lathe built by the W. P. Davis Machine Co., Rochester, N. Y. The accompanying illustration shows a 16-inch by 8-foot engine lathe, built by the same company, provided with a motor attachment. This latter can be attached to any size or type of lathe and is of a very simple design. A small lever is placed directly under the table on which the motor and counter-shaft are mounted; by means of this lever the belt can be tightened from time to time and no lacing is required. A friction clutch is provided in the counter-shaft, attached directly to the inside of the large spur gear. By means of this friction clutch the counter-shaft can be stopped and started as required without stopping the motor.

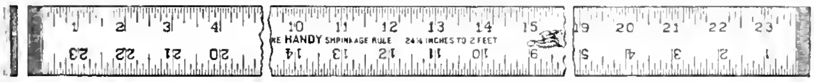
A quick change feed device is provided on the lathe by means of which any thread ranging from 3 to 40 threads per inch can be cut, and any feed required for turning obtained. A feature of considerable convenience and importance in this lathe is introduced in form of a small dial attached to the right-hand side of the carriage, by which, when cutting threads, a nut can be opened and closed on the lead-screw, so as to "catch" the thread at the proper moment.



Davis 16-inch by 8-feet Motor-driven Engine Lathe

HANDY SHRINKAGE RULE

A handy shrinkage rule, as shown in the accompanying illustration, has been brought out by the Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J. It is intended to fill the demand for an accurate, well finished shrinkage rule at a moderate price. The particularly desirable feature of this shrinkage rule is that each of the four edges is graduated in 16ths, instead of in 8ths, 10ths, 12ths and 16ths, on respective edges, as is the case with the old style shrinkage rule. All the edges are numbered from left to right, so that the rule is always in proper position for use. The rule is two feet long, nominal size, the graduations being made in four different scales for 12.1, 12 1/8, 12 3/16 and 12 1/4 inches shrinkage measure, respectively, to the foot.



Keuffel & Esser Shrinkage Rule

* * *

A German company has, according to the *Scientific American*, placed on the market a special electric generating equipment adapted to be operated by wind power. The installation comprises a dynamo and a storage battery, the latter serving to store the excess power until such time as it is required. The apparatus is entirely automatic, and requires absolutely no attention except in time of storm, when it is necessary to reduce the sail area of the wind wheel. A special regulator used with this apparatus automatically keeps a constant pressure on the lighting circuit, this being entirely independent of the number of revolutions of the dynamo or the condition of the storage battery.

* * *

A large power station is being built in Japan to furnish current for Tokyo, Yokohama, and adjacent cities and towns, which will have a capacity of 60,000 horse-power. The power will be derived from a 600-foot head of water. Six generators of the 3-phase, 25-cycle type, directly coupled to turbines, will be installed. Each turbine will develop 13,500 horse-power.

NEW MACHINERY AND TOOLS NOTES

SET OF COLD AND CAPE CHISELS: Lynn Tool & Forge Co., Lynn, Mass. Set contains twelve tools consisting of hand forged cold and cape chisels, including center punch. The tools are hand forged from 7/16-inch octagon steel, [illegible] inches long, and placed in a cloth case with a place for each tool.

COMBINED MILLING AND BORING MACHINE: Cincinnati Punch & Shear Co., Cincinnati, O. This tool resembles a slab milling machine of the planer type, except that the spindle is provided with the longitudinal feed necessary for boring. This makes a combination tool which has been found very useful on a wide range of work.

TEST INDICATOR: J. L. Wolfe, Bridgeport, Conn. This indicator is readily applied to work in the lathe, milling machine, and shaper, or on the bench. It has a dial graduated to thousandths of an inch, and the scale covers 1/16 inch in either direction. It is simple and compact and for this reason suitable for work in the machine shop.

FRICTION DRIVEN DRILL PRESS: Barry & Zecker Co., Lancaster, Pa. In this machine the driving friction disk rests directly on the driving pulley, and the friction is secured by means of the weight of the disk. The position of the disk in relation to the driving pulley is controlled by the foot, as is also the position of the driving belt. The friction disk can easily be raised out of contact with the wheel, so that a single pulley drive can be used. The machine will drill up to 9/16-inch holes.

FLAT TAPER SHANK DRILL: Cleveland Twist Drill Co., Cleveland, O. This tool, known as the Paragon drill, is twisted from flat stock and provided with a flat shank, not twisted, but forged and ground to size. The shank is of uniform taper on the flat sides as well as on the rounded edges. A socket to take these flat drills is also provided, the outside of which fits the regular drill socket tapers. The strain on the flat shank is distributed over its total length, thereby eliminating danger of breakage.

DOUBLE BACK-GEARED ENGINE LATHE: New Haven Mfg. Co., New Haven, Conn. This lathe is built in two styles, either with quick change gear device or with a feed box having three feeds. Threads or feeds from 2 to 28 per inch can be obtained by the former, while with the latter, threads ranging from 1 to 28 per inch can be obtained with only nine change gears. The lathe has nine spindle speeds for each counter-shaft speed, which with a two-speed counter gives from 7½ to 333 revolutions per minute.

OIL BURNING FURNACE FOR HEAT TREATMENT OF STEEL: Tate, Jones & Co., Pittsburg, Pa. This furnace has been designed on account of the ease with which the temperature can be regulated in oil burning furnaces, and is of iron construction with fire-brick lining. The oil is carried in a tank at the side of the furnace and is forced into the burner from the tank by means of air pressure from the regular shop blast, or from a small blower placed at the side of the machine. The flame is so diverted that a uniform temperature is maintained in all sections of the furnace.

PLAIN GRINDING MACHINE: Modern Tool Co., Erie, Pa. This machine, known as the No. 12 grinder, is heavily designed and the head-stock and foot-stock are secured to the vertical rail

by special clamping devices. The automatic cross-feed gives a range from 0.00025 to 0.004 inch for each reversal of the table. The machine will grind straight or taper work up to 5 inches in diameter and 31 inches long, with any taper up to 1¾ inch per foot. The wheel is 12 inches diameter by ¾ inch face and the floor space 41 x 110 inches.

Oval Socket Breast Drill: Lancaster Machine & Knife Works, Lancaster, N. Y. The distinguishing feature of this breast drill is the fact that its socket is provided with an oval taper hole for driving drills with oval taper shanks. This system of driving was described in the department of New Machinery and Tools in the September, 1908, issue of Machinery. The drills with the oval tapers are made by the Whitman & Barnes Mfg. Co., of Akron, O., who offer them as a regular article of trade independent of the breast drills here mentioned.

Combined Surface and Tool Grinder: XX Century Tool Co., 1289 Marquette Road, Cleveland, O. The most prominent feature of this machine is the height of the spindle and table, the former being 51 inches from the floor, thereby bringing the work so high that the operator does not have to stoop to watch it. The machine is designed especially for grinding screw machine and other tools with parallel surfaces, and can also be used as a surface grinder for small work. The traverse of the table is 6 inches, the cross-feed 3 inches, and the vertical adjustment 4 inches.

Rapid Blue-Printing Machine: Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa. A special feature of this blue-printing machine is the rapidity with which the prints can be produced. When used in pairs, the light from one set of lamps will be sufficient for two machines, and the maximum capacity of blue-prints is then 16 feet per minute for the two machines, at the cost of one set of lamps. Each machine in a pair is independent of the other, and one can be run at its maximum speed for fast blue-printing while the other is run slowly for sepia or negative work.

Electric Recording Pyrometer: Edward Brown & Son, 311 Walnut St., Philadelphia, Pa. This instrument is constructed for use in conjunction with a thermo-couple, but the type of recording gage used can also be employed for very accurately recording pressures of steam and air, voltage, etc. When used as a pyrometer, the instrument can be supplied for any desired range in temperature, and the record charts can be made to revolve once in twenty-four hours, or once in seven days, as preferred. The instrument is very simple in its construction, which is of great advantage when used under regular industrial conditions.

Grinding and Polishing Machines: Adamite Surface Machine Co., 217 High St., Newark, N. J. These machines are both of the vertical and horizontal type, equipped with cloth belts charged with abrasive. The vertical type of machine has two belts, one for roughing and one for finishing the metal being ground. The belt containing the abrasive runs over an endless leather belt, both belts being supported back of the work, which rests on a table in front. The horizontal type is better adapted to work which is more easily handled by holding it down onto the belt. A special machine is built for polishing tubing, shafting and similar work.

Heavy Power Press: George A. Ohl & Co., 157 Oraton St., Newark, N. J. This machine is of powerful design capable of cold bending up to ½-inch soft steel to a right angle, and is designed for forming the thick sheet metal work which enters into the construction of steel passenger cars, metal furniture, etc. The openings in the housings through which the work passes are 30 inches wide by 15 inches high. The stroke is 4 inches with a position adjustment of 4 inches to suit different heights of dies. The height of the machine is 16 feet over all. It occupies a floor space of 16 by 8 feet and measures 12½ feet between the housings. The machine weighs 108,000 pounds and requires 35 H. P. for driving.

Portable Electric Breast Drill: Willey Machine Co., Jeffersonville, Ind. This is the smallest size in the line of breast drills built by the makers; the largest size with gear drive was shown in the November, 1908, issue of Machinery. The main feature of this line of drills is the simplicity of construction, which is a most important matter in devices of this kind, which are often subjected to rough usage when in service. The present size is suitable for drilling holes up to ¼ inch in diameter. The entire machine can be easily taken apart by simply removing two nuts, leaving the whole mechanism open for inspection. The drill chuck is attached directly to the armature shaft, and a snap switch located on the side of the frame makes the starting and stopping of the drill very convenient.

* * *

A New York concern—Wyckoff, Church & Partridge—has taken the agency for the Herring-Curtiss aeroplane, and advertises machines for sale, subject to delivery within forty days from date of order. This announcement indicates that the flying machine proposition has reached the commercial stage so far as supplying the wants of amateurs is concerned, at least.

STANDARDS FOR RECIPROCATING STEAM ENGINES FOR ELECTRICAL PURPOSES

The Engineering Standards Committee of Great Britain has just issued a report on reciprocating steam engines for electrical purposes, which contains some propositions for standardization which may well be considered in this country as well. The steady increase in steam pressures that has marked the development of the steam engine during the last few decades has led to a certain specific, yet somewhat loose, classification of types, which at times is rather confusing. The committee has, therefore, defined the meaning to be attached to such phrases as low pressure, high pressure, extra high pressure, medium vacuum and good vacuum, etc. In respect to steam pressures the following standards for pressures measured at the throttle valve are suggested:

	Pounds per Square Inch Gage Pressure
Low pressure	100
Intermediate pressure	150
High pressure	200
Extra-high pressure	300

With respect to vacuum measured by mercury column at the exhaust flange of the engine, the following values are suggested as definitions of "medium" and "good":

	Pounds per Square Inch, Absolute.
Medium vacuum	2.5
Good vacuum	1.5

With respect to speeds of engines the following table is given to indicate the limits of the terms "slow," "medium," and "high" speed in reference to revolutions per minute and rated output:

Rated Output in Kilowatts	Revolutions per Minute at Rated Output		
	Slow	Medium	High
30	...	...	625
40	...	...	600
50	...	...	575
60	...	...	575
80	...	...	525
100	107	250	500
150	107	250	428
200	107	250	375
250	107	250	375
300	94	214	375
400	94	214	375
500	94	214	300
750	83	188	250
1000	83	188	250

Regarding the size of engines to be used for different sizes of generators the committee lays down the general rule that the engine shall be capable of driving the generator continuously at all loads up to the rated output and for at least two hours at twenty per cent above the rated output of the generator without undue heating of the bearings, or other mechanical trouble. It is also suggested by the committee that the size of engine cylinders should be such that the mean pressure in pounds per square inch referred to the low pressure cylinder at full load should not exceed that indicated by the table below:

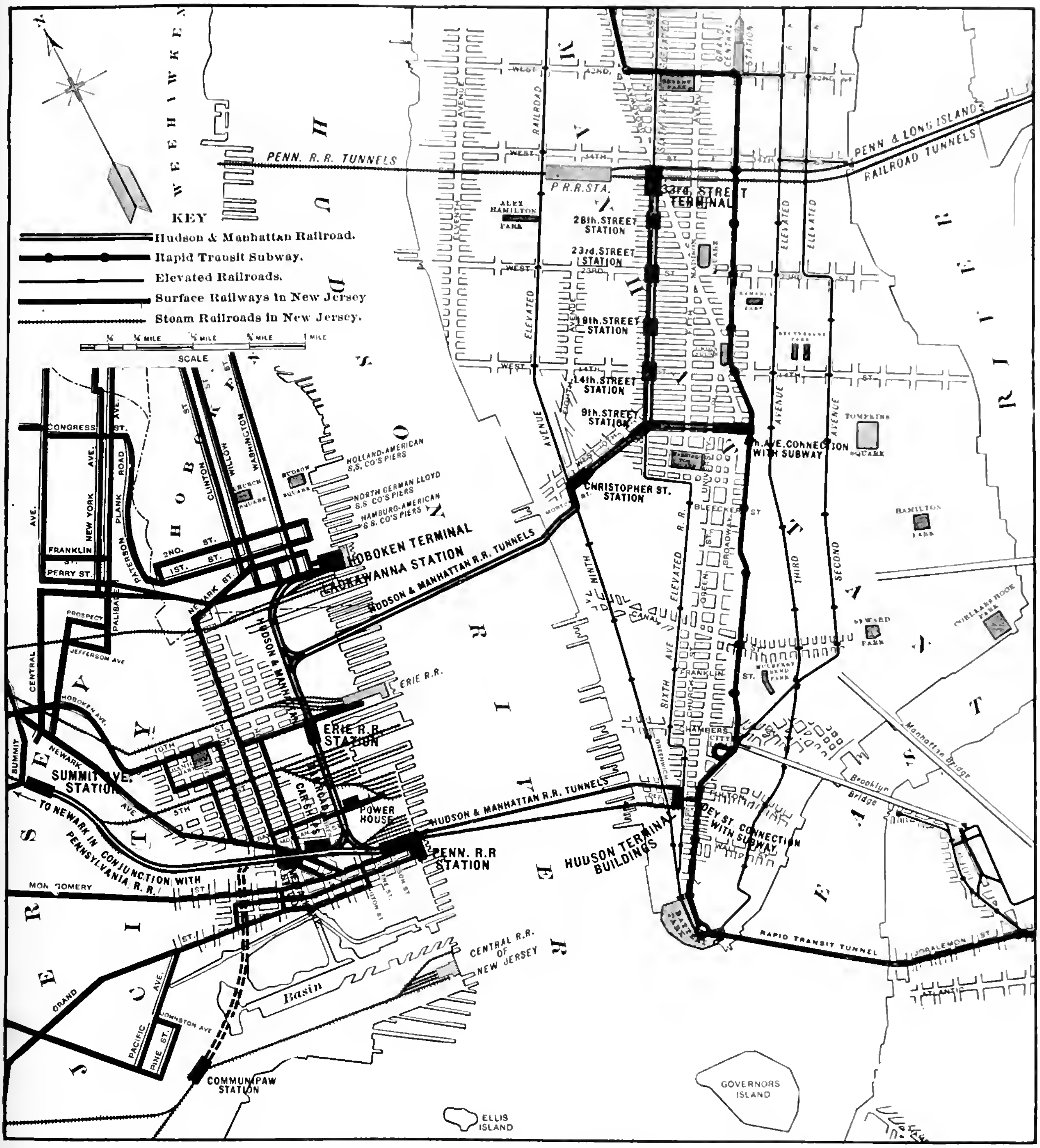
Steam Pressure, Pounds per Square Inch	100		150		200		300	
Class of Engine	Compound	Triple	Compound	Triple	Compound	Triple	Compound	Triple
Non-condensing	35	..	44	42	51	48	59	56
Condensing, medium vacuum	32	29	40	36	45	40	50	45
Condensing, good vacuum.	30	27	37	34	41	37	46	41

Regarding the speed variation it is stated that the maximum temporary variation in speed due to the load being varied gradually, or by steps not exceeding twenty per cent of the rated load, should not exceed five per cent of the standard full load speed.

OPENING OF SECOND HUDSON TUNNEL

The downtown tunnel of the Hudson & Manhattan Railway Co., connecting the Hudson Terminal in New York and the Pennsylvania Railroad terminal in Jersey City, was opened to public traffic July 19. The completion of this tunnel adds another link to the great transportation system that will eventually connect all the railroad terminals in New York City, Jersey City and Hoboken, with the exception perhaps of the West Shore R. R. The tunnel opened February 25, 1908, connects the Hoboken terminal of the Delaware, Lackawanna & Western R. R. with Christopher Street station and the stations on Sixth Avenue including 23rd Street. This line will soon be completed to the new Pennsylvania R. R. station at 33rd Street, and a franchise was recently granted for extending it to the Grand Central station on 42nd Street, the terminal of the New York Central and the New York, New Haven & Hartford railroads.

Early in August the link connecting the Pennsylvania R. R. station with the Lackawanna will be completed, which also connects with the Erie R. R. When the system is completed it will be possible for a traveler to reach any of the railroad terminals of New York by the tunnel route with the exception noted above, on payment of a five-cent fare. The tunnel system will connect with the New York Subway at Broadway and 9th Street, and a foot path tunnel will connect the Hudson Terminal with the Subway at Broadway and Dey Street. The two great tunnel systems will thus be connected so as to make emerging to the street unnecessary in a trip from Brooklyn or the Bronx to New Jersey.



Map of the Hudson & Manhattan Railroad Co.'s Tunnel System, showing also Subway, Surface and Elevated Railway Lines

The Hudson Terminal consists of two great twin buildings on Church Street covering a large portion of the two blocks between Fulton and Cortlandt Streets. In the common basement of the buildings is a great concourse extending under Dey Street, and in the sub-basement are the tracks and passenger platforms. The machinery trade is interested in the Fulton building particularly because of the Machinery Club on the 21st and 22nd floors which has a large membership in the machine tool and other lines of machinery trade. It is possible for a member to enter an elevator at the club floor and emerge on

the concourse floor and take a train to Jersey without going onto the street. See MACHINERY, March and June, 1908.

It is estimated that the tunnel system will handle 100,000,000 passengers annually from the start, much of which will be new business, judging from the history of other New York transit improvements. The present ferry traffic across the Hudson is estimated at 128,000,000 annually, but it is not likely that there will be serious diminution of the ferry traffic until the railways have made the tunnel system a more closely connected part of their terminal systems. When that time comes, the total estimated capacity of the tunnels may be required, that is 220,000,000 passengers annually with eight-car trains operated at an interval of 1⅛ minute in rush hours.

The cost of the tunnel system will be about $70,000,000 when completed. It was begun in 1874 by D. C. Haskins, a civil engineer who conceived the idea of constructing a brick tunnel from Hoboken to New York. About 1,200 feet of the tunnel was built when the company failed and in 1880 the work was temporarily abandoned. In 1890 another company was organized with English capital and added about 1,800 feet to the part already built, when it also failed and once more the enterprise was held up. In 1901 William G. McAdoo, a young Southern lawyer, became interested in the project of rapid transit to the Jersey shore, and organized the present company. The old method of construction using a brick lining was abandoned. The present tunnel is lined with cast iron rings made in sections and bolted together. The chief engineer is Charles H. Jacobs, to whom much credit is due for the rapid progress of the work and the remarkable freedom from serious accidents to life and limb that has characterized this gigantic and dangerous undertaking.

SHOP DOOR CLOSING DEVICE

The heating of machine shops, factories, round-houses, and other buildings having large doors is seriously retarded by the leakage of volumes of cold air in over the doors at the top. The ordinary large sliding or swinging door almost invariably bulges at the top making a crack of considerable width through which the cold air blows in greater or less volume according to the exposure, and velocity of the gale. During the past few years the heating of large shops and round-houses has received a great deal of attention, and no modern structure is considered complete without adequate means of heating. The old idea that the men should keep warm by hustling has been generally discarded and now every up-to-date factory manager realizes the importance of providing as nearly as possible a uniform, comfortable temperature in all work-rooms. The cost of heating large buildings in northern latitudes is a heavy item, and practical means that will shut out the cold air where it should not enter merit attention.

Realizing the serious loss that results from bulging doors in railway shops, as well as in other works having large doors, through the lack of close fit at the top, Mr. J. C. Hassett, technical instructor of apprentices of the Erie Railroad, Meadville, Pa., has devised the shop door closing device illustrated in Figs. 1 and 2 in which the action of the device and the details of the component parts are illustrated. As will be seen, the arrangement provides means by which the door is clamped and forced solidly against the jamb at the top by means of the curved piece *A* which is worked by a connection and lever conveniently located on the door. The connecting rod may be of any length required to suit the door height,

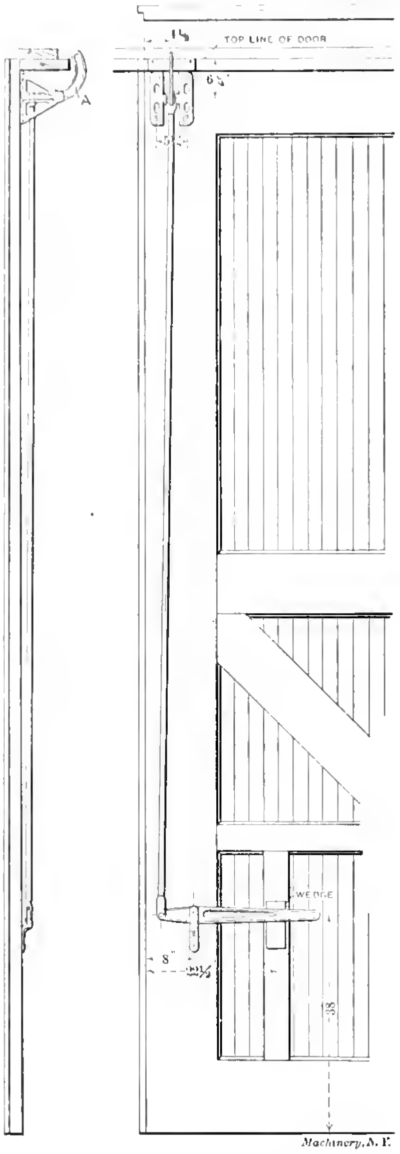


Fig. 1. Shop Door Closing Device

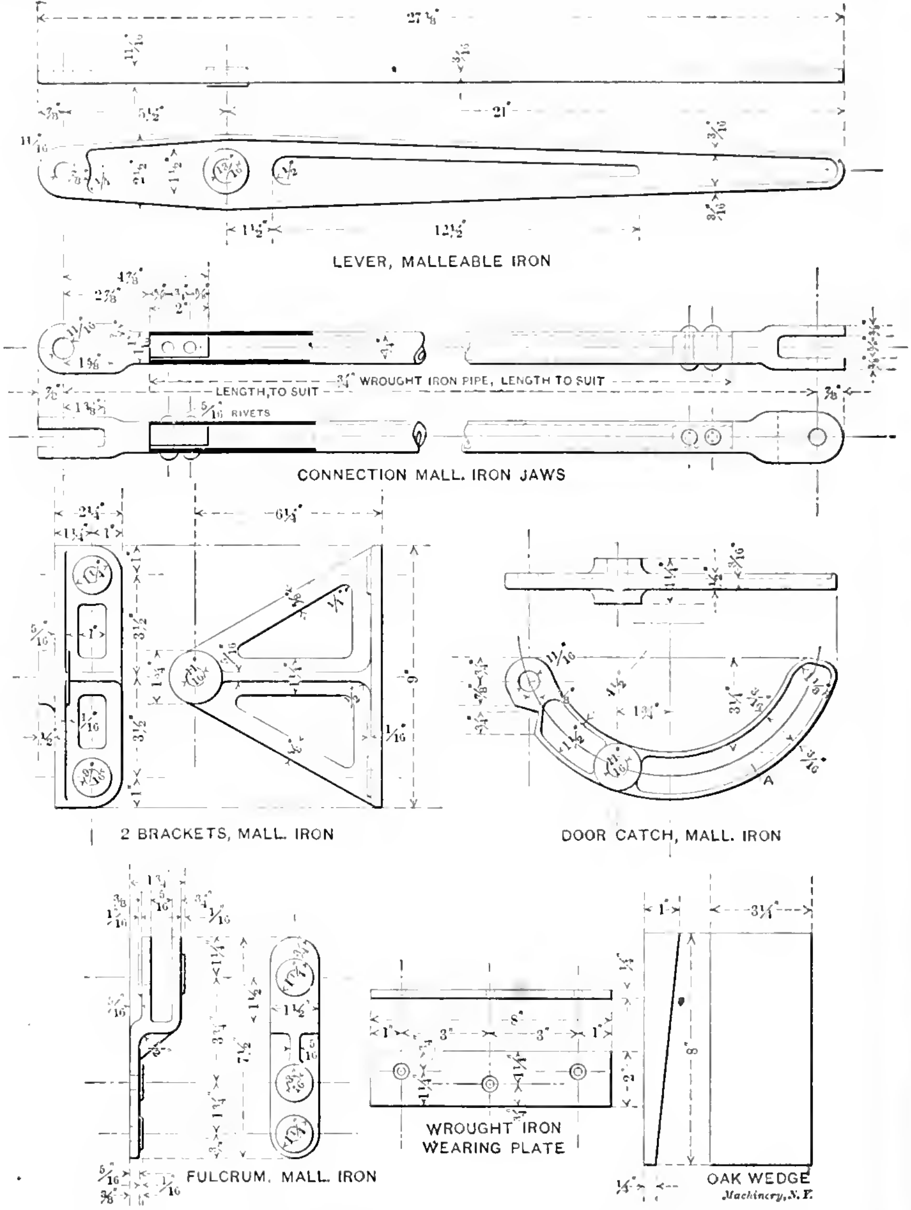


Fig. 2. Details of Hassett Shop Door Closing Device

THE RESULT OF ONE YEAR OF THE FITCHBURG IDEA

Last September a co-operative high school and industrial training course was inaugurated in Fitchburg, Mass., as described in the October number of MACHINERY. It was an adaptation of Prof. Herman Schneider's idea worked out in the University of Cincinnati and known as the co-operative industrial course, but modified to suit the local conditions of Fitchburg and its high school. The course was conducted under the direction of Prof. William B. Hunter, and the result of the work has fully justified the enthusiasm of Prof. Hunter and others responsible for the initiation of the work and its successful conduct.

The course of study was patterned after that in the University of Cincinnati, it being a form of apprenticeship system whereby the boys receive instruction in the shop one week and instruction at the school the next week. The course is of four years duration and the first year is spent wholly in the school, thus leaving three years for the alternate weekly work in school and shop. The shop work consists of instruction in the operation of lathes, planers, milling machines, punch and shear work and other mechanical work within the ability of apprentices. The boys are paid for their work in the shop. For the first year the rate of payment is 10 cents per hour, for the second year 11 cents and the third year 12½ cents per hour, making $5.50 per week or $165 for the first year, $6.05 per week or $181.50 for the second year and $6.87 per week or $206.25 for the third year. Thus the boy in this course may earn a total of $552.75 in three years while obtaining a practical and theoretical education.

The principal, instructors, students and manufacturers of Fitchburg speak highly of the results of the initiatory year. The *Fitchburg Daily News* for June 17 gives an extended account of the close of the school year with a list of eight questions propounded to twenty-two boys and the answers received from fourteen, which will be found of interest by those closely concerned with industrial education.

* * *

AEROPLANE CROSSES ENGLISH CHANNEL

Louis Bleriot, a Frenchman, crossed the English Channel Sunday morning, July 25, on his aeroplane. The distance across the channel is twenty-one miles, and the trip was made in thirty-seven minutes, the rate of travel, therefore, being thirty-four miles per hour. The trip was without accident except at the landing when the machine was whirled around two or three times and the propeller broken by striking the ground. Bleriot wins the *Daily Mail* prize of $5,000 offered to the first man who performed the exploit. The Bleriot machine is a monoplane, there being only one supporting surface, as compared with the biplanes used by the Wright brothers, Curtiss, Farman, and others which have two superimposed planes.

* * *

PERSONAL

Perley E. Harey, master mechanic of the Chapman Valve Mfg. Co., Springfield, Mass., has resigned his position.

A Munch, manager of the railway department of the Northwestern Metal Mfg. Co., Minneapolis, Minn., has been elected a director and the secretary of the company.

H. C. Patterson has taken the position of electrical and mechanical engineer with the Illinois Traction System, vacated by the resignation of Mr. H. C. Hoagland.

Arthur Williams, chief inspector of the New York Edison Co., has been elected one of the Board of Trustees of the Museum of Safety and Sanitation, New York.

Fred E. King, Springfield, Mass., has resigned his position with the King Automobile Co., to become foreman of the tool room of the Dickinson Mfg. Co., of that city.

J. A. Bell has been appointed master mechanic of the Dubuque division of the Illinois Central R. R., with headquarters at Waterloo, Ia., succeeding R. J. Turnbull.

P. V. See, who until recently was in the employ of the Twin City Traction Co., of St. Paul and Minneapolis, has been appointed general foreman of the Illinois Traction Co.'s shops at Decatur, Ill.

The volume of studies of American life and labor, "Social Engineering," by Dr. William H. Tolman, director of the Museum of Safety and Sanitation, New York, has been translated into French.

E. M. Haas, formerly connected with the Southern Illinois McKinley Interests, has been transferred to Decatur, Ill., to fill the position of superintendent of the bridge and building department of the Illinois Traction System.

Coker F. Clarkson was elected assistant general manager of the Association of Licensed Automobile Manufacturers in June to fill out the term of Mr. C. E. Chalfant, who recently resigned as general manager.

A. P. Warner, vice-president of the Warner Instrument Co., Beloit, Wis., has purchased a Herring Curtiss areoplane. Probably it will be fitted with a special anemometer connected with a Warner autometer to indicate the velocity of flight!

Leon J. Canova, Havana, Cuba, has been appointed, by President Gomez, director of the Bureau of Information, established at the beginning of the present fiscal year. Manufacturers interested in Cuban trade are invited to communicate with him.

Otto Shilling, formerly superintendent of the Peoria division of the Illinois Central R. R., will re-enter railroad work after being some time engaged in other business; he has taken the position of train-master for the Texas & Pacific Railway at Texarkana, Texas.

Dr William H. Tolman, director of the Museum of Safety New York, read a paper at the twenty-second convention of the National Association of Accident Underwriters, Hotel Clifton, July 13-16, Niagara Falls, New York, entitled "Perils of Peace, or a Safer America."

The jurisdiction of Frank Lane, chief electrician of the Wabash Railroad, Moberly, Mo., has been extended over the entire Wabash system, his headquarters being at Decatur, Ill. Mr. Lane's successor at Moberly is William Erwin, who has been night stationary engineer at the Decatur shops.

Benjamin Whittaker resigned as treasurer of J. H. Williams & Co., manufacturer of drop forgings, Brooklyn, New York, July 1, and will now give his entire time to the exporting business for the same company and others, with headquarters at 17 State St., New York.

Herbert V. Purman, formerly assistant superintendent of the National Manufacturing Co., Worcester, Mass., and more recently labor superintendent of the Corbin Motor Vehicle Corporation, New Britain, Conn., has returned to Worcester to act as general foreman of the Heald Machine Co.

William Threlfall has resigned his position of general manager of the Chapman Valve Mfg. Co., Springfield, Mass. A number of the foremen gave Mr. Threlfall a banquet at the Worthy Hotel, June 8, at which he was presented with a handsome hunting case gold watch with suitable inscription.

August Kittleberger, who for the past fifteen years was associated with the Clayton Air Compressor Works, has been engaged by the American Air Compressor Works as superintendent of its Brooklyn plant. Mr. Kittleberger's long experience in the construction of air compressors and vacuum pumps has well fitted him for his new position.

Hugh M. Wilson, formerly editor and publisher of the *Railway Age*, became associated with the Barney & Smith Car Co., Dayton, Ohio, August 1, as director and vice-president. Mr. Wilson disposed of his publication business something more than a year ago, having recently returned to the United States after spending nearly a year in foreign travel.

Joseph H. Williamson, for eighteen years business manager of the Manufacturers' Advertising Agency, New York, and for seven years business manager of the Viennot Advertising Agency, Philadelphia, Pa., resigned from the Viennot Agency October, 1907, and up to April, 1909, had charge of the company's New York business on a salary basis. Mr. Williamson has now opened an office at 719 Temple Court, New York, where he will act as a representative of trade journals. He is well known to the publishers of trade journals in the United States, and any business entrusted to him will receive careful attention.

* * *

OBITUARIES

Gust. A. Dalin died at the Rockford Hospital, Rockford, Ill., July 10, aged forty-seven years. He was in partnership with his brother in the firm of Dalin Bros., machinists. He was the inventor of a friction drill, and was engaged in the manufacture of small milling machines. The business will be conducted by the brothers, A. G. Dalin and S. Dalin. Mr. Dalin is survived by a mother, four sisters and three brothers.

A. Bradshaw Holmes, secretary and treasurer of the Independent Pneumatic Tool Co., and the Aurora Automatic Machinery Co., Chicago, Ill., died June 30, 1909, from injuries received by accidentally falling from the piazza of his hotel. Mr. Holmes was well known in the pneumatic tool business, having been connected with the Standard Pneumatic Tool Co., and the Rand Tool Co. for a number of years prior to his connection with the Independent Pneumatic Tool Co., of which concern he was secretary and treasurer since its organization. He was thirty-one years old and unmarried

Brown & Sharpe Mfg. Company

Providence, Rhode Island, U. S. A.

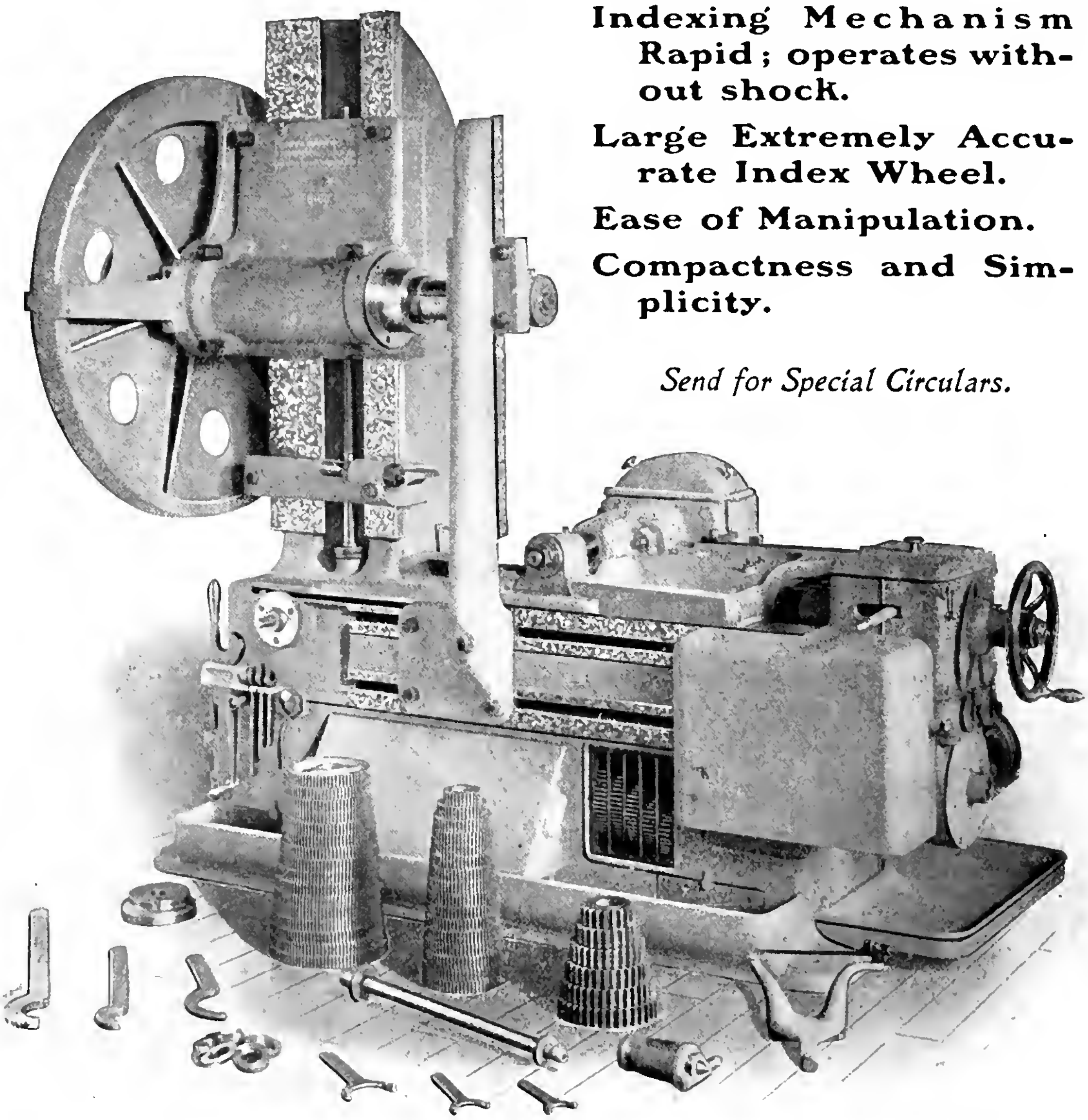
B. & S. Automatic Gear Cutting Machines

Designed and Built for the Rapid Production of Gears of Great Accuracy.

IMPORTANT FEATURES

- Correctly Designed, Accurate Bearing Surfaces.
- Cutter Spindle Powerfully and Smoothly Driven.
- Exceptionally Large Diameter Work Spindle.
- Indexing Mechanism Rapid; operates without shock.
- Large Extremely Accurate Index Wheel.
- Ease of Manipulation.
- Compactness and Simplicity.

Send for Special Circulars.



No. 6 Automatic Gear Cutting Machine.

Brown & Sharpe Mfg. Company

Providence, Rhode Island, U. S. A.

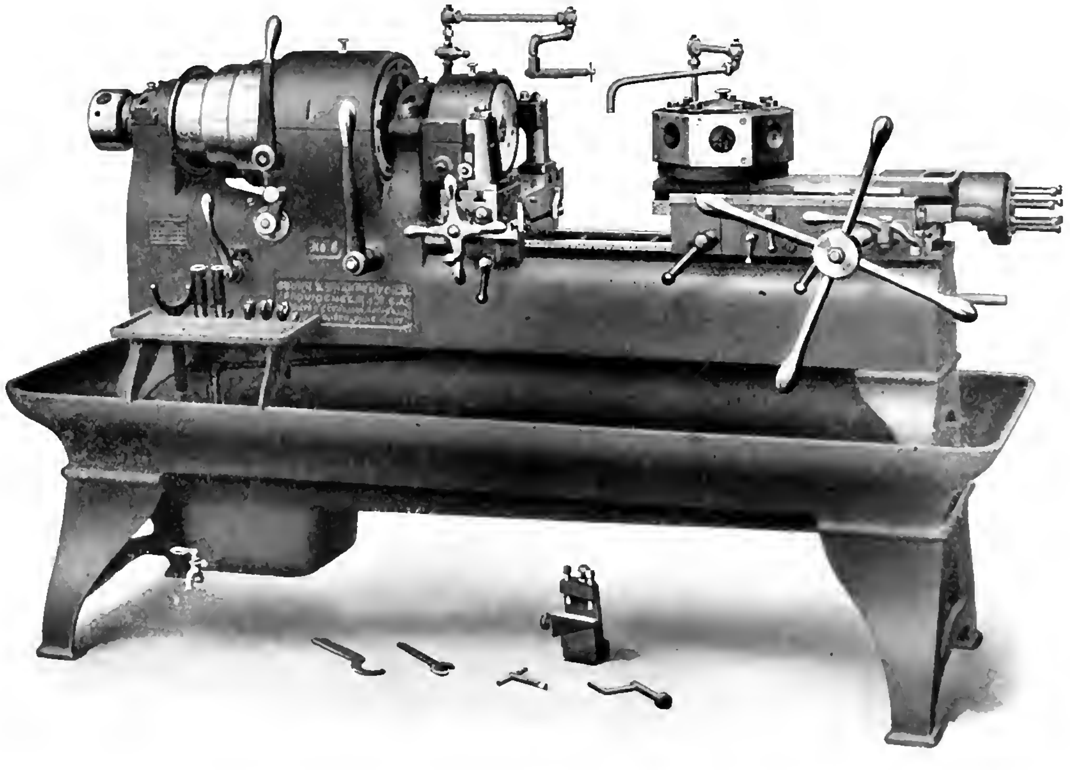
B. & S. Wire Feed and Plain Screw Machines

Correctly Designed and Carefully Constructed Machines of Great Accuracy and Remarkable Durability.

IMPORTANT FEATURES

Rigid Construction of All Parts.
Economical Consumption of Power.
Independent Stop for each Hole in Turret.
Vertical and Transverse Adjustment for Turret Slide.
Graduated Scale on side of Turret Slide.
Adjustable Stop on Cross Slide.
Gearing Fully Enclosed.

Send for Special Circulars.



No. 6 Wire Feed Screw Machine.

COMING EVENTS

August 9-14. Seventeenth National Irrigation Congress, Spokane, Wash., for the consideration of an action on irrigation, drainage, forestry, good roads, deep waterways, and home building. Arthur Hooper, secretary, Board of Control, Spokane, Wash.

September 25-October 9. Hudson-Fulton celebration of the three hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the *Tribune* building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

September 27-October 1. Autumn meeting of the Iron and Steel Institute, London. G. C. Lloyd, secretary, 28 Victoria St., London, S. W.

October 4-8. Annual conventions of the American Street and Interurban Railway Association, American Street and Interurban Railway Accountants' Association, American Street and Interurban Railway Engineering Association, American Street and Interurban Railway Claim Agents' Association, American Street and Interurban Railway Transportation and Traffic Association, American Street and Interurban Railway Manufacturers' Association, at Denver, Col. Bernard V. Swenson, secretary and treasurer, 29 West 39th St., New York.

October 12-13.—Convention of National Machine Tool Builders' Association, New York. P. E. Montanus, secretary, Springfield, Ohio.

October 11.—MACHINERY's seventh annual outing.

April 1-June 30, 1910. American Exposition in Berlin to stimulate trade relations with Germany and American export business generally. The exposition will be held in the Exposition Palace, having 110,000 square feet floor space. Max Viewger, American manager, 50 Church St., New York.

SOCIETIES AND COLLEGES

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION held its seventeenth annual meeting at Columbia University, New York, and Pratt Institute, Brooklyn, June 24-26. The program included papers on technical education, features of engineering practice, etc., among which were: "Present Tendencies in Technical Education," President Frederick E. Turneaure, dean of the University of Wisconsin; "Highway Engineering," L. W. Page, director of the Office of Public Roads, United States Department of Agriculture; "The Relation of Engineering Education to Industries," Charles B. Going, editor *Engineering Magazine*; "Efficiency in Education," Prof. George F. Swain, Massachusetts Institute of Technology; "The Extension Work of the University of Wisconsin," Prof. Louis E. Reber, University of Wisconsin; "The Requisite Qualifications of an Engineering College Instructor," Oliver B. Zimmerman, Charles City, Iowa; "Employer's Requisites of Technical Graduates," Prof. Hugo Diemer, The Pennsylvania State College.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Boston, Mass., has appointed Dr. Harold Pender to the professorship of Theoretical and Applied Electricity which is connected with the Department of Electrical Engineering. Dr. Pender is a graduate of Johns Hopkins University and took the degree of Ph.D. at that university in 1901 under the direction of Prof. Rowland. He thereafter taught for a year and a half, during which period he completed the classical experiments of Prof. Rowland which demonstrated the magnetic effect of a moving charge of electricity. Poincaré, the eminent professor of the Sorbonne in Paris and a member of the French Academy, having suggested the desirability of these experiments being performed in Paris for the benefit of French scientists, the Carnegie Institution of Washington arranged with Dr. Pender to go to France for the purpose. Upon returning from France, where his experimental demonstration had been received with acclamation, Dr. Pender went into the employ of the Westinghouse Electric Co., and he has since been in regular engineering employ. He is recognized as notable in his work in mathematical and experimental physics. His teaching at the Institute of Technology will consist of a course for third-year undergraduate students and courses for graduate students in the more advanced theories of electric current flow and the electric transmission of power, in addition to the direction of experimental research by advanced students.

NEW BOOKS AND PAMPHLETS

STEEL SQUARE POCKET BOOK. By Dwight L. Stoddard. 159 pages, 3¼ x 5 inches, 150 diagrams. Published by the Industrial Publication Co., New York. Price, 50 cents.

This book on the use of the carpenter's steel square has passed into the second edition and has been partly rewritten and rearranged. New matter has been added, including about forty new diagrams. It treats of the uses of the steel square, showing how to cut rafters, lay out angles, and apply this indispensable tool generally to the many purposes required of it by the expert carpenter.

LESSONS IN TELEGRAPHY. By Charles H. Sewall. 88 pages, 5 x 7 inches. Published by D. Van Nostrand Co., New York. Price, $1.00.

This work is designed for use as a text-book in schools and colleges and for individual study, its aim being to furnish the student with not only the ordinary instructions in telegraphy necessary to learn the art, but to teach him what bad telegraphic habits to avoid. It contains sending and receiving exercises for commercial and railway business, press news, market reports, etc. The work contains much that the ordinary amateur never learns until he enters a commercial office, and for this reason should be highly useful to a class of learners who cannot readily acquire such advantages.

TABLES AND DIAGRAMS OF THE THERMAL PROPERTIES OF SATURATED AND SUPERHEATED STEAM. By Lionel S. Marks and Harvey N. Davis. 106 pages, 6½ x 8¾ inches. Published by Longmans, Green & Co., New York. Price, $1.00.

The older tables giving the properties of saturated steam were based on the investigations of Regnault carried out more than sixty years ago. It has been apparent for some time that the total heat of dry and saturated steam as determined by Regnault's researches are below the correct values, and new determinations have been made. The new tables are based on the investigations of Dieterici, Smith Griffiths, Henning, Joly, Grindley, Griessmann, Peake, Knoblauch and Thomas. The book comprises tables of superheated steam temperatures, saturated steam temperatures, saturated and superheated steam, superheated steam at high temperatures, boiling points for thermometer calibrations, thermal properties of water, conversion tables, logarithms to the base of 10, logarithms to the base of *e*. Part III of the book is given up to discussion of sources of the data as follows: Absolute temperature, the specific heat of water, the mechanical equivalent of heat, the pressure-temperature relation, the specific heat of superheated steam, the specific volume of superheated steam, the total heat of saturated steam, the specific volume of saturated steam at high temperatures and the computation of the tables.

GEAR CUTTING MACHINERY. By Ralph E. Flanders. 319 pages, 5¼ x 8 inches. 219 illustrations. Published by John Wiley & Sons, New York. Price, $3.00.

The work gives a complete review of American and European gear cutting machines, and explains the theory of action. It is largely made up of the series of articles on gear cutting machines published in the engineering edition of MACHINERY, 1908, which treated the subject in the thorough manner that its importance deserves. Chapter I describes the methods of forming teeth of gears, and classifies gear cutting machinery accordingly. There are five recognized principles of action and four methods of operation. The formed tool, templet, odontographic, describing-generating and molding-generating principles are illustrated diagrammatically and simply described, and the impression, shaping or planing, milling and grinding methods are similarly treated, thus introducing the reader to the general subject with a full comprehension of the principles and action. The second and third chapters treat of machinery for cutting spur gears, the third chapter taking up in detail a subject that is attracting much attention at the present time, *i.e.*, the hobbing process. Chapter IV describes machinery for cutting the teeth of internal gears and racks. Machines for cutting the teeth of worms and helical gears are described in Chapter V, and worm-wheel cutting machines in Chapter VI. Machines for forming teeth of bevel gears are treated in Chapters VII and VIII. The work is the only complete treatment of gear cutting machinery published; it comprised every known commercial machine at the date of publication. It will be found of much interest and value to those concerned in the art of producing cut gearing.

CATALOGUES AND CIRCULARS

HOGGSON & PETTIS MFG. CO., New Haven, Conn. Catalogue of hand cut steel stamps for all purposes, also seal presses and cutting dies.

EMERSON ELECTRIC MFG. CO., St. Louis, Mo. Bulletin No. 3216 of bi-polar ventilated motors, ½ H.P. direct current.

E. J. BROOKS & CO., 227-229 Fulton St., New York. Circular of nailed box strap and seal and strap pulling device for sealing cases.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Sheet illustrating crane hook thrust ball bearing mounting equipped with Hess-Bright ball bearings.

WALTHAM MACHINE WORKS, Waltham, Mass. Circular on sub-press die work, illustrating samples of the work done and giving a brief treatise on sub-press dies.

MESTA MACHINE CO., Pittsburg, Pa. Circular of rubber mill machinery illustrating a three-roll calender and a 20 x 22 inch x 72 inch rubber grinder and mixer.

HOGGSON & PETTIS MFG. CO., New Haven, Conn. Pamphlet advertising engraved rolls, molds, cutting dies, rollers, gages, etc., for the manufacture of rubber goods.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Folder illustrating uses of lifting magnets in handling structural material, car axles, scrap, track bolts in kegs, railway rails, cylinder castings, etc.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Sheet illustrating drill press spindle with Hess-Bright thrust ball bearing mounting, showing two forms recommended.

WICKES BROS., Saginaw, Mich. Catalogue of plate working tools, comprising vertical and horizontal bending tools, punches, shears, riveting machines, flanging presses, annealing ovens, etc.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Pamphlets entitled "Metals and Alloys Free from Carbon Produced by the Thermit Process" and "Butt Welded Wrought Iron and Steel Pipe by the Thermit Process."

ARTHUR C. FRASER & USINA, 170 Broadway, New York. Bulletin of patent and trade-mark law, comprising the new copyright law, the trade-mark situation, an important patent decision and the revocation of patents in Great Britain.

LINK-BELT CO., Philadelphia, Pa. Bulletin No. 84 of "Maximum Silent Chain," illustrating its application to line shafting, machine tools, centrifugal pumps, blowers, air compressors, cylinder boring machines, mine fans, etc.

NATIONAL METAL TRADES ASSOCIATION, Robert Wuest, commissioner, 1005 Fourth National Bank Building, Cincinnati, Ohio. Synopsis of proceedings of the eleventh annual convention held April 14 and 15, 1909, Hotel Astor, New York.

SCHUCHARDT & SCHUTTE, 90 West St., New York. Catalogue of tachometers and tachographs. These instruments indicate on a dial or record on a chart the revolutions and rate of engine and motor shafts, the speed of fly-wheel peripheries, rate of travel of motor cars, etc.

PEERLESS AUTOMATIC MACHINE CO., Cleveland, Ohio. Leaflet illustrating the Peerless automatic multi-spindle screw machine having a capacity of 1 inch round, 15/16 inch octagon, 7/8 inch hexagon, and 11/16 square stock; length of work 5 inches. See July issue of MACHINERY for description.

BURROUGHS ADDING MACHINE CO., Detroit, Mich. Booklet entitled "A Better Day's Work," being a disquisition on accounting from the Stone Age down to the present, with particular reference to the value and use of mechanical adding machines for accurate and rapid work.

AMERICAN ENGINE CO., Bound Brook, N. J. Pamphlet treating of the balancing of reciprocating forces in steam engines, and illustrating the American-Ball angle compound engine, in which the high-pressure cylinder is horizontal and the low-pressure cylinder is vertical.

INTERNATIONAL-ACHESON GRAPHITE CO., Niagara Falls, N. Y. Circular on Acheson graphite, which is said to be the purest graphite made, being entirely a manufactured product. The circular lists electrodes, battery fillers, paint pigment, lead pencils, oil lubricants, ball bearing lubricants, etc.

INTERNATIONAL EXHIBITION OF RAILWAYS AND LAND TRANSPORTATION, Argentine Republic, Buenos Ayres. Circular No. 14, giving the aim and scope of the exhibition, statistics of the products of the Argentine Republic, railway mileage, organization of the exhibition, and names of the executive committee.

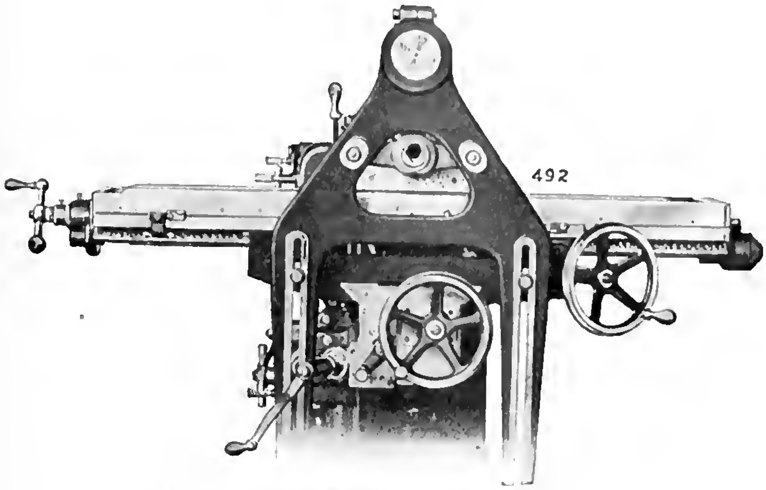
JOYCE-CRIDLAND CO., Dayton, Ohio. Bulletin No. 35 on automatic lever jacks. The construction of the automatic jack is described and illustrated, showing the various operations. It is claimed that these jacks have the power, simple action and closely graduated action obtained with hydraulic jacks without the complication and liability of failure.

MORSE CHAIN CO., Ithaca, N. Y. Bulletin No. 8, illustrating the application of Morse silent-running high-speed chains to line shafts, shapers, gear cutters, boring mills, engine lathes, punches and shears, rack cutting machines, grinding machines, screw machines, boring machines, blowers, bending rolls, milling machines, angle shears, forging machines, bolt threaders, etc.

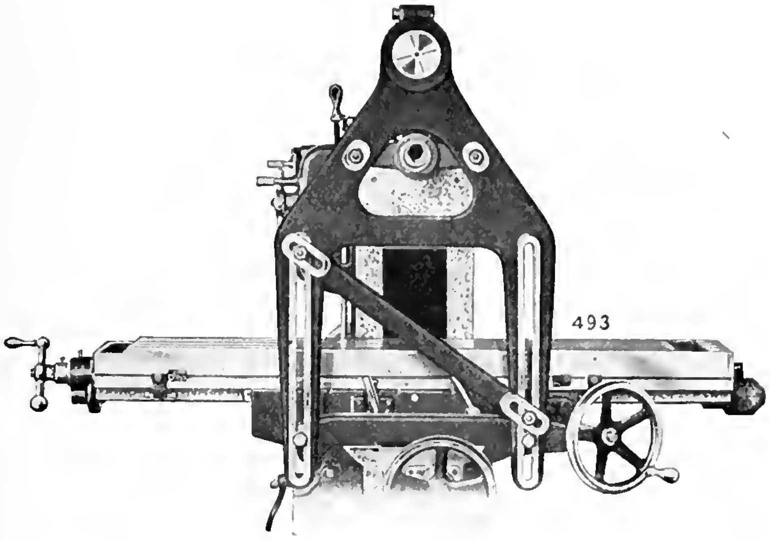
BUILDERS' IRON FOUNDRY, Povidence, R. I. Reprint from the journal of the American Society of Mechanical Engineers of the paper "A New Transmission Dynamometer" by Prof. W. H. Kenerson, Providence, R. I., which was presented before the Washington meeting, May, 1909, of the American Society of Mechanical Engineers. Copies will be sent free to all interested parties.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Booklet entitled "Electric Power for Domestic Purposes," which contains many suggestions for the use of small motors in the home. Among the many labor-saving applications of electric power are the sewing machine, vacuum cleaner, washing machine, ice-cream freezer, meat chopper, ironing machine, silver polisher, dish-washer, and pump.

CINCINNATI HIGH POWER ARBOR SUPPORTS



Usual position of table when doing heavy cutting



Unusual position of table.
Braces provided with an additional truss member

The importance of a rigid support for the outer arbor bearing is evident when we remember that this bearing gets as heavy pressures due to the cut, as does the main bearing of the machine.

The resultant of these pressures is approximately horizontal, in the direction of the table travel.

Our outer bearing support is designed to provide the greatest stiffness against this pressure.

It is made in one piece, truss form, bolted to its supporting member on the knee.

For work requiring the knee in a low position an additional diagonal brace makes it a double truss.

This is the principle on which bridges are designed.

It also applies in correct machine tool design.

WE HAVE APPLIED THIS PRINCIPLE IN EVERY IMPORTANT PART OF OUR HIGH POWER MILLERS.

Get the Catalog.

THE CINCINNATI MILLING MACHINE CO.

MILLING SPECIALISTS

CINCINNATI, OHIO

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
CANADIAN AGENT—H. W. Petrie, Ltd., Toronto, Montreal and Vancouver.
AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.

NEW HAVEN MFG. CO., New Haven, Conn. Catalogue of engine lathes [illegible] to 65-inch swing, in all lengths of bed from 8 to 36 feet; [illegible] capacity 24 inches to 60 inches square and up to 20 [illegible], and slotters of 10 inches stroke. The catalogue [illegible] the construction of the New Haven lathe head-stock [illegible] change gear device, compound rest, double wall apron. [illegible] will be found an interesting catalogue by those concerned with [illegible] of equipment and use.

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Pamphlet entitled "Electric Motor Control," consisting of a series of five articles written by Mr. A. C. Eastwood, president of the company. The pamphlet treats of the importance of the controller, theory and operation of rheostatic controllers, series parallel controllers, magnetic switch controllers and dynamic braking. The pamphlet is of general interest to all interested in the matter of electric motor control.

HOGGSON & PETTIS MFG. CO., New Haven, Conn. Catalogue 8C of the Sweetland lathe chucks, which are made in a large variety of sizes and styles. The catalogue lists three and four-jaw combination chucks from 6 inches to 42 inches sizes; three and four-jaw universal chucks in 4 inches to 42 inches sizes. Independent chucks are listed in sizes from 1½ inches to 36 inches, and geared scroll chucks from 2½ to 15 inches. The company also makes special chucks for all sorts of service.

VEEDER MFG. CO., Hartford, Conn. Circular on Veeder die castings, which are made of an alloy having strength of 15,000 pounds per square inch section in tension and 20,000 pounds in compression. These die castings are exact in form and dimensions. It is possible to produce castings within a limit of one-thousandth inch length or less, depending on the size. These castings are largely used on speed counters, cyclometers, coin counting machines, cash registers, typewriters, voting machines, telephones, and other apparatus made in large quantities.

CAREY MACHINERY & SUPPLY CO., 119-121 East Lombard St., Baltimore, Md. General catalogue, sixth edition, of machinery and supplies, comprising Corliss engines, horizontal and vertical steam boilers, hoisting engines, steam water heaters and purifiers, steam separators, boiler fittings, fire pumps, vacuum pumps, steam pumps, centrifugal pumps, geared pumps, engine lathes, pulley lathes, precision lathes, hand and bench lathes, shapers, planers, milling machines, screw machines, grinding machines, polishing lathes, wood-working machinery, wood trimmers, chucks, drills, taps, reamers, machinists' tools, etc.

ROCKWELL FURNACE CO., 46 Cortlandt St., New York. Catalogue illustrating various products of the company, comprising boiler flue heaters, heaters for skin drying molds for foundry purposes, furnaces for annealing gold, silver and bronze strips for coinage purposes, portable annealing, hardening and tempering furnaces, core ovens, apparatus for heating circular saws, semi-steel melting furnaces, rivet furnaces for structural work, annealing ovens, melting furnaces for brass and other alloys, regenerative furnaces for high temperatures, etc.

LONG & ALLSTATTER CO., Hamilton, Ohio. Catalogue No. 21 of punching and shearing machinery, comprising a great variety of sizes and styles for bridge, structural steel, railway car and other shops requiring machinery for punching or shearing of materials. The machines listed and illustrated comprise angle iron shears, bar iron shears, beam punching machines, bending and forming machines, boiler punches, cross-cut shears, deep throated machines, disk notching machines, disk punching machines, drop hammers, gate shears, horizontal punches, lever punches, lever shears, etc.

KEUFFEL & ESSER CO., Hoboken, N. J. Booklet describing the origin, growth and present scope of the Keuffel & Esser Co., manufacturer of drawing materials, mathematical instruments, surveying instruments, measuring tapes, etc. The booklet contains a reproduction of the first monthly rent receipt for $5.50, given in 1867, which is an indication of the humble origin of the present great business which now employs 900 people. Interspersed throughout the booklet are various illustrations of the factory buildings and the departments devoted to the manufacture of drawing materials, mathematical instruments, surveying instruments, and measuring instruments. Fourteen buildings are comprised in the plant, covering 237,000 square feet of floor space.

J. H. WILLIAMS & CO., 150 Hamilton Ave. and Richards St., Brooklyn, New York. Catalogue of iron, steel, copper, bronze and aluminum drop forgings. The catalogue has a beautiful cover showing an open end drop forged wrench in striking relief on a black cover. The catalogue lists a full line of wrenches, comprising single head and double head engineers' wrenches, single head and double head set-screw wrenches, box wrenches, double head tool post wrenches, straight handle and track wrenches, pin spanners, construction wrenches, etc., for all classes of users; drop forged lathe dogs, general service clamps, crank handles, tool-post fittings, thumb nuts, crane hooks, wire sockets, yoke ends, etc. The company's line of Vulcan drop forged chain pipe wrenches, special forgings for automobile work, etc., are also listed.

AMERICAN EXPOSITION, Berlin, 1910. Catalogue listing names of members of American advisory committee, German advisory committee and prominent business men interested in the exposition. The exposition is intended to show Europeans the excellence of American manufactured products and to strengthen existing relations between America and Germany. The management announces that the exposition will be unique in that the price of space per square foot will include the usual incidental expenses; it will cover suitable foundations for machinery, carpets, water heat, light, and janitor service. The exhibitors will also be protected from loss by fire or theft by insurance to the extent of $25 per square foot. The rental including all extras is to be $4 per square foot. Exhibits will be held in the Exposition Palace, erected in 1907 at a cost of $1,500,000. It consists of two connected buildings of stone and steel construction and has a combined floor space of approximately 110,000 square feet.

JONES & LAMSON MACHINE CO., Springfield, Vt. Treatise entitled "Machine Building for Profit, and the Flat Turret Lathe." 252 pages, 6 x 9 inches. This publication touches on the economics of construction, principles of lathe design, turret lathe design, observation of running machines, views from various points, importance of adaptability, and contains extracts from "The Evolution of the Machine Shop," a work published by Mr. Hartness some years ago. The Hartness flat turret lathe is described in detail, its parts and the work produced being illustrated. The remarkable adaptability of the Hartness flat turret lathe to all classes of machine work is well illustrated by numerous halftone engravings. Diagrams follow, illustrating the operations on various classes of work and giving the dimensions and the time required. The treatise is unique and should claim the interested attention of every machine shop manager and foreman concerned with the economical production of manufactured products. A number of interesting hints will be found on machine shop management.

MANUFACTURERS NOTES

GOODELL-PRATT CO., Greenfield, Mass., has a new foundry in construction by the Aberthaw Construction Co., of Boston.

HOGGSON & PETTIS MFG. CO., New Haven, Conn., has moved its New York office from 107 Liberty St., to 103 Chambers St.

LINK-BELT CO., Philadelphia, Pa., announces that the Renold "silent" machinery driving belt, manufactured and sold by it, will hereafter be known as the "Maximum Silent Chain" (Renold type).

ROCKFORD MACHINE & SHUTTLE CO., Rockford, Ill., manufacturer of drill presses, milling machines, bench lathes, etc., has moved into its new factory, the improved facilities of which will largely increase its output.

AMERICAN PULLEY CO., 29th and Bristol Sts., Philadelphia, Pa., opened a store July 1 at 139 South Clinton St., Chicago, Ill., where a complete assortment of wrought steel belt and sash pulleys will be kept.

B. F. STURTEVANT CO., Hyde Park, Mass., reports that its fan and blower business has so increased that it was necessary to enlarge its plant to handle the increased business, and it intends to add still further to the plant next Spring.

RAY D. LILLIBRIDGE, technical publicity manager, has removed his office to 100 Broadway, eleventh floor, and has taken into partnership William L. Rickard. The business will be continued as heretofore under the name Ray D. Lillibridge.

THE NORTHWESTERN METAL MFG. CO., Minneapolis, Minn., has been appointed exclusive sales agent for the "plunger throttle plastic packing," which is a new packing material for locomotive throttle valve stems and similar purposes.

WHITMAN & BARNES MFG. CO., Akron, Ohio, has consolidated its offices at Akron, which is the headquarters of the company. Heretofore its business has been handled from several different points, and the change is made to give the trade better service.

CROCKER-WHEELER CO., Ampere, N. J., reports several orders received recently for large alternating current generators, one of which was for a 1,000 KVA, three-phase, 6,600 volt generator, for the De Laval Steam Turbine Co., Trenton, N. J.

CARLYLE JOHNSON MACHINE CO., formerly of Hartford, Conn., removed its business July 1 to Manchester, Conn., nine miles east of Hartford on the Willimantic division of the N. Y. N. H. & H. R. R., where its manufacturing facilities are much improved.

WELLS BROS. CO., Greenfield, Mass., invites all persons interested in the manufacture and use of screw cutting tools and machinery to visit its factory. It is suggested that vacationists make up their itineraries to include a visit to Greenfield and the company's works.

KEARNEY & TRECKER CO., Milwaukee, Wis., is building a new power plant in which an Allis-Chalmers Corliss engine is being installed. The company is otherwise making preparations to extend its machine equipment and plant generally to take care of the demands for the Milwaukee milling machines which are sold out far in advance.

BROWN & SHARPE MFG. CO., Providence, R. I., announces that its works will be closed from August 6 to 23 for the annual vacation and repairs. During the vacation the office will be open as usual and orders for machine tools, machinists' tools, and measuring tools will receive the same attention as at other periods of the year.

WESTERN ELECTRIC CO., 463 West St., New York, reports that for the first half of its fiscal year ending May 31 its business is running at the rate of approximately $46,000,000 yearly as compared with $33,000,000 for the fiscal year of 1908, and $53,000,000 for the fiscal year of 1907. Business thus has increased 40 per cent over 1908, and is 87 per cent of the 1907 record.

CROCKER-WHEELER CO., Ampere, N. J., directors held a meeting in July in the New York office of the company. Dr. Schuyler Skaats Wheeler was continued as president, and the other officers elected were: Gano Dunn, vice-president; A. S. Doremus, second vice-president; Gano Dunn, engineer; Rodman Gilder, secretary; W. L. Brownell, treasurer; G. W. Bower, assistant treasurer.

LINCOLN MOTOR WORKS CO., Cleveland, Ohio, has changed its corporate name to the Reliance Engineering & Electric Co., instead of the Reliance Engineering Co., as was erroneously stated in the July number. The management remains the same and the company will continue to manufacture the Lincoln variable speed motors and complete line of constant speed motors.

BROWN & SHARPE MFG. CO., Providence, R. I., is building a new power house, which will be a consolidation of the five separate power plants now in the works. The new power plant will have a capacity of about 3,000 horse-power, and will comprise up-to-date equipment such as Stirling water-tube boiler, Taylor gravity under-feed stokers, gas engines and producers, etc.

FOOS GAS ENGINE CO., Springfield, Ohio, reports that the United States Government recently placed an order for six Foos vertical gas engines to be used for the operation of locks on the Ohio River. The locks are worked by air, the engines being required for driving the air compressors, and are 100 horse-power each. The engines specified are the regular Foos vertical three-cylinder single-acting type, using natural gas as fuel.

CINCINNATI IRON & STEEL CO., Cincinnati, Ohio, has installed a 30-ton electric Case crane with the Cincinnati Traction Co., and has received an order for a 10-ton Case electric crane for the Nashville Railway & Light Co., Nashville, Tenn. The company also has an order for a 180,000 pound shear to cut six-inch square metal for the Goldberger Iron Co., Cincinnati, Ohio. The shear is being built by the Mesta Machine Co., Pittsburg, Pa.

INTERNATIONAL-ACHESON GRAPHITE CO., Niagara Falls, N. Y., received on the afternoon of July 2 a telegraphic order calling for a shipment by express of a carload of electrodes 8 x 48 inches. The shipment was immediately loaded on an express car, and at 5:30 P. M. the car was pulled out of the switch and delivered to the Michigan Central Railway, and early on Saturday, July 3, the electrodes were delivered to the consignee in Chicago.

WESTINGHOUSE MACHINE CO., Pittsburg, Pa., has made a contract with the Public Service Corporation of New Jersey for four 13 x 12 inch three-cylinder Westinghouse gas engines direct connected to Root positive blowers for their Hoboken and Passaic gas plants for the purpose of boosting the gas pressure in the mains. The engines are of the vertical type and develop 90 horse-power each, and use illuminating gas for fuel.

CUTLER-HAMMER MFG. CO. has purchased the plant, business and patents of the J. L. Schureman Co., of Chicago. The manufacture of the Schureman controller apparatus will be continued and Mr. S. M. McFedries, general manager of the Schureman Co., will remain in active charge of the manufacture of the Schureman apparatus. Mr. J. L. Schureman retires from business. Until further notice, customers of the Schureman Co. should direct orders or inquiries to the old address, J. L. Schureman Co., 70 West Jackson Boulevard, Chicago, Ill.

MCGRAW-HILL BOOK CO., 239 West 39th St., New York, is a consolidation effected July 1 of the book departments of the McGraw Publishing Co. and the Hill Publishing Co. The new company takes over the book departments of both houses with a list of about 250 titles, comprising industrial and college text-books and covering all lines of engineering. It will continue the retail, importing and jobbing business of the two houses. The officers are: President, J. A. Hill; vice-president, James H. McGraw; secretary, Edward Caldwell; treasurer, Martin Foss.

AMERICAN AIR COMPRESSOR WORKS, 26 Cortlandt St., New York, has engaged Mr. August Kittleberger, who for the past fifteen years has been associated with the Clayton Air Compressor Co., as superintendent of the American Air Compressor Works plant in Brooklyn, New York. The company regard the engagement of Mr. Kittleberger as an important addition to its manufacturing department, and with the

GENUINE
STUBS ENGLISH
REAMERS OR BROACHES

We have just imported an exceptionally large quantity of these Broaches in all sizes from No. 65 Stubs Drill Gauge to 21-64 in. diameter and are ready to make immediate shipment.

Send us your specifications and we will quote.

HAMMACHER, SCHLEMMER & CO.

Hardware, Tools and Supplies
NEW YORK, SINCE 1848

4th Ave. and 13th St.

CONTENTS FOR AUGUST

revival of trade conditions and increased business resulting therefrom, looks for an enhanced popularity of the American Fairhurst air compressors and vacuum pumps.

Pratt & Whitney Co., Hartford, Conn., has been awarded a contract for equipping a small arms factory in Australia for the Australian government. The contract was obtained in competition with British manufacturers, the Pratt & Whitney bid being $340,000 as against $500,000 by one British concern and the time of delivery one year as against three years required by a British concern. Minister of Defense Joseph Cook would willingly have been influenced to give the work to a British concern, but he was obliged to accept the American tender, as conditions all around were much better.

Builders' Iron Foundry, Providence, R. I., is making and marketing the Kenerson transmission dynamometer invented and patented by Prof. W. H. Kenerson, and illustrated and described by him in a paper read before the Washington meeting of the American Society of Mechanical Engineers, May, 1909. (See Machinery, June, 1909.) This dynamometer is a device which indicates by means of a pressure gage the amount of power transmitted through it. The dial on the gage is graduated to indicate H. P. per 100 revolutions per minute of the shaft to which the dynamometer is attached. In all probability it is the most sensitive and practical dynamometer designed for measuring transmitted power yet devised.

Technical Index, a comprehensive record of current technical literature published in Belgium, announces that hereafter it will be represented in the United States by the George H. Gibson Co., *Tribune* Building, New York City. The *Technical Index* appears monthly and gives a systematic descriptive record of original articles appearing in over 200 engineering and technical journals and reviews, also indexing the proceedings of technical societies and technical books issued in all countries. The method of indexing covers the name of the author, the title of the article in full, an explanatory note stating the contents of the article, the name and date of the publication in which the article appeared and the length of the article.

New York Leather Belting Co., 51 Beekman St., New York, is carrying on a campaign for the standardization of leather belting, and honesty of manufacture. In the manufacture of its "Phœnix" belting, a strip of leather about 30 inches wide and 4 feet long only is used from one hide, the remainder being rejected for other purposes. Care is taken to cut this section so as to get the best results. For belts 8 inches wide or over, absolute centers are used, this part being that immediately over the backbone. Narrow double belts, 2 to 4 inches wide, are made up from the section immediately adjoining, and the remaining section is devoted to double belts 4 to 6 inches wide. This division of material makes belts that wear evenly and stretch uniformly. Illustrated literature shows the approved and condemned methods of cutting hides into belting.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

DRAFTSMEN cannot know too much about shop practice—many of them know too little and are handicapped thereby. Machinery's Shop Operation Sheets can help greatly. They are direct, definite and practical. The set now comprises 108 distinct operations. Write for "Self-Education." Machinery, 49-55 Lafayette St., New York City.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DRAFTSMAN.—Experienced mechanical draftsman. Apply MARKS & WOODWELL, Consulting Engineers, 103 Park Ave., New York.

DRAWINGS, TRACINGS, ETC., MADE.—Prices reasonable. Box 1302, Orange, Mass.

FORMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in Machinery's Reference Series, and for practical use in mechanical work promises to be the most widely useful book published in years. Price 25 cents. Address Machinery, 49-55 Lafayette St., New York City.

GOOD AUTOMOBILE AND TOOL DRAFTSMAN wanted. No others need apply. Ask for Mr. Allen, Chief Draftsman, THE TOLEDO MOTOR CO., Toledo, Ohio.

Have you any intricate mechanical problems to solve? If you have let me solve them for you at a saving of money, time and trouble. Developing inventions to a practical and commercial basis my specialty. BENJAMIN BROWNSTEIN, Mechanical Engineer and Expert Designer, Gundling Bldg., Trenton, N. J.

LATHE, PLANER AND BORING MILL HANDS WANTED for night and day shift. No labor troubles. Increasing force. Applicants must state wages desired, past experience and if employed at present, to receive further consideration. Apply to INGERSOLL-RAND CO., Painted Post, New York.

MECHANICAL DRAWING.—An Eastern College will have a position open about September 1st for a technical graduate, as Junior Instructor of Mechanical Drawing. Applicant must state age, education, drawing office experience with references and salary expected. Address Box 221, care Machinery, 49 Lafayette St., New York.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an investigation and report if a patent can be had and the exact cost. Send for full information. Trade-marks registered.

TECHNICAL GRADUATE, progressive, practical, age 28, married, familiar with design and operation of electrical and mechanical power distributions, electric motor applications and electric lighting installations and who has done some work in power plant and industrial building design, now in engineering department of large industrial corporation, can swing a bigger job and wants one. Draughting-room, office and construction experience. Capable of developing labor-saving methods and devices. Good executive and correspondent. Salary $1,800, employer to pay moving expenses from near New York to new location. Address Box 217, care Machineay, 49 Lafayette St., New York.

USE OF FORMULAS and of Tables of Sines and Tangents, without a knowledge of Algebra or Trigonometry, is made easy to you by SHOP ARITHMETIC FOR THE MACHINIST, which is No. 18 in Machinery's Reference Series fully described in a pamphlet sent free on request. Machinery, 49-55 Lafayette St., New York City.

WANTED.—Agents in every shop to sell Calipers. Liberal pay. Address E. G. SMITH CO., Columbia, Pa.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—A firm long established, employing 2,000 men, desires a thoroughly practical and efficient general machine shop foreman. Must be capable of satisfactorily handling sub-foremen and able to supervise the output of 400 machinists. Unless at present employed, will not be considered. Address Box 220, care Machinery, 49 Lafayette St., New York.

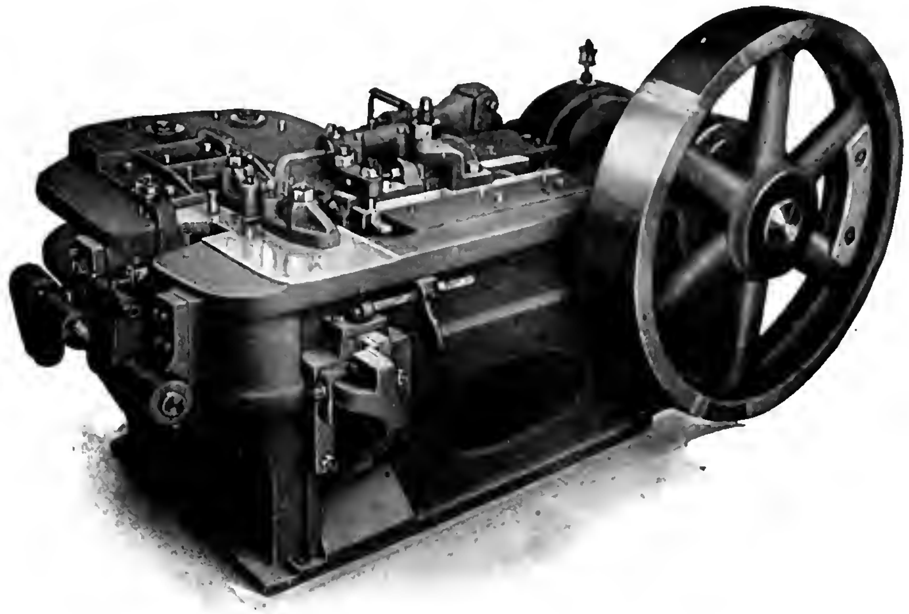
WANTED.—MACHINIST FOREMAN to do everything necessary to get out machines in good interchangeable condition. Must have experience. Write fully. Address Box 222, care Machineay, 49 Lafayette St., New York.

WANTED.—SUPERINTENDENT, an American, 30 to 45 years of age; good mechanic, good executive, systematic, progressive and aggressive; up on duplicate manufacturing with not less than three years' experience as superintendent of a gas engine factory; must have earned at least $1,800 per annum and saved something; to such a person we offer superintendency of our modern gas engine works, backed by all of the money, tools, appliances and material necessary to turn out 3,000 engines per year at least possible expense; time is an important consideration; give full and complete history and be prepared to pay us a visit, if apparently satisfactory. WITTE IRON WORKS CO., Kansas City, Mo.

WE CAN DESIGN YOUR COMPLICATED TOOLS, Drawings, tracings, blue prints. We also make tools, dies, jigs, models, etc. Experimental work. Inventions perfected. Send sample or blue print for estimate. Designers, draftsmen and toolmakers. BEACON TOOL WORKS, 146 Ward St., Naugatuck, Conn.

WE MANUFACTURE SPECIALTIES.—Let us figure on your metal stampings, punch press dies, tools, special machinery, etc. We guarantee to save you money. Address THE PENNSYLVANIA SPECIALTY MANUFACTURING CO., Cochranton, Pa.

SAVE MONEY ON YOUR RIVETS



Ajax Standard Rivet and Bolt Heading Machines

are not only exceedingly powerful, built from best materials, with extra large bearing and wearing areas, but each machine is equipped with the Ajax Absolute and Automatic Side Arm Relief to the Gripping Die Mechanism which prevents the destruction of the dies should the rivet be accidentally caught on the die faces.

This is one of the Ajax features that cuts down production costs—when such an accident occurs in our machines the relief mechanism acts instantly and the dies become dead until the rivet is dislodged.

We build these machines in five sizes, belt or motor driven as desired, and will send special circular on request.

THE AJAX MANUFACTURING COMPANY
CLEVELAND, OHIO

New York: Hudson Terminal Building, 50 Church Street
Chicago: 621 Marquette Building

de Fries & Co., Dusseldorf, Germany
European Builders and Distributors

The New High Speed Steel

NOVO SUPERIOR

THE LATEST INVENTION IN METALLURGY

Is now in stock in our Warehouses in all current sizes, flats, squares and rounds, annealed and unannealed.

It is claimed, for **NOVO SUPERIOR STEEL** that according to conditions, the speed can be increased over the present high speed steels, and sometimes 25, 50 and even 100 per cent. more speed has been obtained and the cutting edge has retained its sharpness from **four to six times longer** than on other high speed steels.

It cuts **harder material** than has heretofore been considered possible. Namely, steel castings, with vitrified sand blowholes, skidded tires, exceptionally hard and partly chilled cast iron.

It is **tougher than other high speed steel.** Therefore particularly adapted for tools that must stand a severe blow or pressure.

It is invaluable for automatic screw machine work where a **very fine cutting** edge is necessary.

Novo Superior steel is suitable for milling cutters, formed cutters, gear cutters, reamers, etc. Will wear from four to six times longer than other steels.

Novo Superior steel hardens in oil or water.

Send us a trial order. We guarantee results.

HERMANN BOKER & COMPANY

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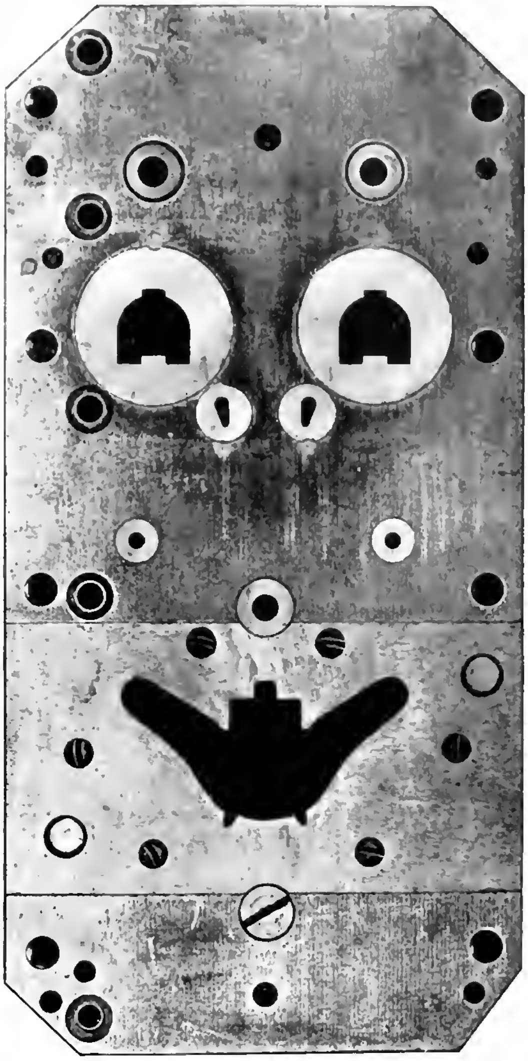
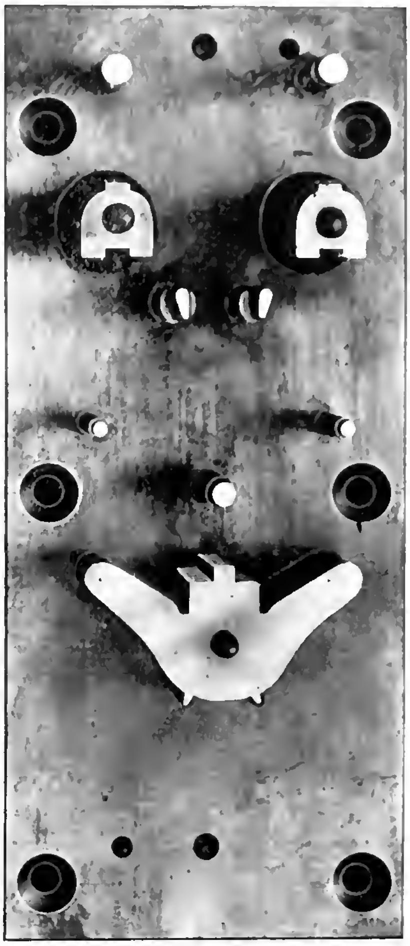
Chicago Warehouse, 57-63 N. Desplaines St.
Montreal, Canada, Warehouse, 332 St. James St.
Pacific Coast Agents, Pacific Tool & Supply Co., San Francisco, Cal.

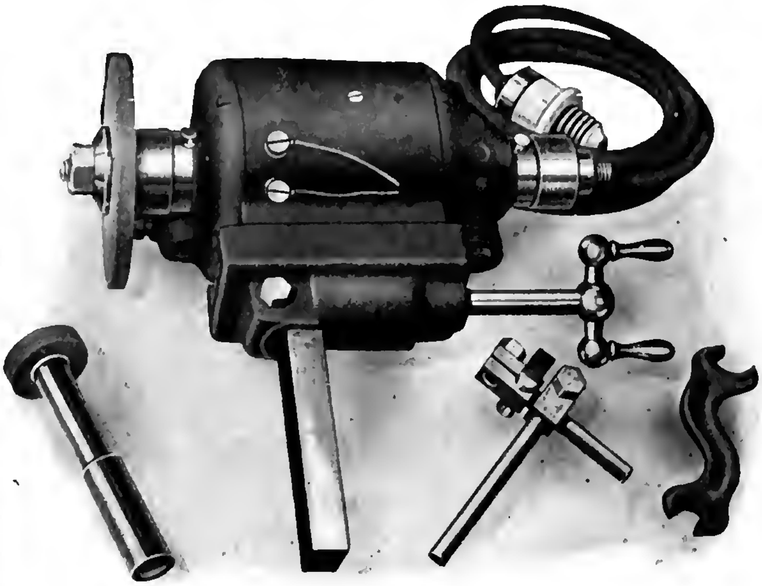




INVESTIGATE AND CONSIDER THE

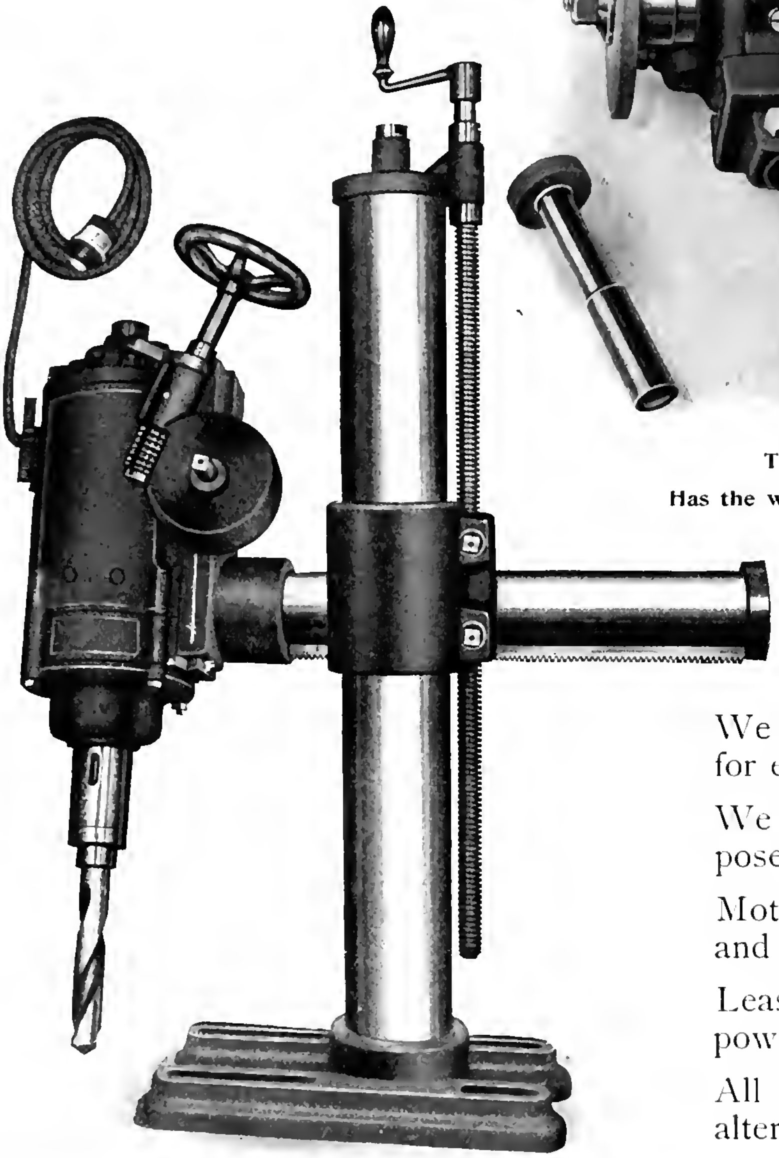
Improved "Hisey" Portable Electric Tools

Let us send you a drill or grinder on 10 days' trial.



TOOL-POST GRINDER

Has the widest possible range of work.



SCOTCH RADIAL DRILL

Can be set up anywhere. Range of work is unlimited.

We make grinders and buffers for every class of work.

We make drills for every purpose from ¼″ to 2″ capacity.

Motors enclosed, dust-proof and air-cooled.

Least watt consumption—more power.

All tools wound for direct or alternating current.

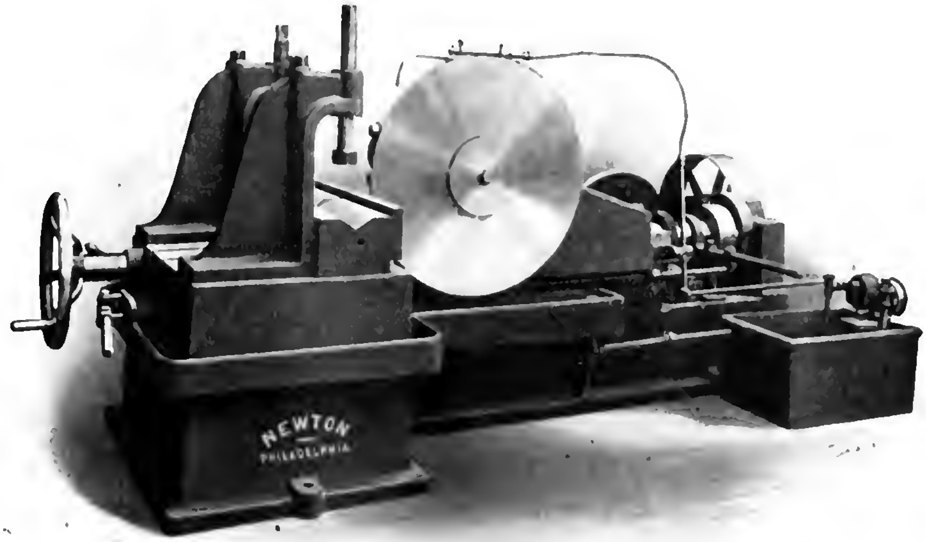
Write for Catalog No. 7, giving full description of our entire new line.

THE HISEY-WOLF MACHINE COMPANY

NEW YORK OFFICE: 50 Church Street

CINCINNATI, OHIO

FOREIGN REPRESENTATION: Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg. J. Lambercier & Co., Geneva. K. Lund & Co., Christiania. Wilh. Sonesson & Co., Malmo. Fenwick Freres & Co., Paris, Barcelona, Brussels. Ing. A. Baldini &Cie, Pontedera. Mitsui & Co., Tokio. Thomas McPherson & Sons, Melbourne. Philip G. Roeder, Mexico City.



No. 2 I-Beam Cold Saw Cutting-off Machine

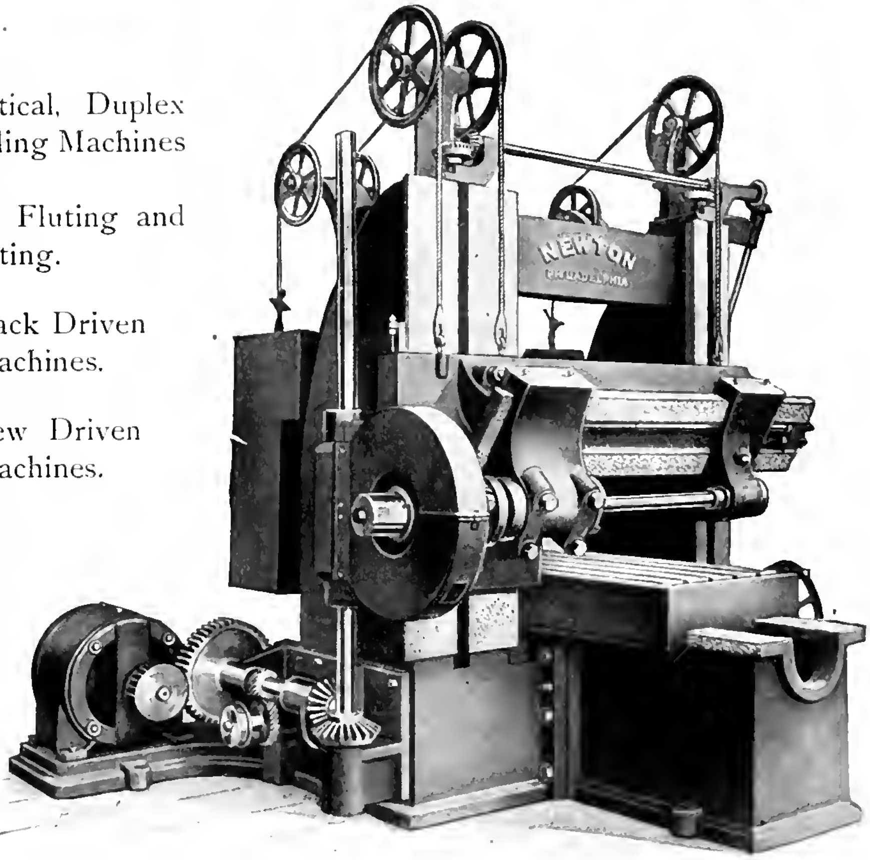
NEWTON

(REGISTERED TRADE MARK)

Horizontal, Vertical, Duplex and Portable Milling Machines for Facing, Sawing, Fluting and Keyseating.

Crank and Rack Driven Slotting Machines.

Portable Screw Driven Slotting Machines.



No. 3 Horizontal Milling Machine

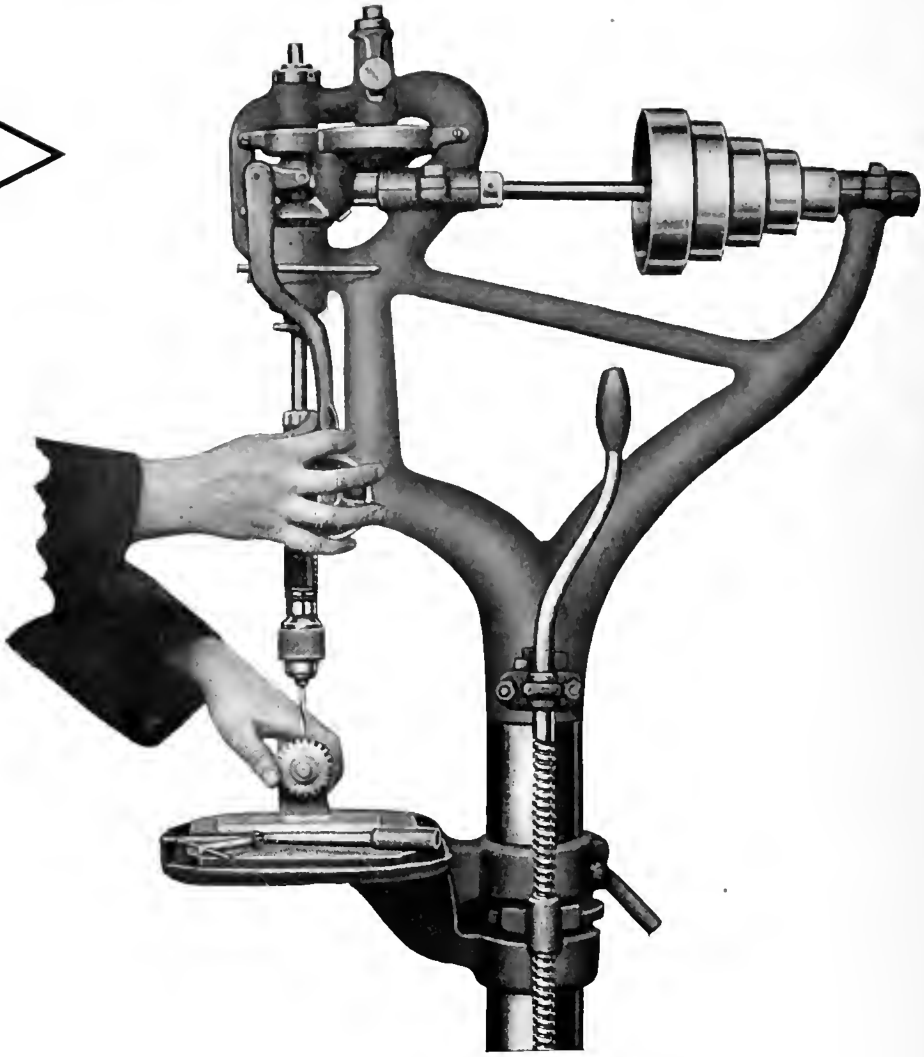
Newton Machine Tool Works, Inc.

Philadelphia, U. S. A.

FOREIGN REPRESENTATIVES—Berlin, Heinrich Dreyer. Vienna, Rudolph Salzer. Italy, Spain, Switzerland, Belgium and France, Fenwick Freres & Co., Paris, France.

THE
ROCKFORD
DRILLING MACHINE Co
ROCKFORD
ILL., U.S.A.

The simplest and most easily controlled device of its kind in the market.



The Rockford Patented Geared Tapper

This new Tapper is not an attachment but a part of the machine. It is always in place and ready for work; though when the tool is required for straight drilling only, the tapper can be lifted out of mesh in a few seconds' time, and as quickly replaced. It is well designed, very strong, has few parts and nothing to get out of order. The piece to be tapped is held in the left hand, while the right hand controls the forward and reverse. The thumb and first finger control the operating lever, the forward movement of which throws the tap into the forward speed, and the backward movement gives instantaneous 2 to 1 reverse. One of the conveniences you cannot afford to be without. Efficient, durable and exceedingly moderate in price.

Write for the details.

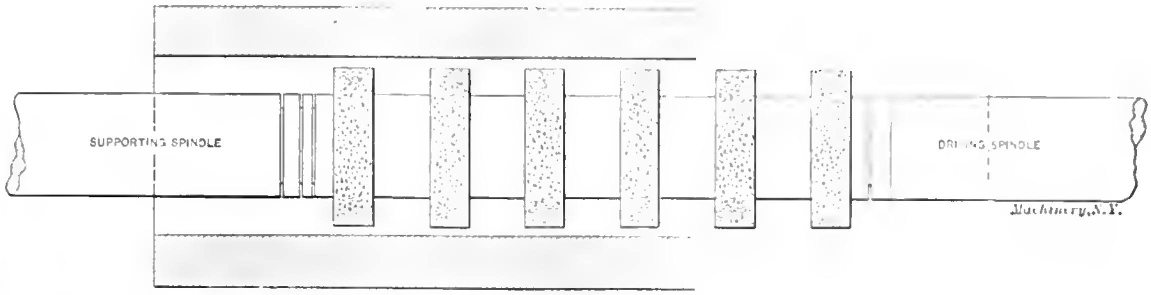
Rockford Drilling Machine Company

ROCKFORD, ILLINOIS, U. S. A.

Henri Benedictus, Agent for Belgium; Edgar Bloxam, Agent for France and Italy; Thomas McPherson & Son, Melbourne; New York Export & Import Co., Agents for India, Japan, China and the Phillippine Islands; Alfred H Schutte, Agent for Western Germany, Switzerland, Spain and Portugal; Theodore Butler, 149 Queen Victoria St., London, E. C.. R. S. Stokvis & Zonen, Ltd., Rotterdam, Agents for Holland and the Dutch Colonies.

Grind your Bushings—Don't Bore Them!

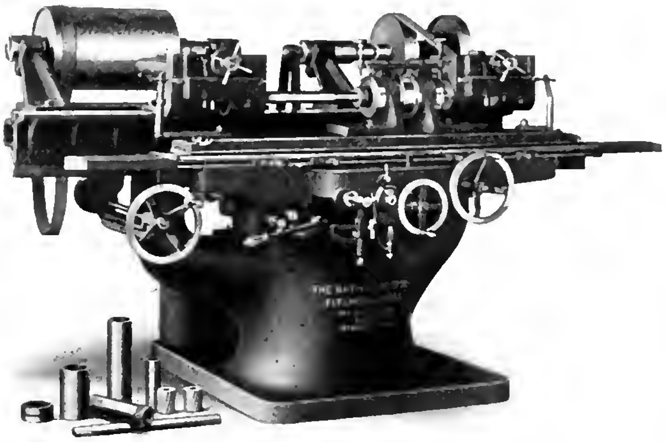
Use the Bath Internal Grinder with supported spindle carrying one to six grinding wheels. There's money in our method.



Cast iron bushing, 10¼" long, hole 3" diameter, internally ground on the Bath Grinder. The spindle is rigidly supported and has six wheels in simultaneous operation instead of one wheel—the usual method employed by the single head grinder.

The Bath Double-Headed Internal Grinder

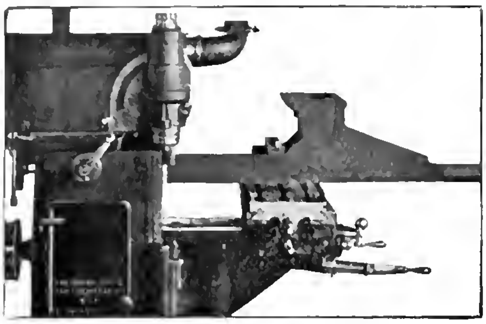
marks a new departure in rapid hole grinding that is quite as remarkable in its own way as the perfection of high speed steel for its purpose. A number of wheels can be used, as shown above, with the supported spindle, or two independent spindles can be simultaneously employed on two pieces of work, or two diameters on the same piece may be accurately and rapidly ground. It is the most rigid machine of its class and adapted for a wide variety of internal grinding. By a special form of construction all vibration is absorbed and there are other advantages well worth your investigation.



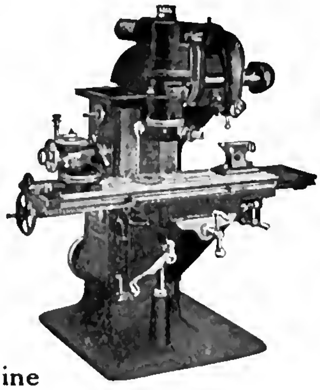
Keep an eye on our announcements—they will give you more *practical* information on the subject of internal grinding than could be obtained from a small library of technical books.

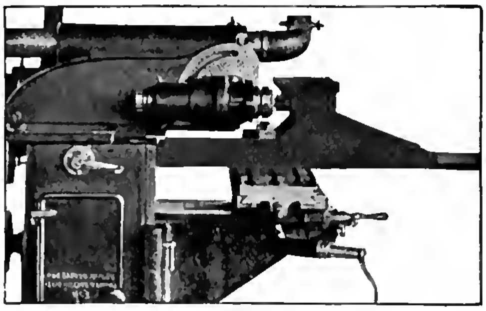
THE BATH GRINDER CO., Fitchburg, Mass., U. S. A.

Foreign Agents—Japan, Alfred Herbert, 224 Yamashito-cha, Yokohama. Northern and Eastern Germany and Austria-Hungary, Heinrich Dreyer, Kaiser Wilhelm str. 1, Berlin. Western and Southern Germany, Switzerland, Holland, Belgium, France, Spain and Italy, Alfred H. Schutte, Neumarkt 18, Cologne.



No. 2 Van Norman "Duplex" with Head set Vertical and Ram drawn back, cutter operating close to the column of the machine.





No. 2 Van Norman "Duplex" with Head set Horizontal and Ram thrown forward, cutting 17 inches away from the column.

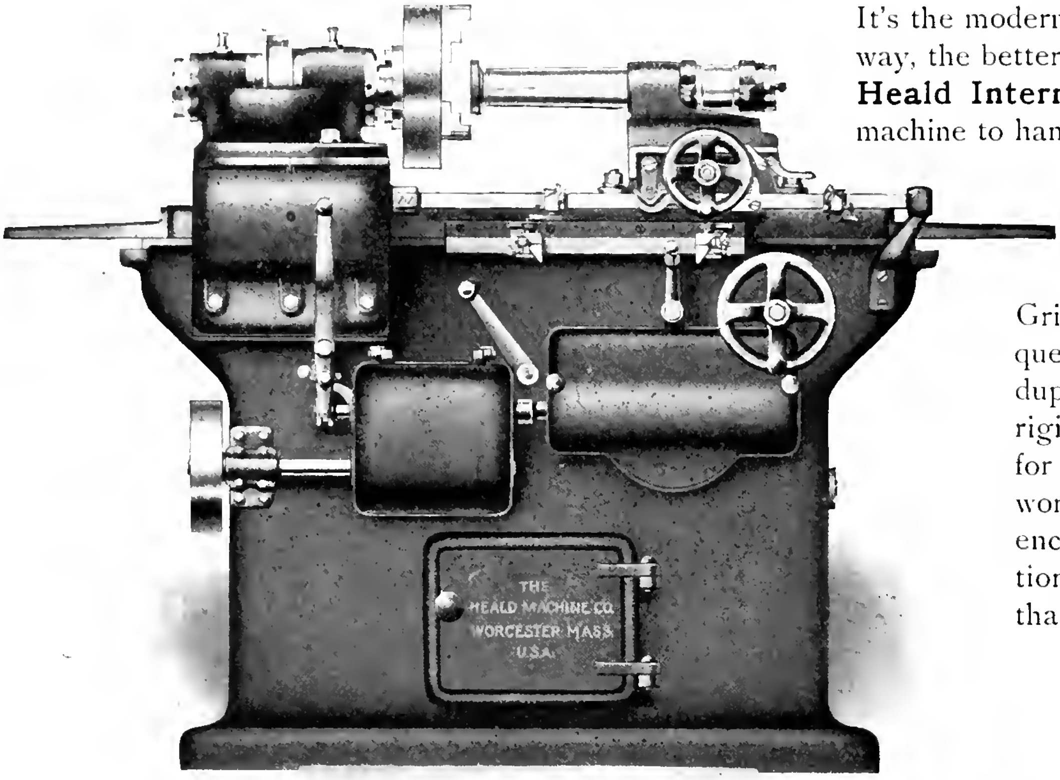
Van Norman "Duplex" Milling Machine

Note the GREAT RANGE and ADAPTABILITY for QUICK CHANGES of OPERATION. Position of Cutter Head and Ram can be changed in a moment and locked rigidly where desired. Made in 3 sizes. Mention Dec. MACHINERY.

ASK FOR MILLING MACHINE CATALOG

WALTHAM WATCH TOOL COMPANY
Springfield, Mass., U. S. A.

Don't Finish Holes by Reaming–Grind Them–



It's the modern way, the cheaper way, the better way and the new **Heald Internal Grinder,** the machine to handle the work.

Look up the fine points of this improved Grinder—it solves the question of exact duplication, has the rigidity so essential for heavy or accurate work, every convenience for rapid operation and is a machine that "makes good."

Catalogue?

The Heald Machine Company, 20 New Bond St. **Worcester, Mass.**

BETTER INVESTIGATE **16-INCH CINCINNATI LATHES**

before purchasing to satisfy yourself of their wearing qualities and secret of superiority. All standard threads cut without removing or duplicating a gear. Furnish another **All Geared Feed Device** with an unlimited range of threads and feeds. Write for details.

THE CINCINNATI LATHE & TOOL CO.
CINCINNATI, OHIO, U. S. A.

ROBBINS ENGINE LATHES

Our 13, 15, 18 and 20" Engine Lathes are of massive and powerful design, are strongly back geared and furnished with compound rest and regular attachments. The range of feeds and speeds is ample, cone carries extra wide belt and operating convenience is a feature. We also make Pattern Makers' Lathes, 16, 20 and 24" sizes. *Send for circulars.*

THE ROBBINS MACHINE CO.
149 Lagrange Street Worcester, Mass., U. S. A.

THIS MACHINE will stand the highest speed and coarsest feed that can be applied to a milling machine for the economical production of articles of brass or cast iron. The machine has been tested for a spindle speed of 620 revolutions on brass, and was then feeding 75 inches per minute. When intended for heavy milling in iron, this machine is made with back gears.

THE DRIVING CONSTRUCTION is very powerful. The belt is easily tightened by a device which keeps equal tension of the belt in any position of the spindle.

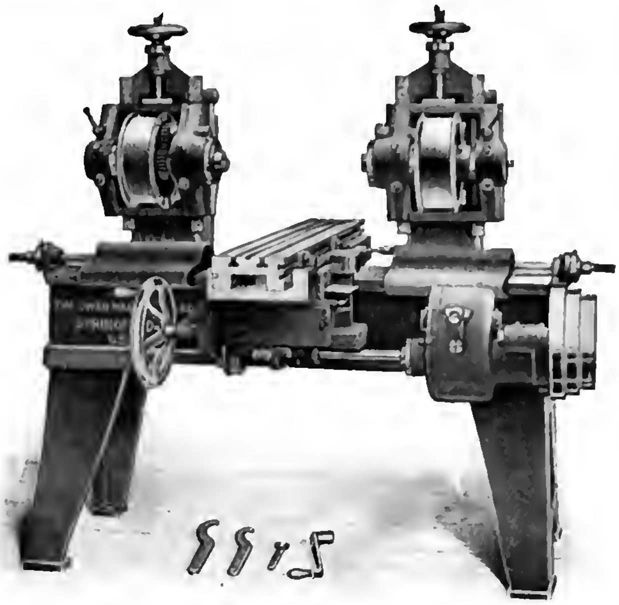
THE SPINDLE is of crucible steel and runs in phosphor bronze boxes. Both boxes and spindle are provided with means to compensate for wear.

T-SLOTS can be made in table to specifications.

THE FEED PARTS are very strong, and ample facilities are provided for oiling. The feed is operated by a lever on the side of the slide and has automatic return of 3 to 1 for brass and 5 to 1 for cast iron. It is stopped automatically at each operation of the table. A light push on a pawl on the side of the slide will start the feed. There are six changes of feed in geometric progression to suit the conditions of the work.

THE COUNTERSHAFT has two drive pulleys and two sets of tight and loose pulleys, allowing two cutting speeds to the countershaft.

Catalog C on request.



The Owen Machine Tool Co.,

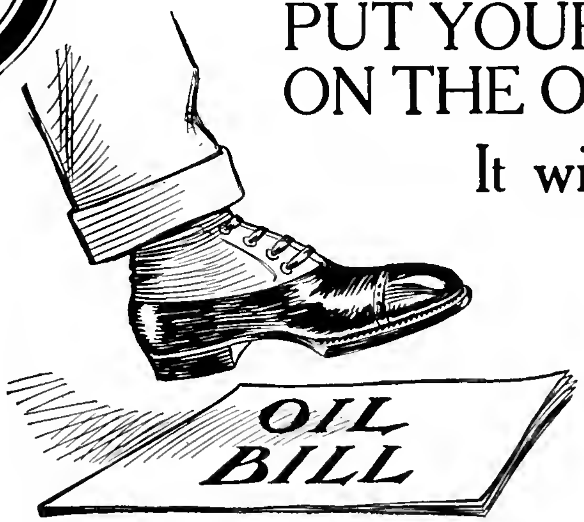
Dept. M., SPRINGFIELD, OHIO

United States Selling Agents—Chandler & Farquhar Co., Boston, Mass. Vandyck Churchill Co., New York and Philadelphia. Syracuse Supply Co., Syracuse and Buffalo, N.Y. Somers, Fitler & Todd Co., Pittsburg. C. C. Wormer Mchy. Co., Detroit. C. A. Strelinger Co., Detroit. Patterson Tool & Supply Co., Dayton, O. and Indianapolis, Ind. Wallis Engineering Co., Columbus, O. B. A. Tozzer, 2344 Prospect Place, Cleveland, O. O. L. Packard Mchy. Co., Chicago and Milwaukee. Fairbanks Co., New Orleans.

Foreign Agents—Alfred Herbert, Ltd., Coventry, Eng. De Fries & Co., Akt. Ges., Dusseldorf, Berlin and Stuttgart, Germany; Milan, Italy; Barcelona, Spain. Louis Besse, Paris, France. Alfred Herbert (France), Ltd., for Belgium and Switzerland. Alfred Herbert, Ltd., Yokohama, Japan.

PUT YOUR FOOT DOWN ON THE OIL BILL—

It will be a stand well taken

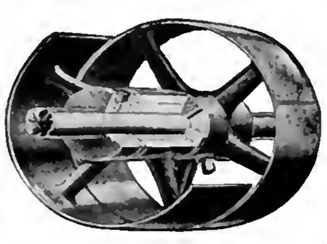


Isn't it sheer waste of time and money to keep pouring oil on loose pulleys when a little thing like ARGUTO will eliminate the necessity for lubrication of any sort?

"Arguto"
TRADE MARK
"REG. U. S. PAT. OFF."

One of the neatest proofs of the efficiency of
ARGUTO OILLESS BEARINGS
is that pulleys so equipped have run
2504 Days
at a stretch without attention.

ARGUTO OILLESS BEARING COMPANY
WAYNE JUNCTION, PHILADELPHIA, PA.



LOOSE PULLEY EQUIPMENT
(Patented)

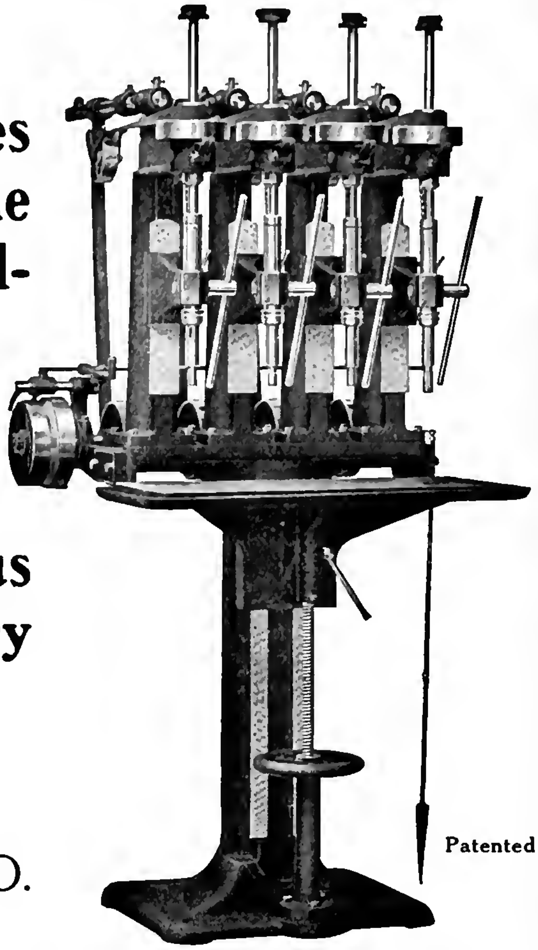
A few words, but to the point!

200 to 400 per cent. more holes can be produced in a given time with the Ball Bearing Drilling Machine than with any other drill press using same amount of power.

Hundreds of spindles—various makes—replaced by the Henry & Wright machines.

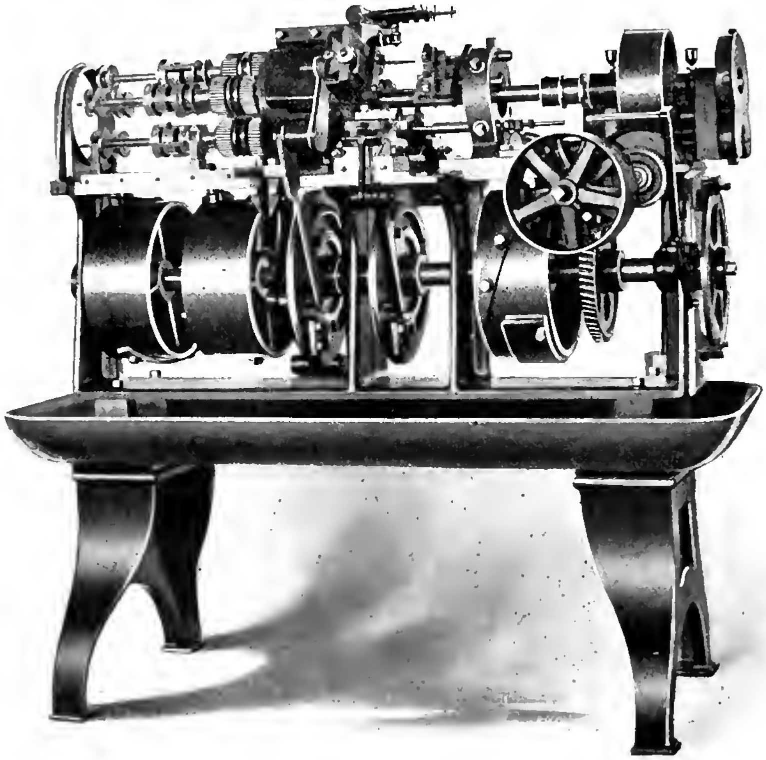
There are several good reasons—glad to explain.

THE HENRY & WRIGHT MFG. CO.
HARTFORD, CONN., U. S. A.



Patented

The Universal Multiple Spindle Automatic Screw Machine



For Screws and Screw Work of every description.

Send us your specifications for steel, iron or brass screws—any shape or size—and let us estimate the cost produced on the Universal.

Our machines are powerfully driven by one straight belt from the countershaft; have a gear driven threading mechanism which permits different speeds for various sizes and kinds of stock, and perform ten operations in the same time required by the ordinary machine to complete the longest single operation.

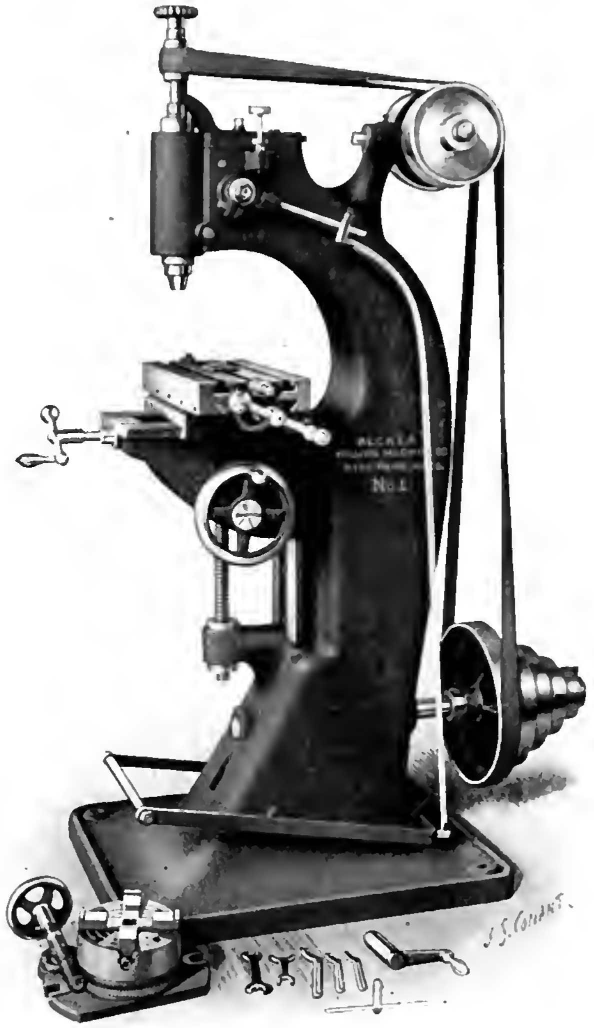
The height of perfection and economy in screw work.

THE UNIVERSAL MACHINE SCREW COMPANY, **Hartford, Conn.**

DOMESTIC AGENTS: Prentiss Tool & Supply Co., New York, Boston, Buffalo. Motch & Merryweather Machinery Co., Cleveland, Detroit, Cincinnati. Brown & Zortman Machinery Co., Pittsburg, Pa. Marshall & Huschart Machinery Co., Chicago, Ill.

How about your Light Milling?

Have you looked into costs on this class of work?



The No. 1 Becker Milling Machine

is a great money saver on the lighter grades of milling.

It is adapted for either wood or metal, handles the most delicate work, is especially adapted for such service as experimental work, model making, jewelers' dies, engravers' stamps, etc., and can also be advantageously used as a sensitive drill press.

The spindle is controlled by a foot lever, has a movement of one and one-half inches, an adjustable auxiliary bearing to relieve it from belt strain and may be speeded, to suit the work to be done, from 2,000 to 10,000 revolutions per minute.

The table on this machine is fitted with jaws made to suit and which are with or without screw adjustment. Four jaw chuck or circular table is provided for the rotary attachment, or both in combination.

Full description furnished on request.

The Becker Milling Machine Company

Hyde Park, Mass., U. S. A.

AGENTS—McDowell, Stocker & Co., Chicago. L. H. Swind, Philadelphia, Pa. A. F. Kummel, Hartford, Conn. J. L. Osgood, Buffalo, N. Y. Mortimer & Alcorn, Cleveland, O. A. B. Bowman, St. Louis, Mo. Bevan & Edwards Propty. Ltd., Melbourne, Australia. Selig, Sonnenthal & Co., London, England. Schuchardt & Schutte, Berlin, Germany; Vienna, Austria; Stockholm, Sweden; St. Petersburg, Russia; Copenhagen, Denmark; Budapest, Hungary; Shanghai, China. A. H. Schutte, Cologne, Germany; Liege, Belgium; Milan, Italy; Barcelona, Spain; Brussels, Belgium; Paris, France; Bilbao, Spain.

The Output of the Reynolds Automatic Screw Driver is only limited by the ability of the operator to handle the work.

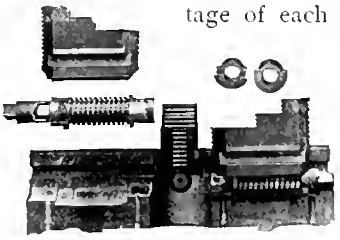
This novel machine has ample power to drive screws anywhere they can be driven by other means, and in many cases they can be set without boring.

Its simplicity makes skilled labor unnecessary, there is no danger of marring screw heads or work, it is strong, efficient, durable and will actually drive machine screws faster than you could drive nails.

Ask us for full description.

Reynolds Machinery Co.
MOLINE, ILL.

The Cincinnati Four Jaw Independent Chuck



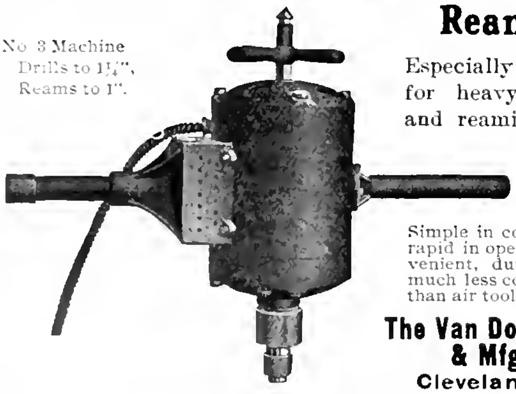
Not only a thoroughly A-1 chuck in point of design, material and construction, but has the unique advantage of each screw being mounted in hardened steel bushings. Outwears other chucks, keeps its alignment, and is the most convenient and efficient Independent Chuck made.

Circular on request.

THE CINCINNATI CHUCK CO., Cincinnati, O.
Chicago Office: 89 W. Randolph St. New York Office: 136 Liberty St.

Van Dorn Portable Electric Drills and Reamers

No 3 Machine
Drills to 1¼",
Reams to 1".



Especially designed for heavy drilling and reaming.

Ask for particulars.

Simple in construction, rapid in operation, convenient, durable and much less costly to run than air tools.

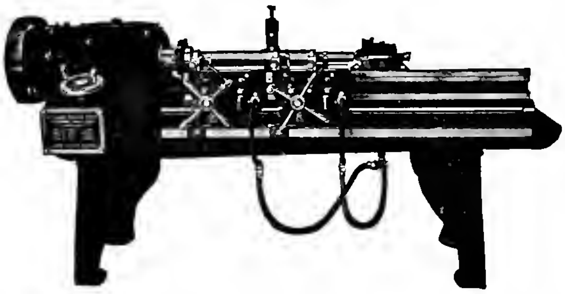
The Van Dorn Electric & Mfg. Co.
Cleveland, Ohio
NEW YORK OFFICE: 126 Liberty Street.

Duplex Independent End Buffing Lathe

This new machine has all the good points of the ordinary double end buffing lathe without any of the well known faults, and is a boon to the trade employing buffing or polishing machines for any purpose. It is very compact in design, strong and simple. The polishing wheels can be independently thrown into or out of engagement by means of simple friction clutches which are operated by conveniently placed hand levers. Bearings and all working parts are protected by dust proof casings. Ends of spindles are detachable, and can be furnished in any length or form, making it possible to use the same machine for all classes of work.

Ask for full particulars. Machine can be run at 3500 R.P.M. and upwards.

A. B. Nutting & Co., Amesbury, Mass.



Ask for Catalogue.

The Lo-swing Lathe

a heavy duty machine for turning straight and taper shafts, cutting two to six diameters at once.

FITCHBURG MACHINE WORKS, Fitchburg, Mass.

Shop Arithmetic for the Machinist

No. 18 in MACHINERY'S Reference Series

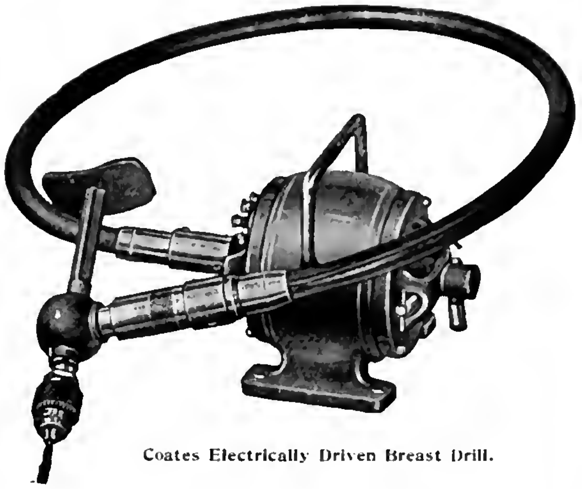
makes the use of Formulas, and of tables of Sines and Tangents easily understood without a knowledge of Algebra or Trigonometry.

Price 25 cents. *Write for pamphlet.*

THE INDUSTRIAL PRESS
49-55 Lafayette Street, NEW YORK

"I got the job done and a half day off— me for a Coates Flexible every time!"

No doubt about it, the **COATES FLEXIBLE SHAFT** is one of the most adaptable tools you can put in the shop and one that will save more time and labor than is easily calculated. The motor can be put any old place, the shop boys can operate it, and for finishing drop forged dies, grinding wrinkles out of metal patterns, cleaning cast iron gear work and drilling in odd corners there's not a tool to equal—let alone surpass it. One outfit serves for grinding, drilling and polishing, and with the patent Multiplier you can increase the regular speed of the shaft 8½ times. Anything in this for you?



Coates Electrically Driven Breast Drill.

COATES

Bulletin 21 for Details.

COATES CLIPPER MFG. CO., Worcester, Mass.

Some of the Exclusive Features of the Schellenbach-Hunt Universal Micrometer and Surface Gage are:

Hardened Bar and Base.

Parts subject to wear that will affect the accuracy of the instrument, hardened and adjustable.

Measures 7 inches horizontally in thousandths.

Measures 8 inches vertically in thousandths

Will scribe lines in thousandths to the full range of the instrument.

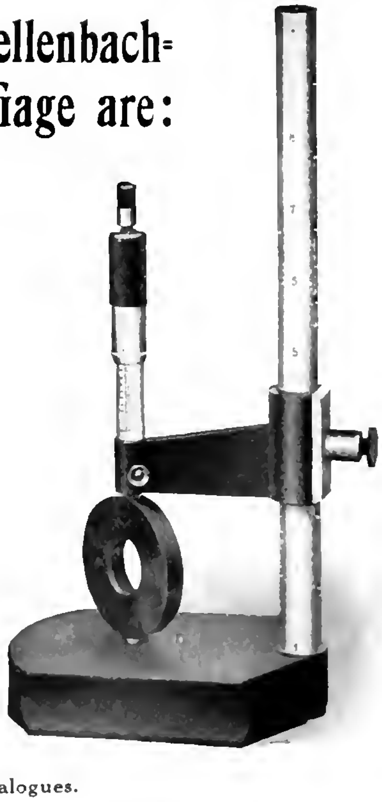
It can be set quicker and covers a greater range than six ordinary micrometers and will measure in positions where the regular micrometers cannot be used at all.

The sliding head is accurately positioned and locked to the bar at the same time. No extra screws or gibs required.

Jig and die work can be laid out in a fraction of the time required by the old methods.

The Instrument is warranted to be within the limits of accuracy of the *best* micrometers made, and is made to *stay* so

We will send for trial one of these tools to any responsible concern upon the above guarantee. If it fails to meet the above conditions, we pay the carriage both ways. We can't say more.



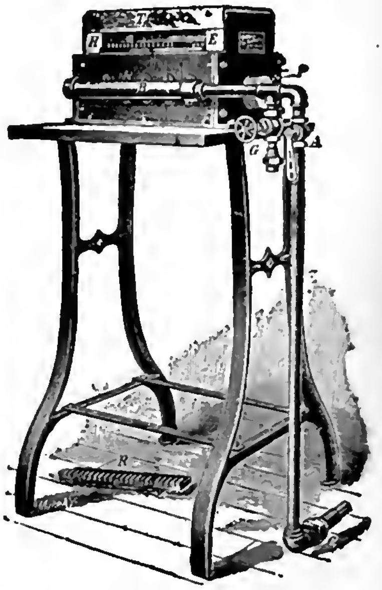
Now Mr. Shop Manager or Mr. Tool Room Man if you are interested in time saving, it is your move. Our circular tells about it. Ask your nearest dealer or write us direct.

Write for our Reamer and Boring Head Catalogues.

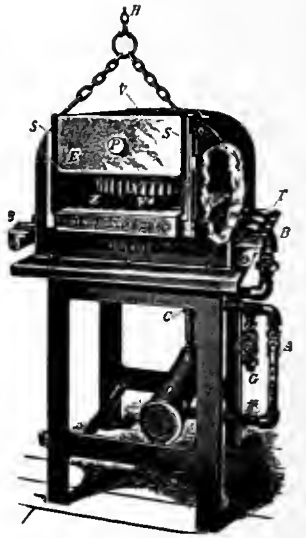
The Schellenbach-Hunt Tool Company

CINCINNATI, OHIO, U. S. A.

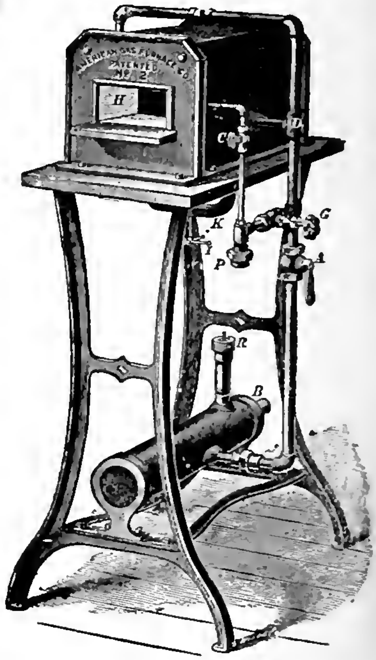
FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England. Markt & Co., 193 West St., New York, Germany and Italy. New York Export & Import Co., 133-137 Front St., New York, China, Japan and Australia. Williams & Wilson, Montreal, Canada. J. S. Cock, Christiania, Norway.



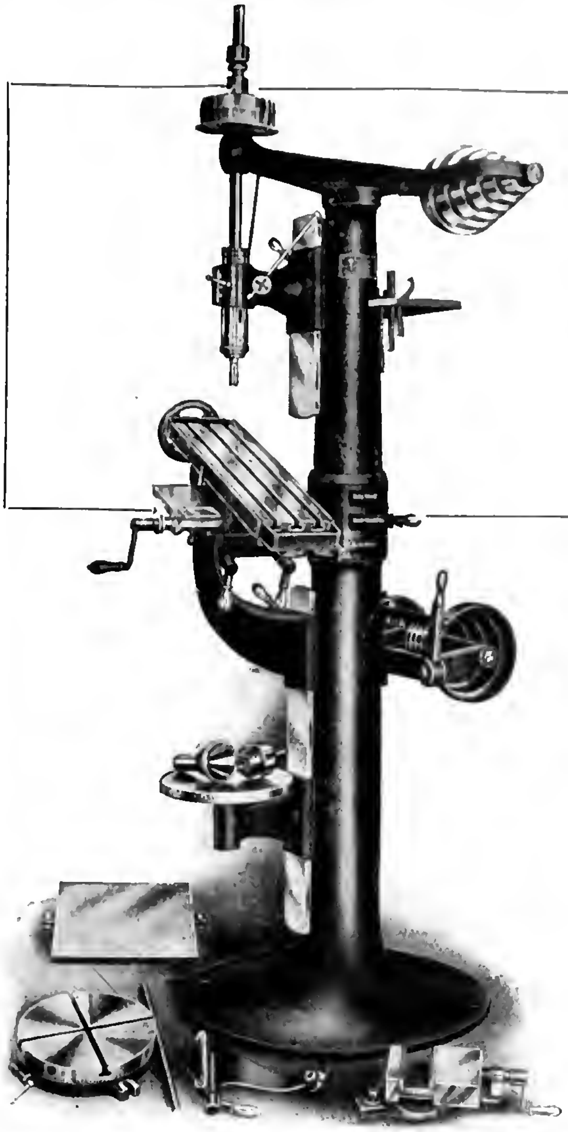
Gas Forge No. 7
For Cutlery, etc.



Oven Furnace No. 38



Tool Room Forge No. 2



Special Characteristics of the

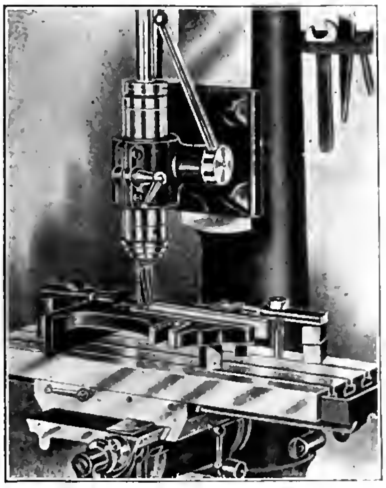
Knight Milling and Drilling Machine

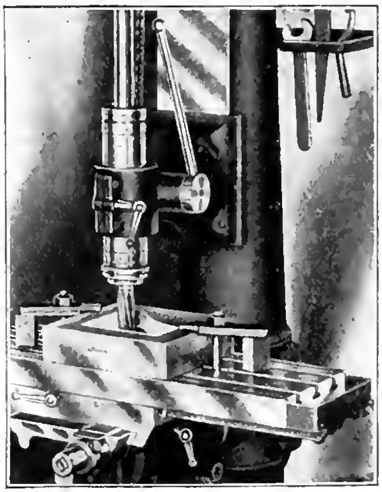
—ARE—

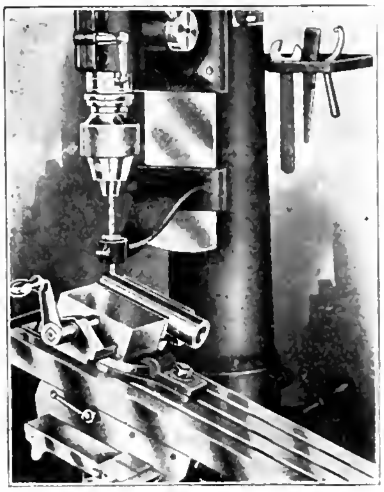
Versatility, Speed and Convenience

The range of work covered includes every kind of operation for which a vertical miller can be used, and a full line of drill work besides.

It is one of the most convenient and useful machines that can be put in the shop. The product is accurate, well finished and turned out in from 20 to 50% less time than by other methods.







Ask for prices and our special circular—shows a score of operations of which the engravings above are samples.

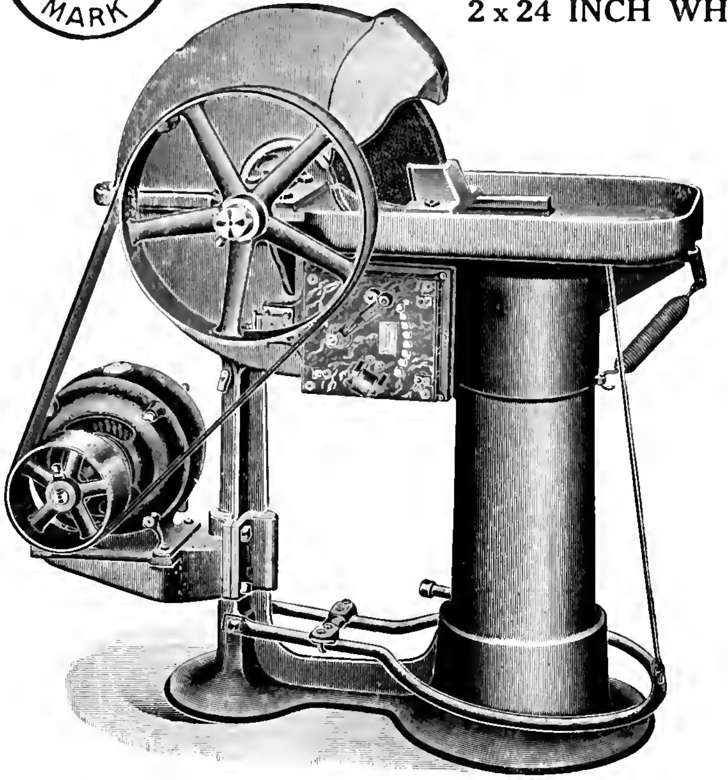
W. B. KNIGHT MACHINERY COMPANY

2019-2025 Lucas Ave., ST. LOUIS, MO., U. S. A.

AGENTS:—Baird Machinery Co., Pittsburgh, Pa. Chandler & Farquhar Co., Boston, Mass. The W. P. Davis Machine Co., Rochester, N. Y. The E. A. Kinsey Co., Cincinnati, Ohio, and Indianapolis, Ind. Manning, Maxwell & Moore, New York, N. Y., Philadelphia, Pa., Chicago, Ill., Syracuse, N. Y., Milwaukee, Wis., and Mexico City, Mexico. The Strong, Carlisle & Hammond Co., Cleveland, Ohio. C. C. Wormer Machinery Co., Detroit, Mich. C. T. Patterson Co., Limited, New Orleans, La. J. W. Wright & Co., St. Louis, Mo. Fred Ward & Son, San Francisco, Cal. FOREIGN AGENTS Schuchardt & Schutte. Alfred H. Schutte.

Water Emery Grinder

2 x 24 INCH WHEEL



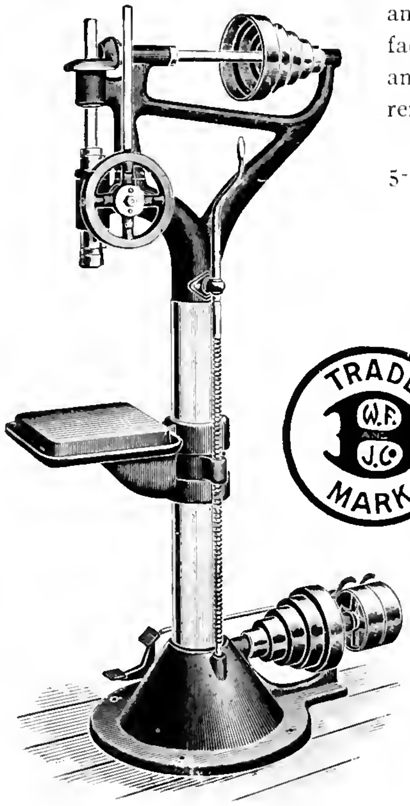
NO VALVES
NO PUMPS
Always ready for use

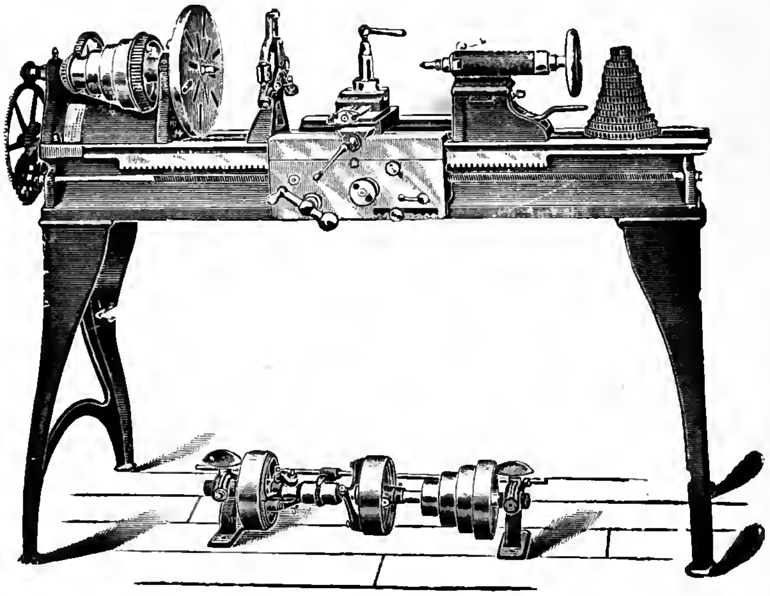
THIS grinder is most efficient in use, simplest in contsruction, and size of wheel best adapted for tool works; a wheel of less diameter or wider face gives all kinds of trouble; we know by experience and our experience saves the customer money.

Can furnish with
Electric or Countershaft Drive
For electric drive we use a 2-H.P. motor
SEND FOR CATALOGUE

These two tools make a pretty good start for a small machine shop. The drill is our No. 7—15-inch Swing Drill, a stiff tool for its size and well adapted for light medium work; just note the combined lever and wheel feed! The lathe is our No. 13 Lathe, swinging 13 inches over the face plate, and made in beds of 5 to 10 feet long; has automatic cross-feed and compound rest; very stiff tool carriage and changes of feed without removing a gear. We can furnish Lathe with foot power if wanted.

A good deal less than $200 will buy this Drill and the Lathe with 5-foot bed. Write for catalogue.

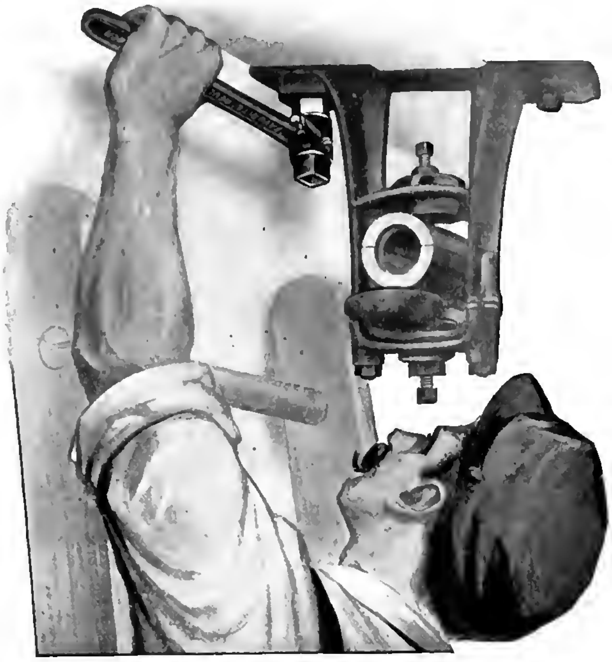


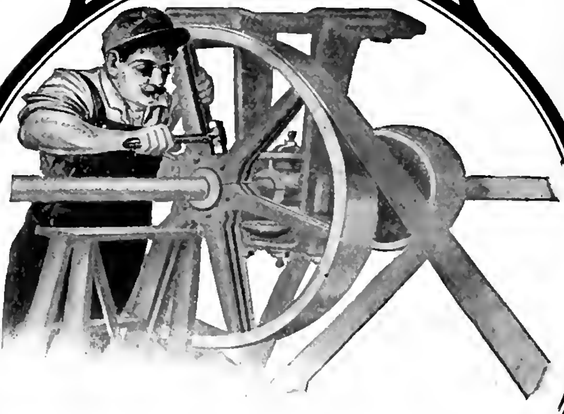


W. F. & JOHN BARNES CO.

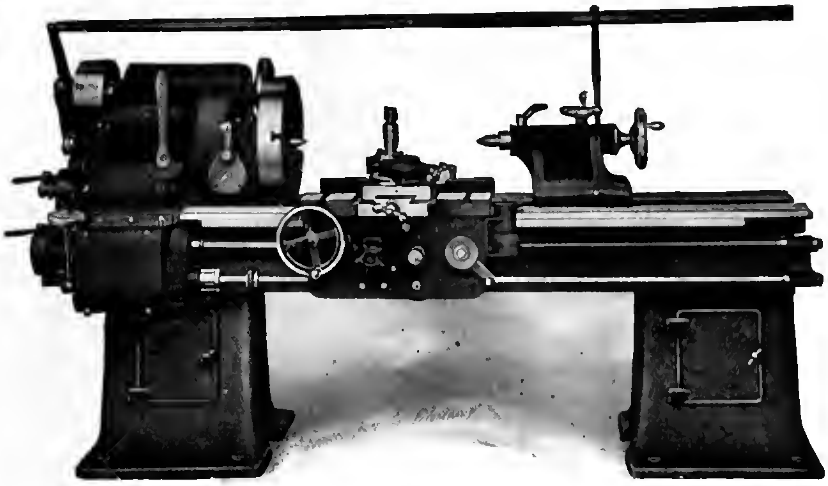
231 Ruby Street Established 1872 **Rockford, Illinois**


MAN WANTED





WHITCOMB



In this New 16-inch Geared Head Lathe

provision is made for 32 changes of feed for turning and threading, without removing or changing a gear. The drive through a single speed pulley with geared connections for speed changes is a conceded advantage, and the new form of clutch through which changes of speed are obtainable combines the good points of both the positive and friction types and at the same time overcomes the faults of both. The spindle is positively driven, yet without shock in engaging or disengaging and with no possibility of continued slipping, as the act of slipping only serves to tighten the clutch more firmly.

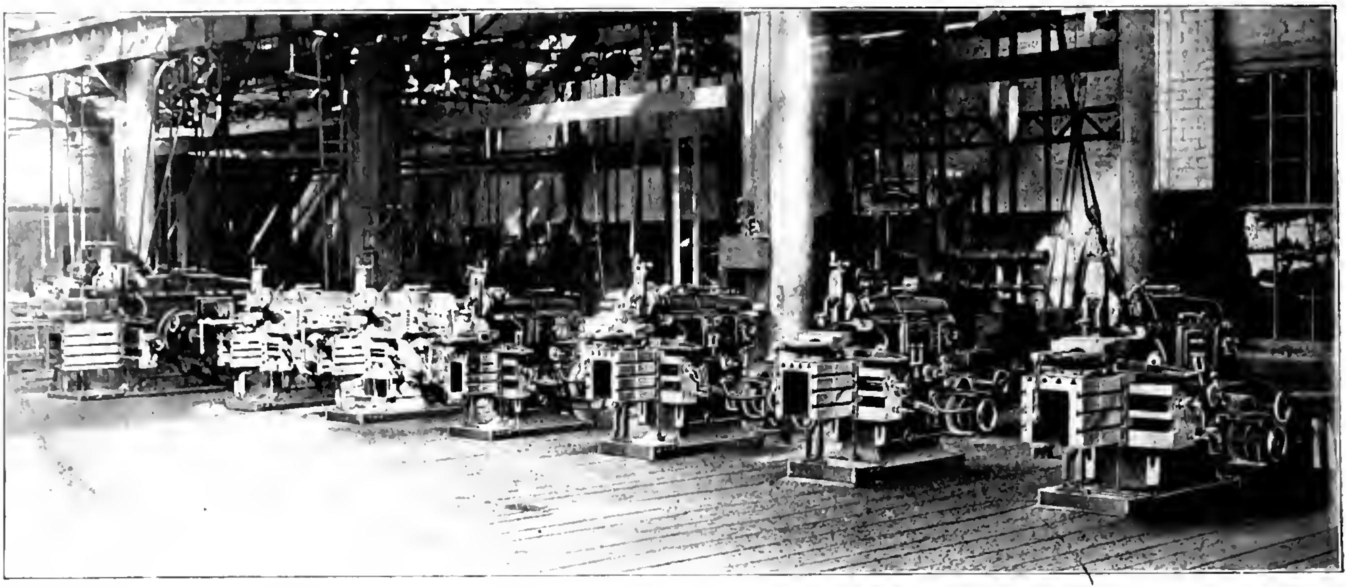
The lathe is smooth running, easily handled, has power for very heavy work and will stand up under hard service. The improved feed box, new chasing dial, adjustable apron friction, clamping arrangements for tailstock and special lubricating system, are other notable points which we shall be glad to explain in detail.

We are also makers of the Second Belt Drive Planers.

Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass.

AGENTS: Hill, Clarke & Co., Boston, Chicago and Cleveland, O., Vandyck Churchill Co., New York and Philadelphia. Thomas & Lowe Machinery Co., Providence, R. I. C. H. Wood Co., Syracuse, N. Y. McDowell, Stocker & Co., Chicago, Ill. Marshall & Huschart Machinery Co., St. Louis, Mo. and Indianapolis, Ind. J. L. Osgood, Buffalo, N. Y. Perine Machinery Co., Seattle, Wash. Pacific Tool and Supply Co., San Francisco, Cal. Somers, Fitler & Todd Co., Pittsburg, Pa. Chas. A. Strelinger Co., Detroit, Mich. Zimmerman-Wells-Brown Co., Portland, Ore. Smith-Booth-Usher Co., Los Angeles, Cal. C. W. Burton, Griffiths & Co., London, England. Fenwick Freres & Co., Paris, France. Ludw. Loewe & Co., Berlin, Germany. De Fries & Co., Dusseldorf, Germany. Wilh. Sonesson & Co., Malmo, Sweden. Van Rietschoten & Houwens, Rotterdam, Holland. Williams & Wilson, Montreal, Canada. A. R. Williams Machinery Co., Toronto, Canada.

BLAISDELL



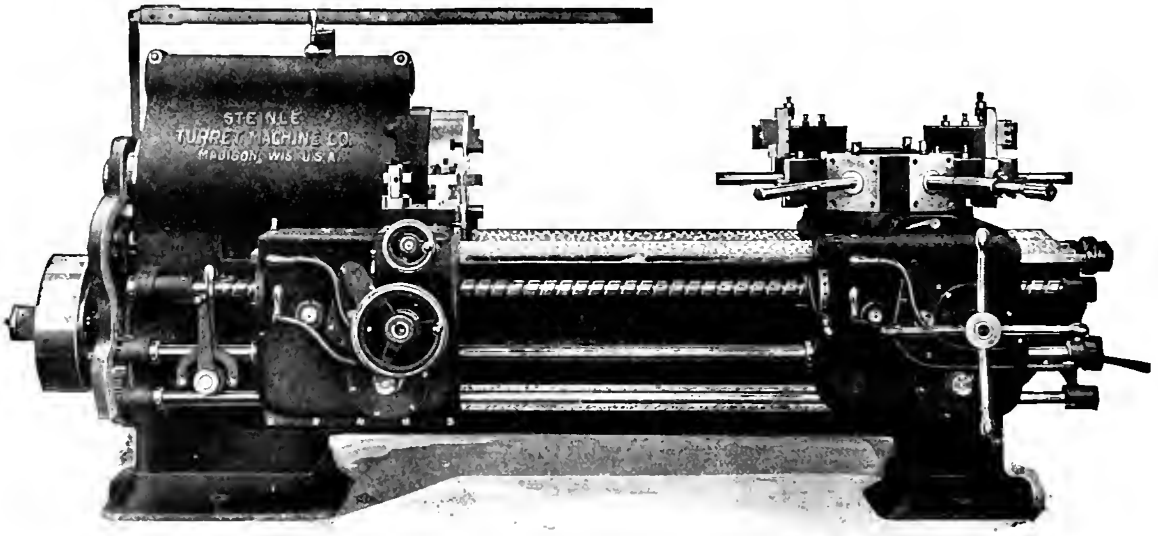
VIEW in tool room of a large steel plant in Ohio, where they are using seven of our Shapers, each motor driven; also five more machines in another building, making a total of twelve EBERHARDT'S PATENT "HIGH DUTY" SHAPERS, all motor driven, in this one plant. *There's a reason—better consult us.*

GOULD & EBERHARDT

"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY
ESTABLISHED 1833 NEWARK, N.J. U.S.A.

THE FULL SWING TURRET LATHE

Increased Capacity - Short Turret Tools - Modern in All Details



STEINLE TURRET MACHINE COMPANY

MADISON, WIS., U. S. A.

SELLING AGENTS.

MANNING, MAXWELL & MOORE, Inc., **New York.** Atlanta, Boston, Chicago, Cleveland, Detroit, Milwaukee, Philadelphia, Pittsburg, St. Louis, Syracuse, Seattle, Portland, Japan, Mexico.	**LUDW. LOEWE & CO., A. G.,** **Berlin.** Austria, Belgium, Denmark, France, Germany, Holland, Hungary, Italy, Norway, Romania, Russia, Spain, Sweden, Switzerland.

See that ram bearing?
That means **accuracy**!

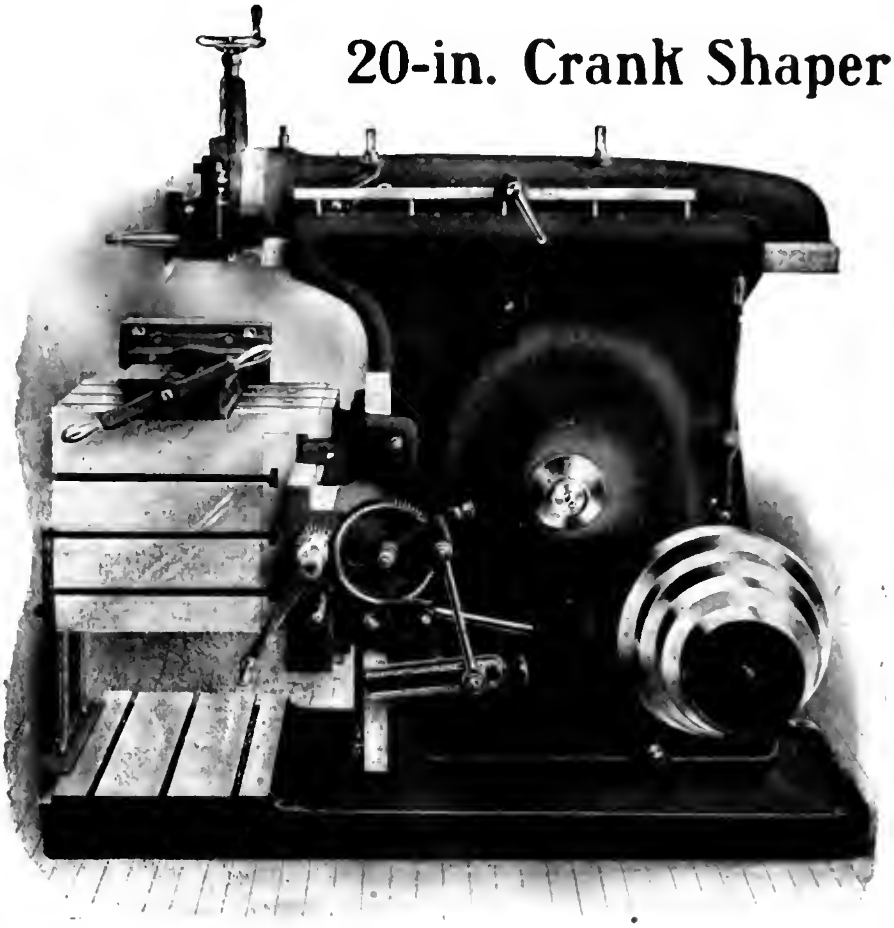
Gearing designed for 6 H. P.
That means **strength**!

Cutting strokes per minute are 7, 10.3, 15.3, 22.6, 33.5, 49.4, 73, 108.
That means **efficiency**!

Notice the beauty and symmetry? These show the work of a wise designer!

Accuracy, Strength, Efficiency, and Practical Design, are characteristics of Walcott tools as exemplified in the 20" Crank Shaper illustrated.

20-in. Crank Shaper

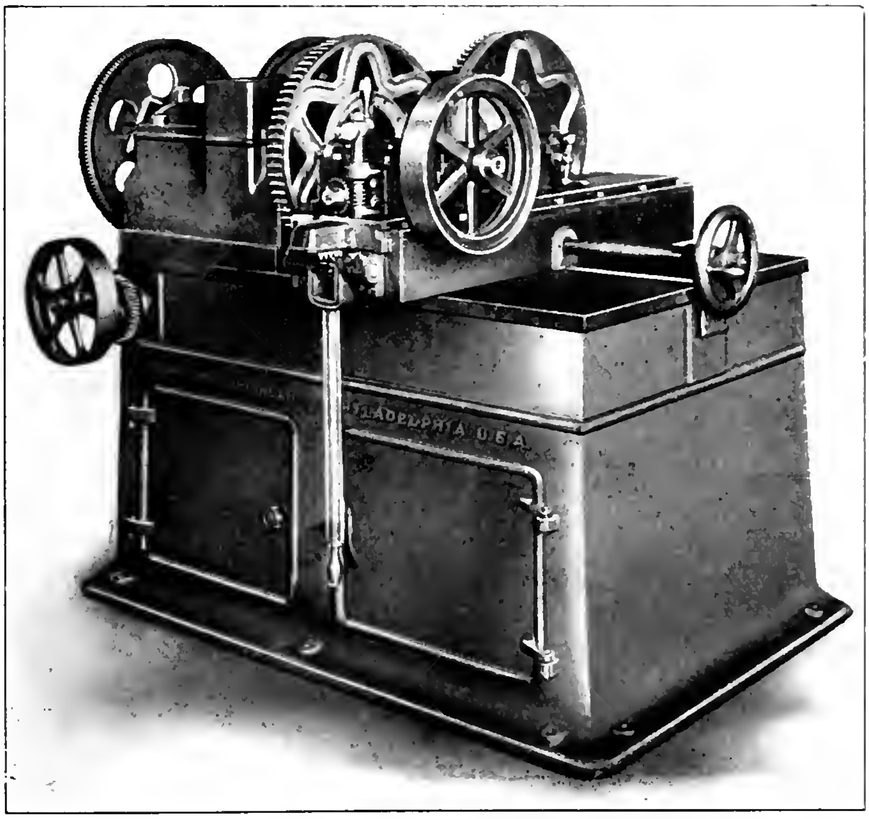


Walcott & Wood Machine Tool Co.

Succeeding
GEO. D. WALCOTT & SON
JACKSON, MICH.

AGENTS: Frevert Machinery Co., New York. Chandler & Farquhar Co., Boston. Chas. G. Smith Co., Pittsburg. Strong, Carlisle & Hammond Co., Cleveland. H. A. Stocker Machinery Co., Chicago.

FOREIGN AGENTS: Fenwick Freres & Co., Paris. Buck & Hickman, Ltd., London.



THIS machine has been specially designed for cutting cams automatically from 1" diameter up to 21" diameter. After the cut is started it requires no attention until it is complete, when the cam is removed and another one put in its place.

For further information write us.

This Cam, 21 diameter, cut automatically in 15 minutes, 1 cut.

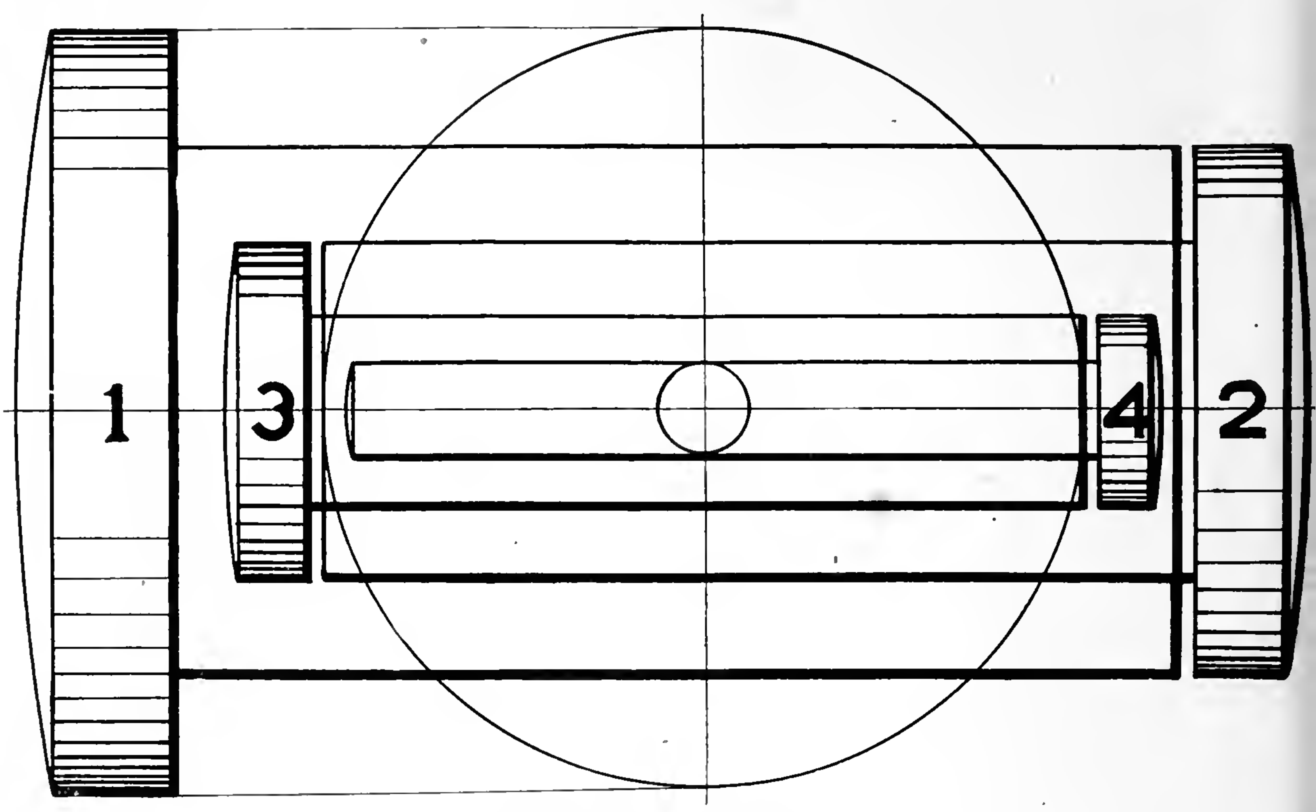
Fay Machine Tool Company

Philadelphia, Pa.

One of the Most Frequ
Equipment of an Automatic Scr

The illustrations show the latest model Cleveland Box Mill, and some examples of work produced.

These are every-day examples of "Cleveland" efficiency that speak for themselves—but it will be clear to every mechanic that it takes a pretty good machine and a pretty good box mill to produce such results.

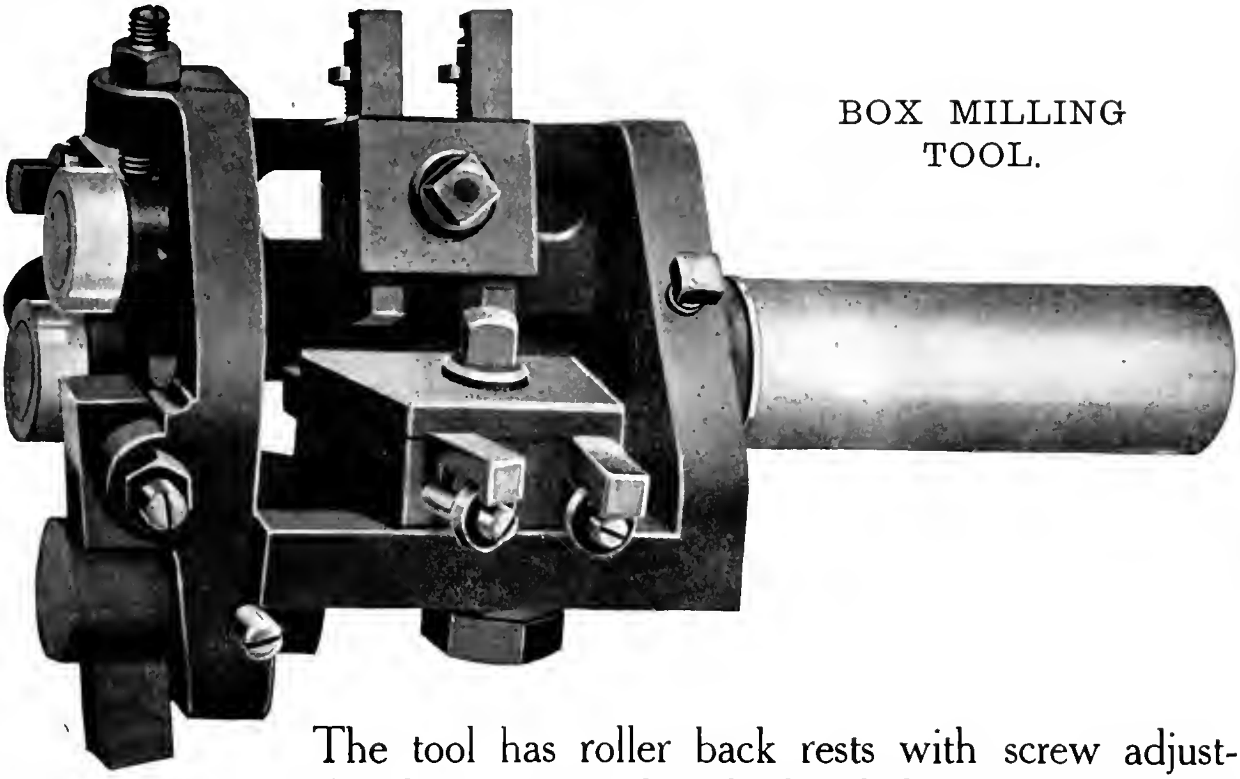


Examples of work.

Cleveland Automatic Machine

Eastern Representative—J. B. Anderson, 2450 No. 30th St., Philadelphia. Western Representative—H. E. Nunn, 67 W.
castle-on-Tyne and Glasgow. Messrs. Schuchardt & Schutte, Vienna, Berlin, St. Petersburg, Stockholm,

ently used Tools in the ew Machine is the Box Mill Tool



BOX MILLING TOOL.

The tool has roller back rests with screw adjustment for diameters, and multiple blades which are also provided with screw adjustment for diameters.

Work shown is actual size, material 10 to 35 points carbon, and the pieces are milled as follows:

Piece No. 1: reduced from 4 inches to 2¾ inches, milling time - 90 seconds per inch.
Piece No. 2: reduced from 2¾ inches to 1¾ inches, milling time 75 seconds per inch.
Piece No. 3: reduced from 1¾ inches to 1 inch, milling time - 35 seconds per inch.
Piece No. 4: reduced from 1 inch to ½ inch, milling time - - 20 seconds per inch.

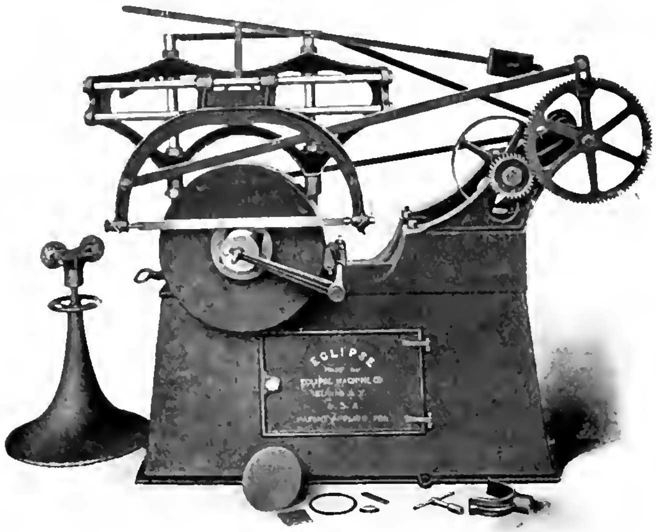
Send for our new Red Catalogue showing full line of machines, tools, attachments, etc. Also look for our advertisement next month.

Company, Cleveland, O., U. S. A.

Washington St., Chicago. Foreign Representatives—Chas. Churchill & Co., London, Manchester, Birmingham, New-
Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milano and Bilbao.

MANNING, MAXWELL & MOORE

INCORPORATED



Automatic Hack Saw

THE **ECLIPSE POWER HACK SAW** NOTED FOR ITS ACCURACY AND SIMPLICITY IN OPERATION. IT IS THE ONLY HACK SAW WHICH TURNS ITS STOCK EACH STROKE, THEREBY PRESENTING AN EASY CUTTING SURFACE TO THE SAW, COMBINING ACCURACY WITH THE SPEED OF A CIRCULAR SAW.

CAPACITY, 3/8 IN. TO 6 IN. "ROUNDS"—4 IN. "SQUARES."

Write for particulars.

SELLING AGENTS

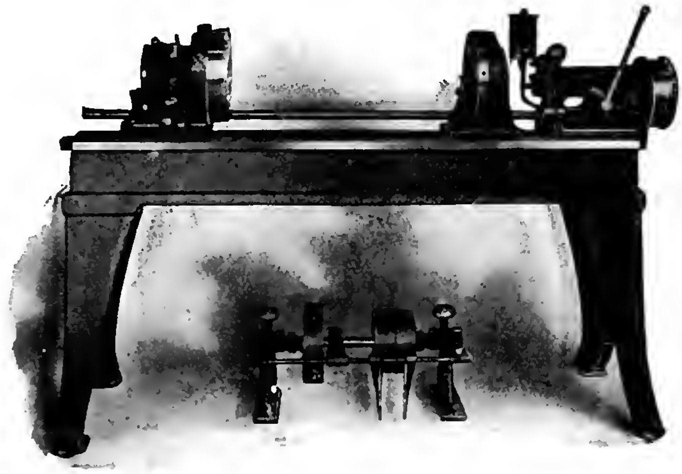
85-87-89 Liberty Street, New York

22-26 S. Canal St., Chicago
921 Arch St., Philadelphia
45 Oliver St., Boston
Frisco Bldg., St. Louis
Park Bldg., Pittsburgh
109 Park St., Atlanta
Kirk Bldg., Syracuse
1262 Ontario St., Cleveland
Traction Terminal Bldg., Indianapolis
White Bldg., Buffalo
Majestic Bldg., Detroit
Merrill Bldg., Milwaukee
Yokohama, Japan

THE WHITON

Revolving Centering Machine

For Accurately Centering Finished Shafts



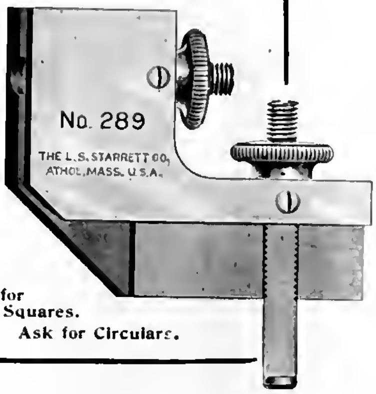
The cut shows new REVOLVING CENTERING MACHINE—a large size of the well known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

Circulars and prices sent upon application.

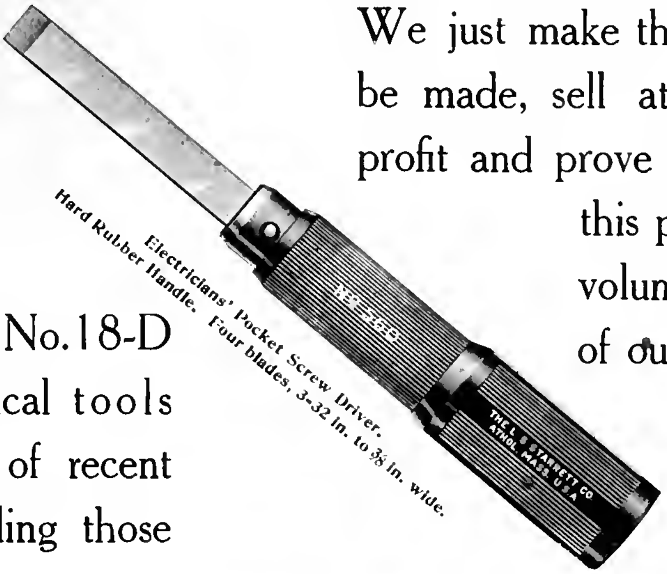
The D. E. Whiton Machine Company
New London, Connecticut

Plenty of men have sufficient foresight to pay the difference between the Best Tools that can be made and the inferior article.



Attachment for Combination Squares. Very handy. Ask for Circulars.

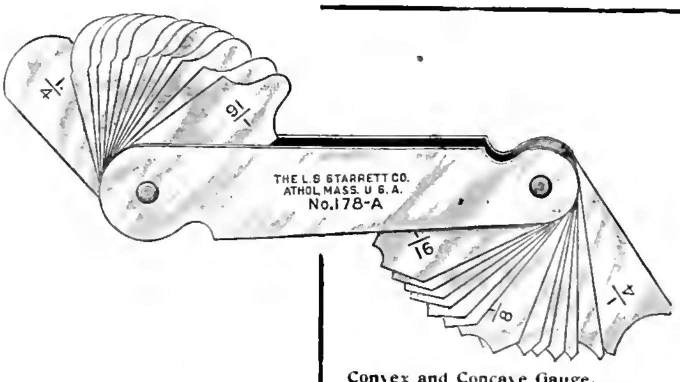
In building Starrett Tools we are never hampered by consideration of either cost or selling price. We just make the best that can be made, sell at a reasonable profit and prove the wisdom of this practice by the volume and growth of our business.



Electricians' Pocket Screw Driver. Hard Rubber Handle. Four blades, 3-32 in. to 3/8 in. wide.

Ask for Catalog No. 18-D of fine mechanical tools and circulars of recent additions including those here shown.

Some tools can be bought for less, but there are none worth more than Starrett's.



Convex and Concave Gauge. Radii indicated by 64ths from 1-16 in. to 1/4 in.

The L. S. Starrett Co.

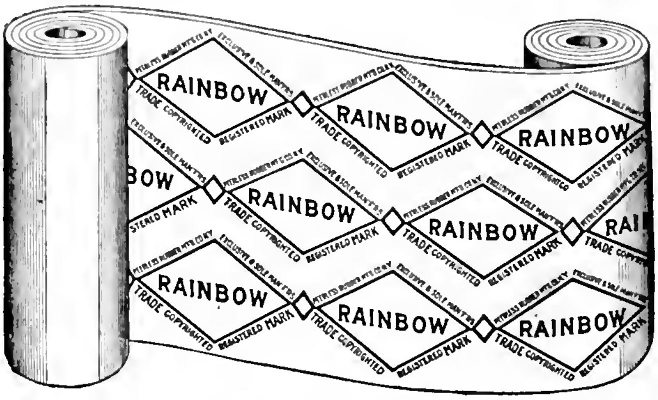
ATHOL, MASS, U. S. A.

NEW YORK	CHICAGO	LONDON
132 Liberty St.	18-20 West Randolph St.	36-37 Upper Thames St., E. C.

Rainbow Packing

Makes Steam, Flange and Hot Water Joints Instantly.

Thousands of Imitations. No Equal. Will Hold Highest Pressure.



Don't have to use wire and cloth to hold Rainbow. Can't blow it out.

THE COLOR OF RAINBOW PACKING IS RED

Notice our Trade Mark of the Word "RAINBOW" in a diamond in Black in

Three Rows of Diamonds extending throughout the entire length of each and every roll of Rainbow Packing

WILL CARRY IN STOCK It is an undisputed fact that Rainbow Packing is the only Sheet or Flange Packing in the World that will carry in stock for months and years without hardening or cracking.

The Peerless Spiral Piston and Valve Rod Packing

Once Tried Always Used.

It will hold 400 lbs. of Steam.

Will run twelve months in high speed engines.

In Boxes 3 to 8 lbs.

Made in Three Different Shapes: Straight, Spiral and Square Spiral, in sizes from 1-4 inch to 2 inches.

WRITE FOR CATALOG

MANUFACTURED, PATENTED AND COPYRIGHTED EXCLUSIVELY BY

THE PEERLESS RUBBER MFG. CO., 16 Warren Street, 88 Chambers Street, **New York**

24 Woodward Ave., Detroit, Mich.
202-210 S. Water St., Chicago, Ill.
38-42 S. Capitol Ave., Indianapolis, Ind.
111-121 W. Main St., Louisville, Ky.
1218 Farnam St., Omaha, Neb.
1323 E. Main St., Richmond, Va.
245-247 Master St., Philadelphia, Pa.
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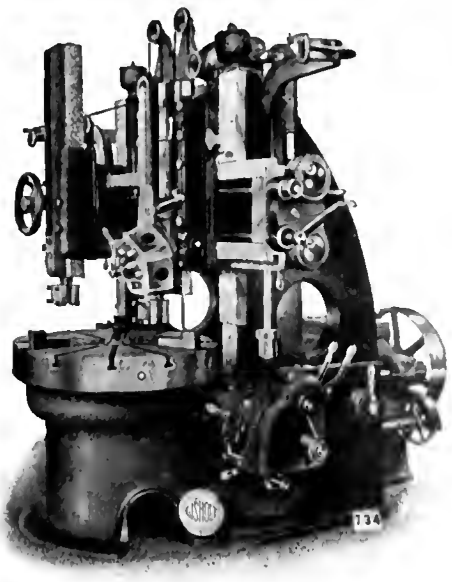
27-29 N. Front St., Portland, Ore.



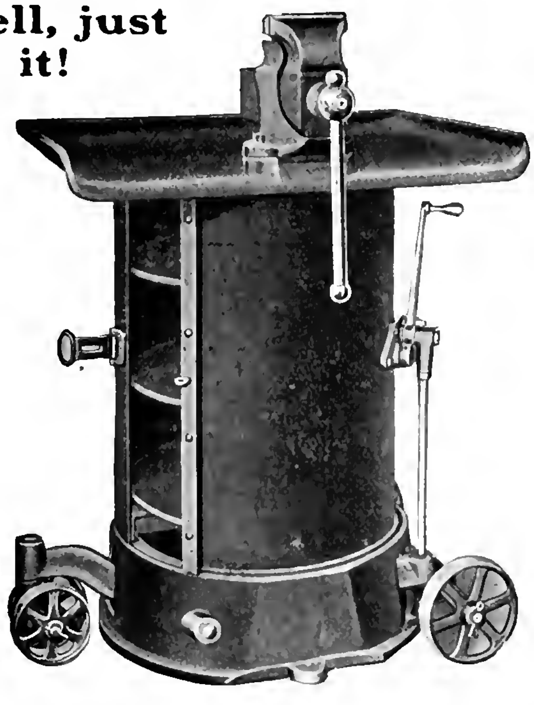
Gisholt Vertical Boring Mills

Turret Lathes and other heavy output machine tools are worth investigating if great reductions in cost are sought. Our experience extends over twenty years of continuous effort to produce the **best** only. Success has rewarded us and given us the unbounded good will of hundreds of customers. We shall appreciate a chance to **earn** yours.

Gisholt Machine Company
Works: Madison, Wis., and Warren, Pa.
General Offices: 1316 Washington Ave., Madison, Wis., U. S. A.
Chicago Display Room: 101 Washington Blvd.

FOREIGN AGENTS: Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Vienna, St. Petersburg, Stockholm, Berlin. C. W. Burton, Griffiths & Co., London, England.

Convenient? Well, just try it!

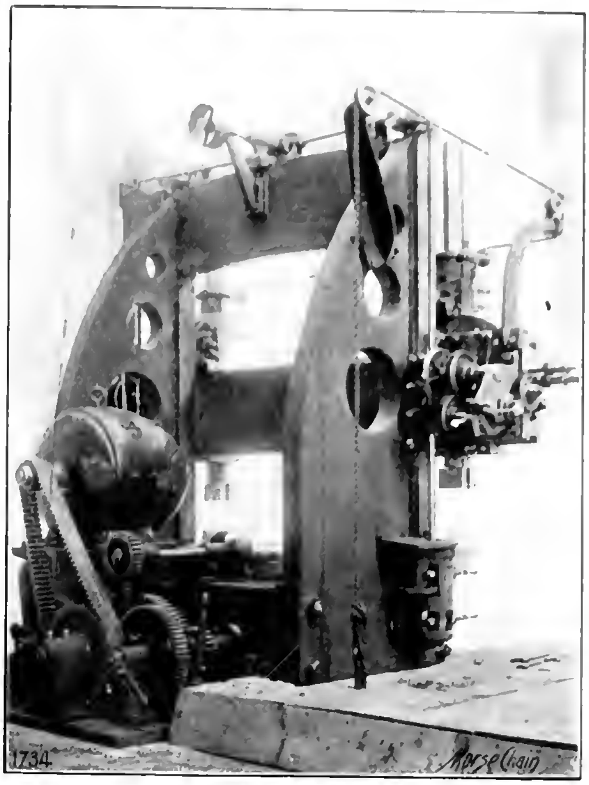


It's just as much a necessity in your shop as an arbor press, for there's always a need for a bench close up to a job, where it can be used handily.

Here's the bench that's easily portable, and yet has the "stuff" in it to resist chipping.

Write us about it.

The New Britain Machine Co.
NEW BRITAIN, CONN.



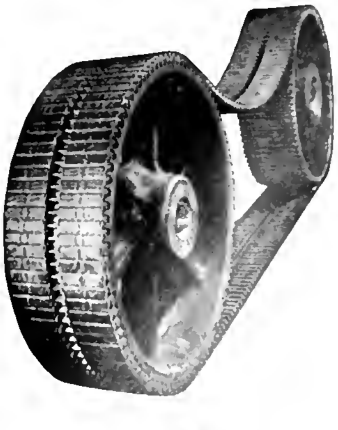
Boring Mill with Morse Chain Drive

500 to 1000 R.P.M. on 4½" centers, Sprockets 17 and 55 teeth
Chain 1, 2" pitch, 4" wide, speed 850 feet per minute.

The positive drive of The Morse Silent-Running Rocker-Joint Chain

makes it particularly effective in machine tool operation. It has an efficiency of almost 99 per cent.

See Catalogue No. 7

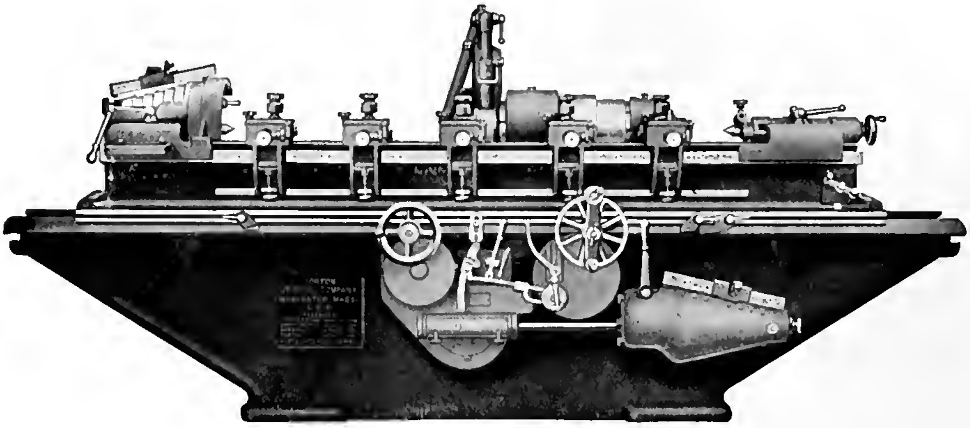


Morse Chain Co.

ITHACA, NEW YORK

Licensees for Great Britain and Europe: The Westinghouse Brake Co., Ltd., York Road, Kings Cross, London, N.

It Is Not Enough to Simply Grind Work Accurately



"Don't you know" we all used to do nice, accurate work in the old days when we had a nicely made machine and Lots of Time? But to do nice, accurate work RAPIDLY is THE PRESENT DAY NECESSITY.

THIS REQUIRES HEAVY MACHINES

with Wide Wheels, and Rigid, Steady Rests

NORTON MACHINES

are Heavy and Powerful, with Rigid, Steady Rests

LET US SHOW YOU

AGENTS—

Vonnegut Hardware Co., Indianapolis.
Robinson, Cary & Sands Co., St. Paul and Duluth.
Manning, Maxwell & Moore, Pittsburg, St. Louis, Philadelphia, Atlanta.
Prentiss Tool & Supply Co., New York, Boston, Buffalo, Syracuse.
Motch & Merryweather Mchy. Co., Cleveland, Detroit and Cincinnati.
The Canadian Fairbanks Co., Montreal, Toronto, Vancouver.
Henshaw Bulkley & Co., San Francisco, Los Angeles.
Ludw. Loewe & Co., Ltd., London, Berlin, European Agents.
F. W. Horne, Yokohama, Japan.

Norton Grinding Company
Worcester, Mass.
Chicago Store: 48 South Canal Street

93-N

Grading Alundum

Alundum is graded to many sizes and numbered according to the meshes per linear inch of the screen. The numbers used in Norton Grinding Wheels are from 10 to 200.

The Right Grinding Wheel Grit

The peculiar structure of Alundum, its temper, or the character of its fracture, is what makes it the ideal grit for use in manufacturing grinding wheels.

In Alundum, the grit, lies much of the success of Norton Wheels.

In manufacturing Grinding Wheels, it is easy to make a wheel that will give long life. It is not so easy to make a wheel that will give **both long life and fast production.**

The success of Norton Wheels in the various kinds of grinding tends to prove that it comes nearer the maximum in both long life and fast-cutting quality—maximum efficiency—than any other grinding wheel made of any abrasive material.

Norton Company
Grinding Wheel Works
Worcester, Mass.

ALUNDUM
TRADE MARK
NORTON
REGISTERED
PATENTED MADE BY ELECTRIC PROCESS

New York: 50 Church Street
Chicago. 48 S. Canal Street
Alundum Plant: Niagara Falls

F-99

Carborundum Grinding Wheels are right—but get the right wheel.

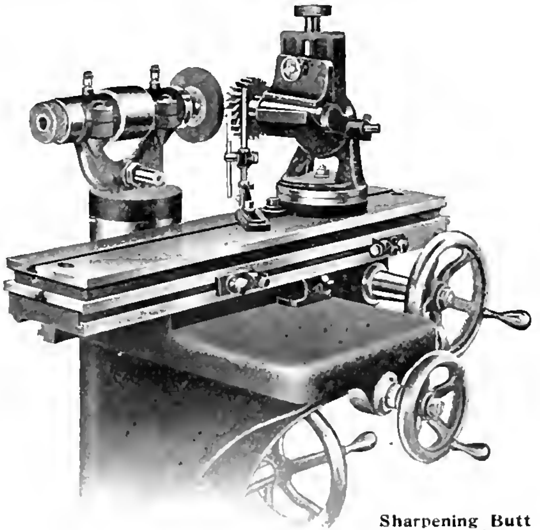
CARBORUNDUM

is made into grinding wheels of every size and shape and grade imaginable—100,000 of them altogether.

Carborundum will increase the efficiency of *your* grinding department—but be sure to get the right grade and size and grit of wheel for the particular work you have to do—

That is where we can help you.

THE CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.



Sharpening Butt Mill having Taper Shank.

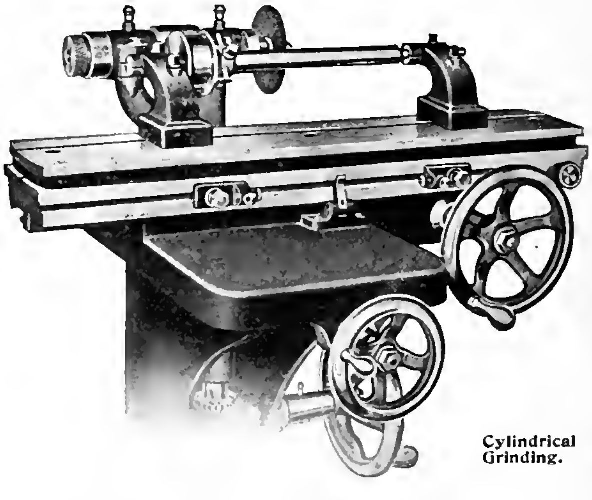
The Variety of Grinding Work that can be handled on a Greenfield Grinder

Puts the everyday machine in the shade.

It is adapted for Cylindrical and Conical Grinding on centers or in the chuck—for internal grinding, sharpening cutters, reamers,—small tools of every description and for a wide range of general grinding.

It is modern, compact, strongly built, with every convenience for easy operation and has such a complete set of fixtures and attachments that it has a place in any manufacturing plant. Specific examples of efficiency if you will ask us.

Greenfield Machine Company
Greenfield, Mass.



Cylindrical Grinding.

DO THESE INTEREST YOU?

A Grinding Machine Manufacturer

writes us: "Referring to the wheel recently sent us, this wheel seems to cut better than any wheel we have tried for some time. It is, in fact, **the best wheel we have used on soft steel.** We do not think this is putting it too strong. The wheel cuts fast, cool, wears very little and seems to remain sharp." (Name on application.)

This wheel was 24" dia., 3" face and 12" hole, and was made of Pure Corundum.

A Manufacturer of Cutlery

says: "Replying to your favor, will say that the last 14 x 4" ring wheel shipped us has been in service about 4 weeks and **is proving very satisfactory.**" (Name on application.)

An Automobile Manufacturer

writes us under date of June 8, 1909: "In reply to your favor, beg to say that after **having tested a variety of different makes of wheels** we have been able to get **the best work from one of the samples you sent us,** namely the 4 x $\frac{3}{4}$ x $\frac{3}{8}$"—No. 36 grade K, hence we would ask you to ship us—etc." (The operation was internal grinding of cast iron cylinders.) (Name on request.)

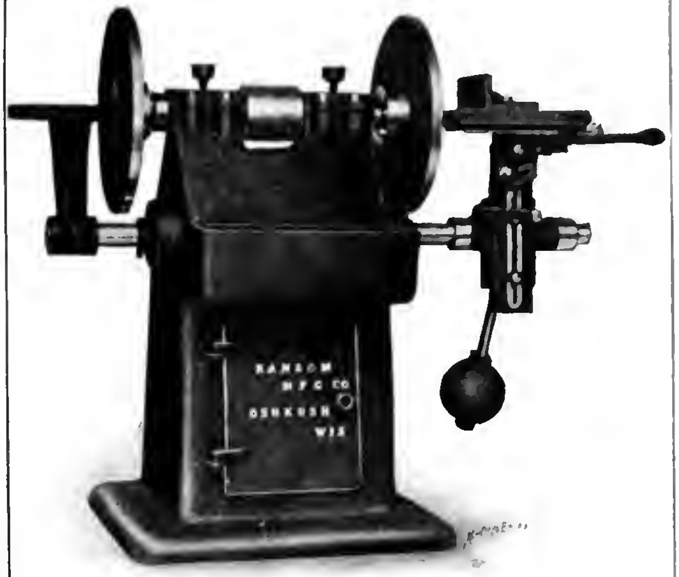
A Large Card Manufacturer

writes: "We have finally completed the tests we were making with the samples of corundum wheels sent us some time ago, and would say they are about **the best** Corundum Wheels **we have ever had the pleasure of testing (and we have tested quite a few in our time.)**" Then follows an order for 430 wheels. (Name on request.)

Why don't **you** give **American** wheels a trial? No matter what your operation may be, we guarantee that **American Emery Wheels** or **Corundum Wheels** will show better results than any wheels you have ever used, or there will be no charge to you.

American Emery Wheel Works
PROVIDENCE, R. I., U. S. A.

Ransom Disk Grinders



This is our 18" L Disc Grinder with lever feed table and automatic stop, upon which we ground 248 cast iron hammers in the record breaking time of *one* hour.

Are you interested?

DISK GRINDER EXPERTS

Ransom Mfg. Co., Oshkosh, Wis., U. S. A.
AGENTS: Ludw. Loewe & Co., Berlin, Germany, London, England

STERLING GRINDING WHEELS

Leaders in the Grinding Field.

Strong, durable and safe. Free cutting and rapid. No dust nor odor; equally efficient used wet or dry. Graded to meet all requirements and adapted for all makes of grinding machines

THE STERLING EMERY WHEEL MFG. COMPANY
Factories and Offices, TIFFIN, OHIO
BRANCHES: New York House, 45 Vesey St. Chicago House, 60 West Washington St.
San Francisco House, 461 Market St.

GRINDING DRILLS BY HAND IS OUT OF DATE

Get a

"New Yankee"

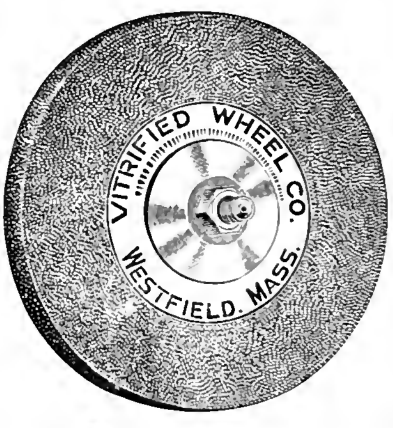
and do it in the modern way. It is the best drill grinder made and finishes grinding a drill before any other machine is even ready to start.

Two adjustments as against nine on our nearest competitor's machine.

Time is wasted, drills are broken and work is spoiled trying to get along with hand ground drills.

Get our catalog and quotations.

WILMARTH & MORMAN COMPANY 580 CANAL STREET GRAND RAPIDS, MICH.
Agents for Great Britain: C. W. Burton, Griffiths & Co., London.
Buck & Hickman, Ltd., London.



DON'T

think you "must cool off" a Vitrified Wheel. Not at all.

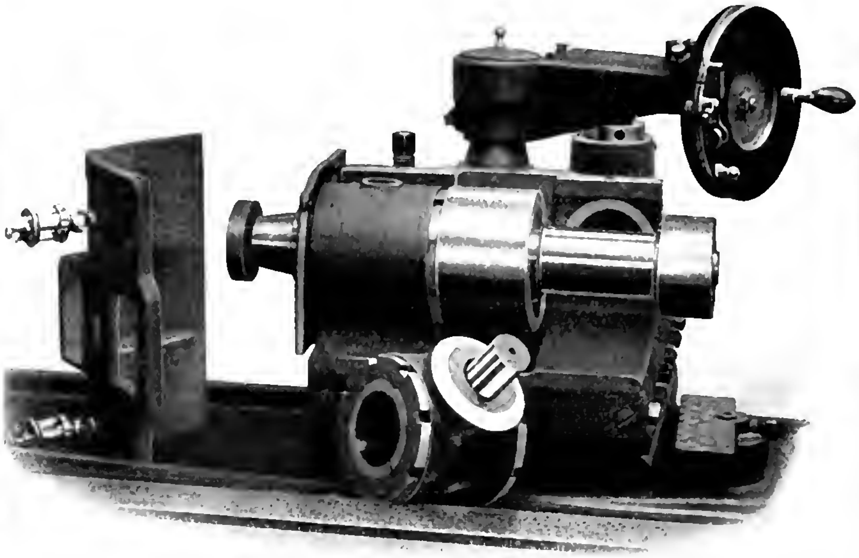
Vitrified Wheels are free and cool-cutting; never glaze, are thoroughly porous and meet modern grinding requirements in a more satisfactory way than any others on the market. Use them wet or dry, in acid or soda. You can't injure their efficiency.

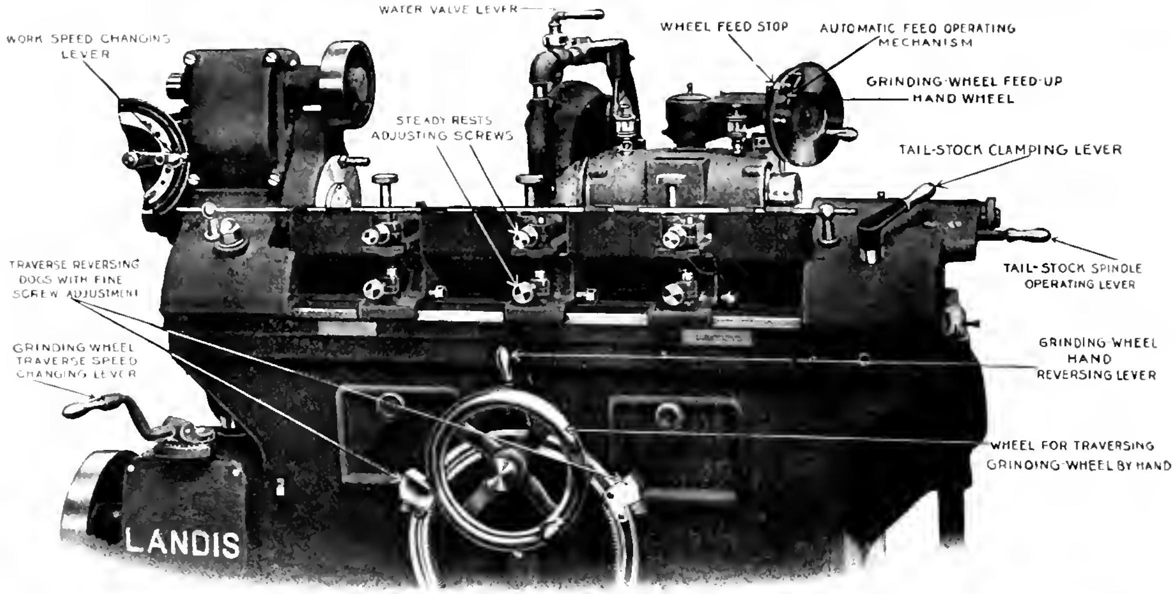
All sizes and grades.

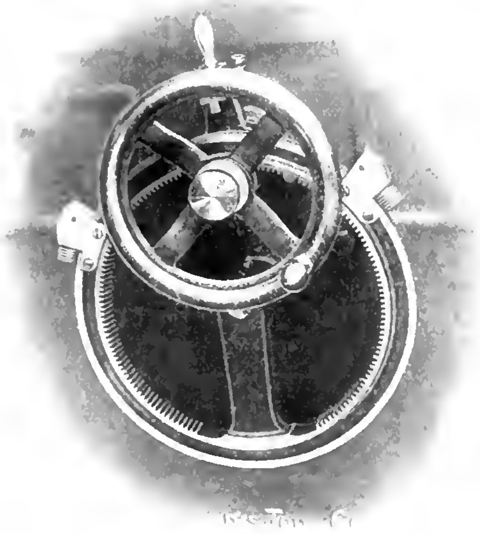
Catalog?

Vitrified Wheel Company
WESTFIELD, MASS.

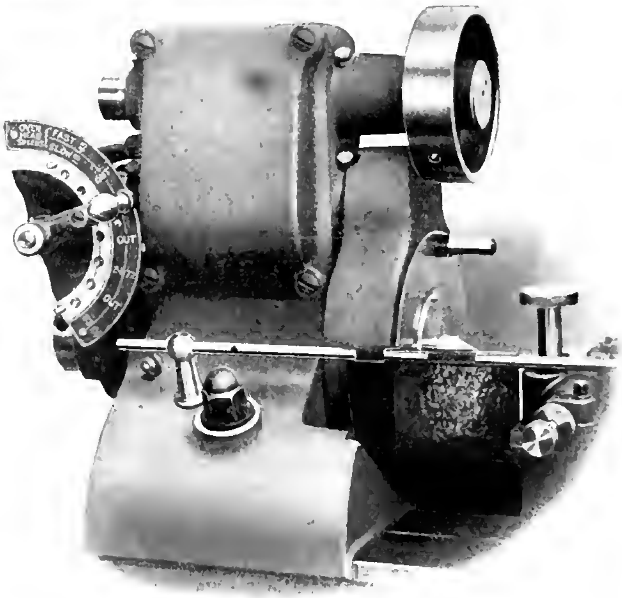
Operating Levers on the Landis Grinders





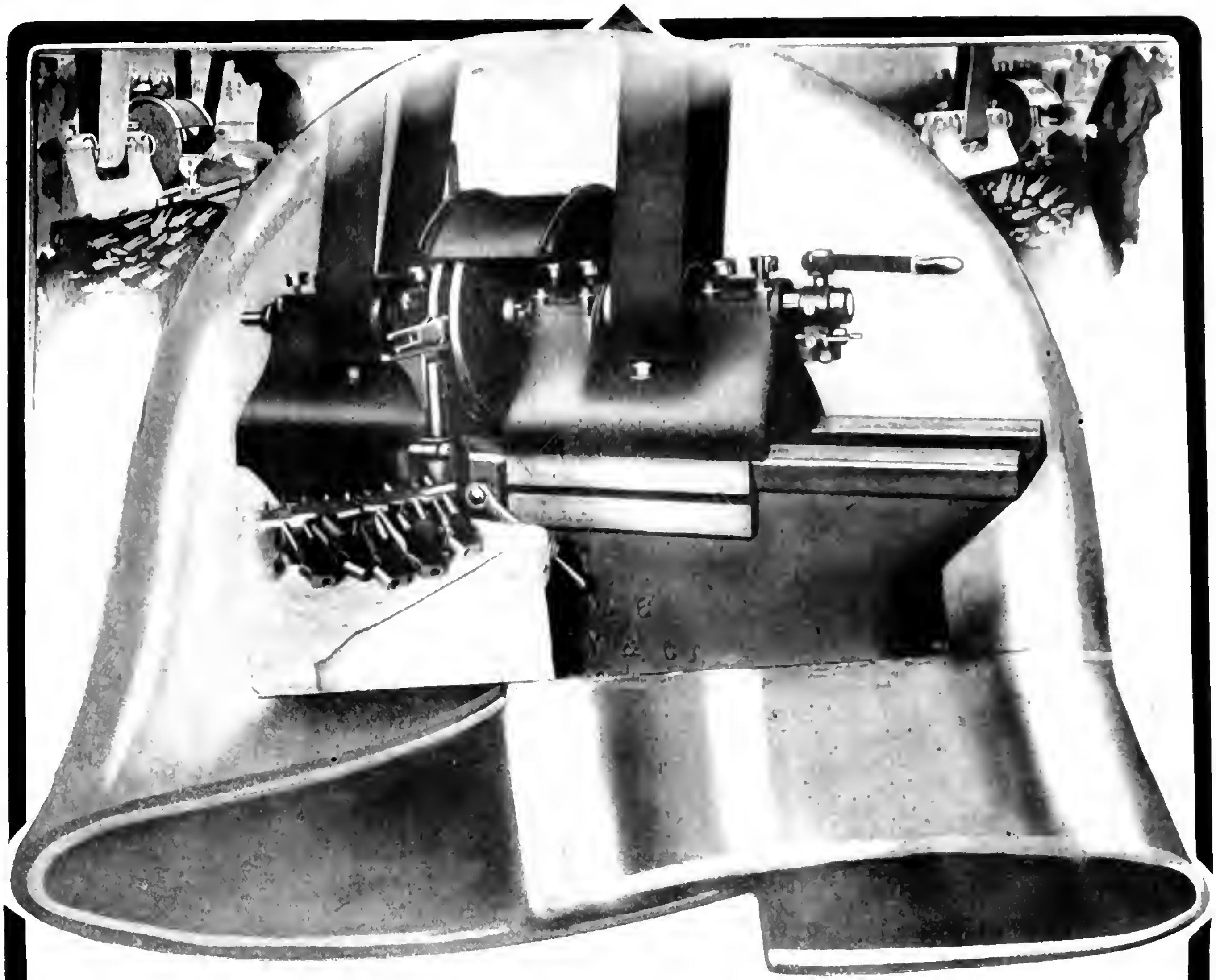


Note
the
location—
accessibility—
simplicity—
and
convenience
in
operation
of
these
levers.



LANDIS TOOL COMPANY, Waynesboro, Pa., U.S.A.

AGENTS — C. W. Burton, Griffiths & Co., London and Glasgow. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Canada.



BESLY GRINDERS

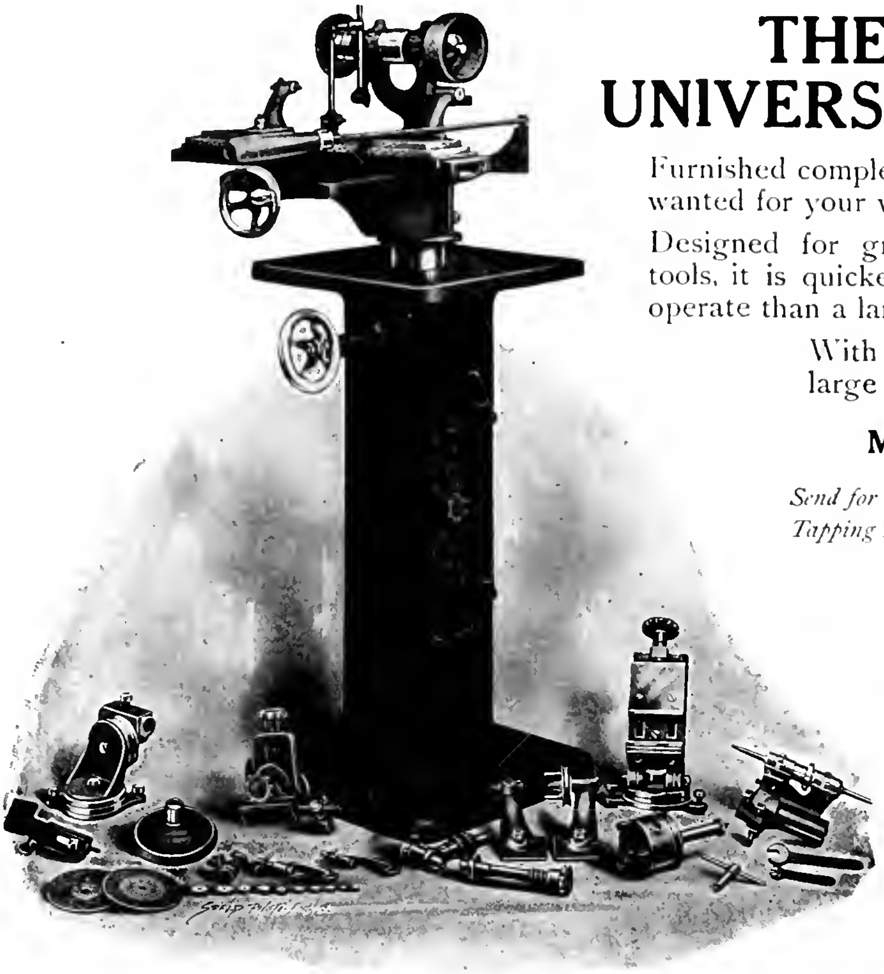
LET US SHOW YOU WHAT WE CAN DO FOR YOU

Illustration shows grinding of Rifle Frame Castings.
Ground on 1905 Model No. 6 Besly Spiral Disc Grinder, grinding two sides of the casting at the same time.
Material—Malleable Iron.
Stock removed—about .025" on a side.
Rough ground 25 Rifle Frame Castings, or 50 sides.
Time:—one hour.
Used No. 5360, Grain No. 16, Helmet Spiral Cloth Circle.
Finish ground 25 Rifle Frame Castings, or 50 sides.
Time:—15 minutes.
Stock removed—.003" on a side.
Finished to .875".
Circles used for both roughing and finishing had a 9" hole in center, thus leaving a grinding zone of 4½" wide.
If these castings were to be ground in a manufacturing way, it would be advisable to reduce the amount of stock on the castings which is left for finish. This materially increases the speed of grinding.
THE PATENTED FEATURES of 1905 Model No. 6 Besly Spiral Disc Grinder, illustrated above, are the Spiral Grooved Steel Disc Wheels, Helmet Spiral Circles, Geared Lever Feed Mechanism and Sliding Motion of Spindle.
Furthermore, with this machine, if desired, we are prepared to furnish our Patented Hinged Nut Grinding Fixture or our Patented Open Top Nut Holder.
THE EXCLUSIVE FEATURES of this machine are the Bed Construction, Heads are mounted on V's planed on Bed Casting, Method of taking up end thrust of spindle, Bearing Construction and Micrometer Adjustment.
When so ordered, this machine is equipped with Automatically Telescoping Dust Hood. End play in Spindle Bearings is adjusted in such a way that machine can be run safely with practically all end play taken up: naturally grinding work to size WITHIN CLOSER LIMITS.
Among our 70 varieties of Besly Disc Grinders is one just suited to your work.
We would like to prove our claims on some of your samples. No charge for the demonstration.
Send us some samples and we'll grind them for you and report time and material used.

CHARLES H. BESLY & COMPANY

15-17-19-21 South Clinton St., (ORIGINATORS OF DISC GRINDERS) Chicago, Illinois, U. S. A.

Besly Works, Beloit, Wis., the home of the Besly Disc Grinders.



THE WELLS UNIVERSAL GRINDER

Furnished complete or with only the fixtures wanted for your work.

Designed for grinding all ordinary sized tools, it is quicker and more convenient to operate than a larger machine.

With it you get everything but large capacity and for

MUCH LESS MONEY

Send for description of Grinders, Speed Lathes, Tapping Machines, Small Screw Machines, etc.

F. E. WELLS & SON COMPANY
GREENFIELD MASS. U.S.A.

LE BLOND

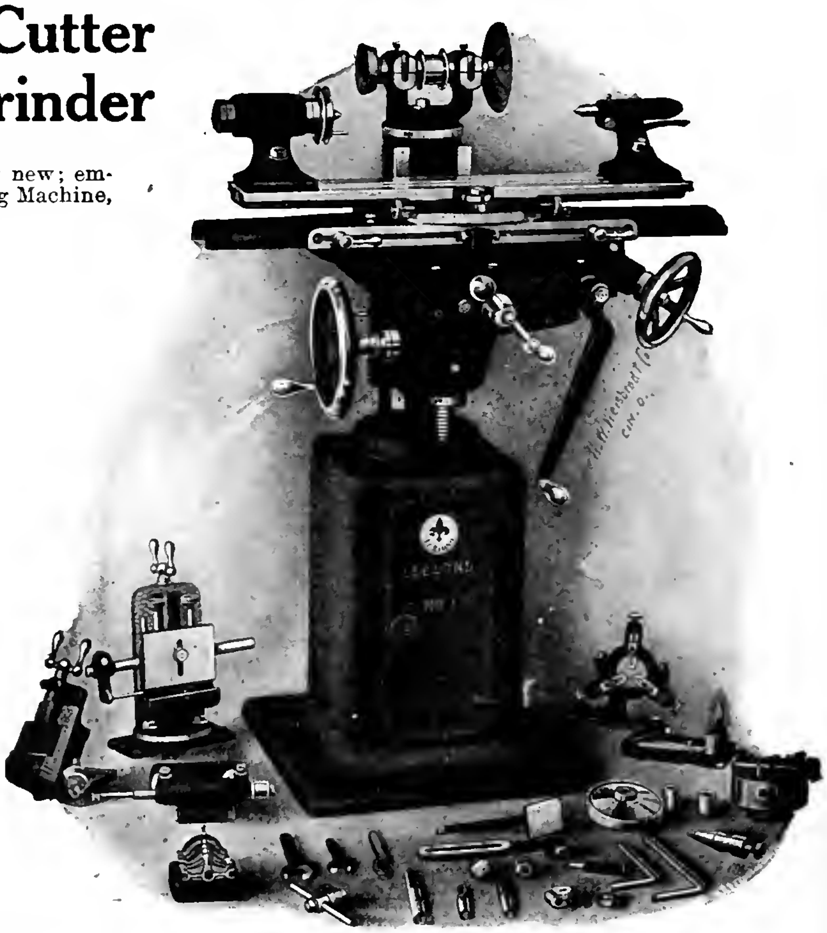
Universal Cutter and Tool Grinder

The Principle of the machine is entirely new; embodies the design of the Universal Milling Machine, consisting of a Knee, Saddle, Swivel, and Table. This gives rigidity that has heretofore been lacking in a Cutter Grinder, and adapts the machine to grind the large inserted-tooth mills of modern milling practice.

Capacity. It is absolutely universal; will grind any angle, taper or face. Grinds all kinds of cylindrical, internal faces and angular work ; face and end mills, reamers, counterbores, circular saws, gear cutters, gauges, flat surfaces and other tool room work.

Attachments include a complete line. Universal Attachment, Circular Grinding Attachment, Internal Grinding Attachment, Gear-cutter Grinding Attachment, Surface-grinding Attachment, etc.

Catalogue giving full description of construction and use, will be mailed upon application.



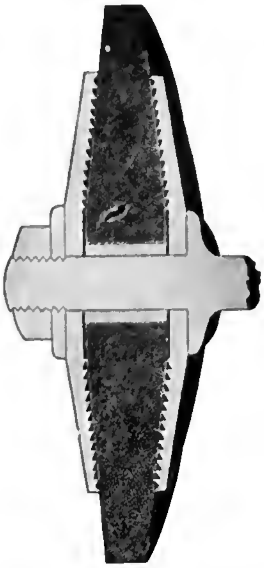
The R. K. LeBlond Machine Tool Co.

4609 Eastern Ave., Cincinnati, O.

RESULTS

are what you want from your grinding.

The greatest and best results can only be gotten



With Safety Wheels

Made of highest quality Emery, Corundum and Carbondite they are *not* pressed or tamped, but are porous and open in texture, even in hardness and absolutely free-cutting. A wheel made of the cement (or bond) used in holding the abrasive together would cut of itself alone.

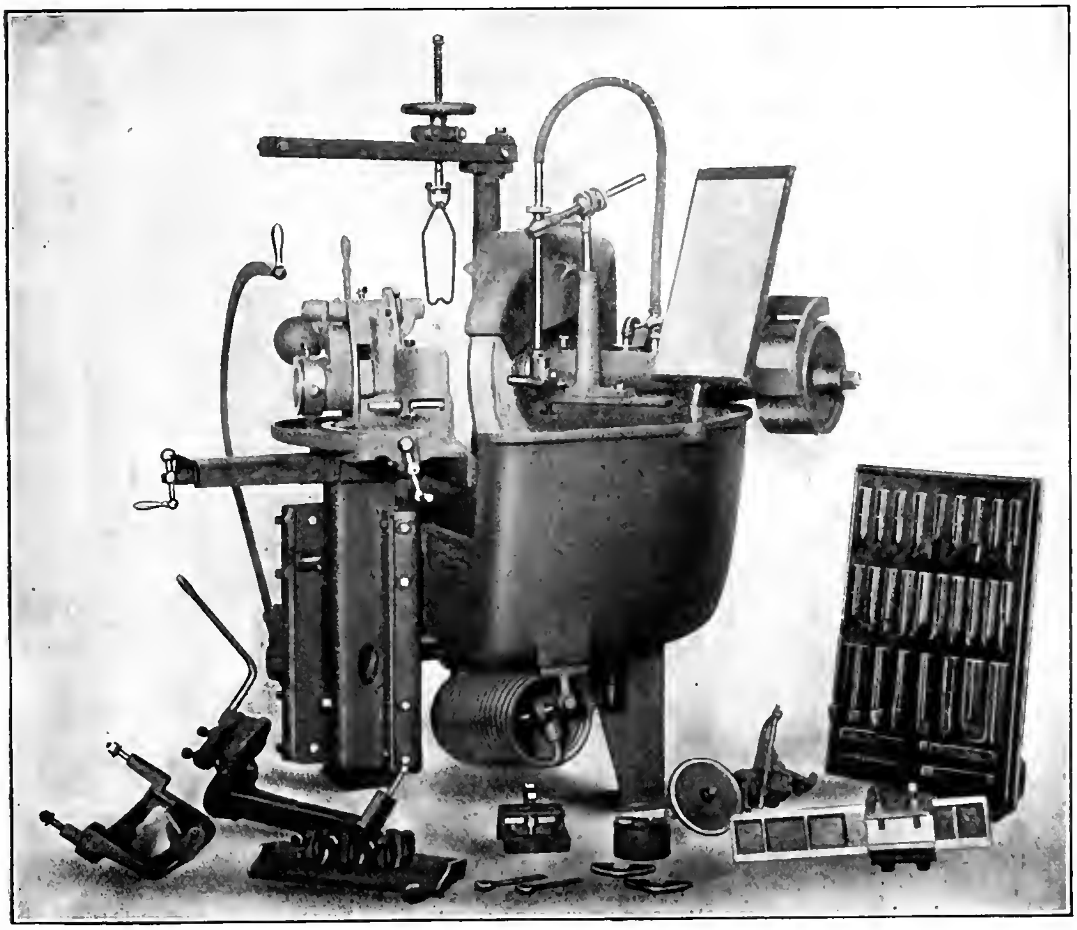
Safety Wheels are not affected by air, water, dampness, acids, or time; require only half as much "truing up" as those of other makes, and are adapted for all grinding purposes, and all grinding machines.

No matter what your grinding need, we can fill it.

The Safety Emery Wheel Company

Springfield, Ohio, U. S. A.

FOREIGN REPRESENTATIVES—Pfeil & Co., London V. Lowener & Co., Copenhagen. Adler & Eisenschitz, Milan. De Fries & Co., Act. Ges., Dusseldorf, Berlin, Wein and Paris. J. R. Baxter & Co., Montreal, Canada.



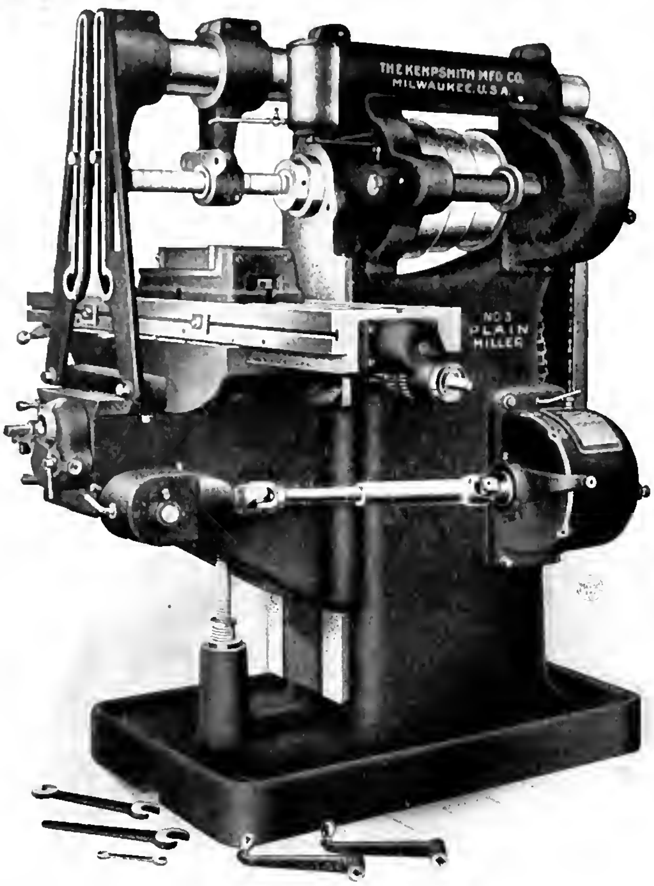
LABOR SAVING MACHINE TOOLS

Our Tool Grinding and Shaping Machine does all work after forging to finish tools to shape, does it quickly, accurately and profitably.

Does not require a mechanic for operator.

We invite investigation and shall be glad to furnish descriptive matter on request.

WILLIAM SELLERS & CO., INC., Philadelphia., Pa.



KEMPSMITH

No. 3 Milling Machine

The greatest work producer of its kind. Exceptional weight and ranges and capacities, massive at points of especial strain, powerful construction in every operative detail.

3 step cone pulley, all steps affording very liberal belt contact and double back gears. After all is said, this is the favorite construction. Maximum productive efficiency and most reliable in continued severe manufacturing milling.

THE KEMPSMITH MFG. CO., Milwaukee, Wis.

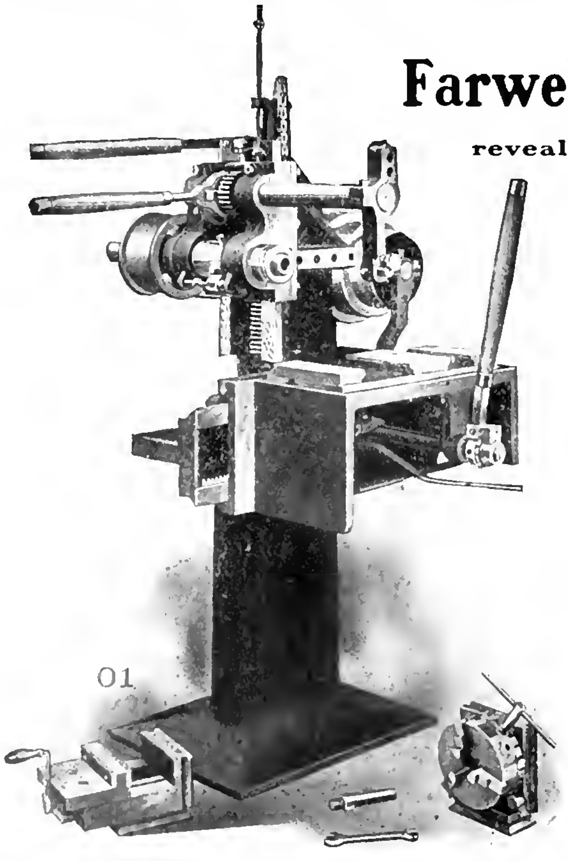
European Agents: Selig, Sonnenthal & Co., London, E. C. Canadian Agents: London Machine Tool Co., Ltd., Hamilton, Ont.

LOOKING UNDER THE TABLE

of the

Farwell Quick Change Miller

reveals no unstable stack of cross slides.



This accounts for the lack of chatter, the use of a rake on our milling cutters, the clean curly chips, the rapidity with which we remove metal and the accuracy of work turned out by our machine.

Note also the quick change clamps which instantly secure the chuck or vise in any of several positions. These fixtures are as rigid as the machine and the chuck is provided with an index for spacing cuts.

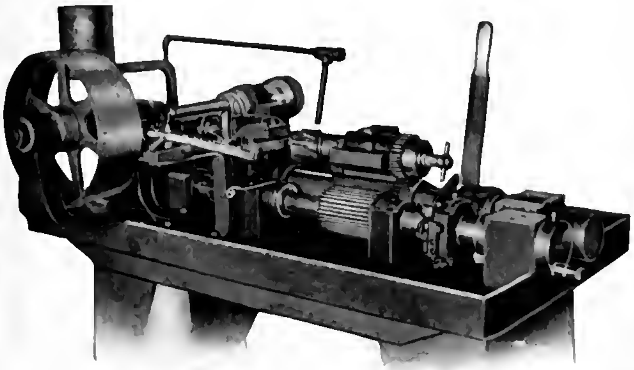
Catalog 68M shows it in use.

The Adams Company

380 White St., DUBUQUE, IOWA, U. S. A.

AGENTS—De Fries & Co., Dusseldorf, Germany. G. Koeppen & Co., Moscow, Russia. J. Lambercier & Co., Geneva, Switzerland V. Lowener, Copenhagen, Denmark. Aktiebolaget V. Lowener, Stockholm, Sweden. Glaenzer, Perreaud & Thomaine, Paris, France. Ducas & Co., Vienna, Austria, Budapest, Hungary.

Tap Thread Milling Machine



TAP MAKERS

If you should chance to be interested in a machine that will thread and relieve 1" pipe taps at a cost of less than

ONE CENT EACH

just drop us a line—that's all.

This machine has been thoroughly tested and we will send a sample of its product, prepaid, to responsible parties in any part of the world.

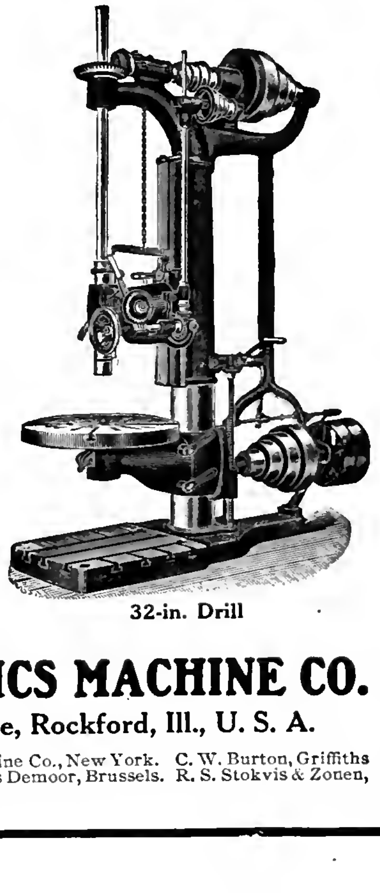
BICKFORD & WASHBURN, Inc.
GREENFIELD, MASS., U. S. A.

OUR LINE

BELT FEED
OR
"POSITIVE FEED"

- **32-in.**
- **26-in.**
- **24-in.**
- **20-in.**
- **14-in.**
- **14-in. B**
- **13-in. B**
- **Standard Drills**

- **No. 1**
- **No. 2**
- **Friction Drills**



32-in. Drill

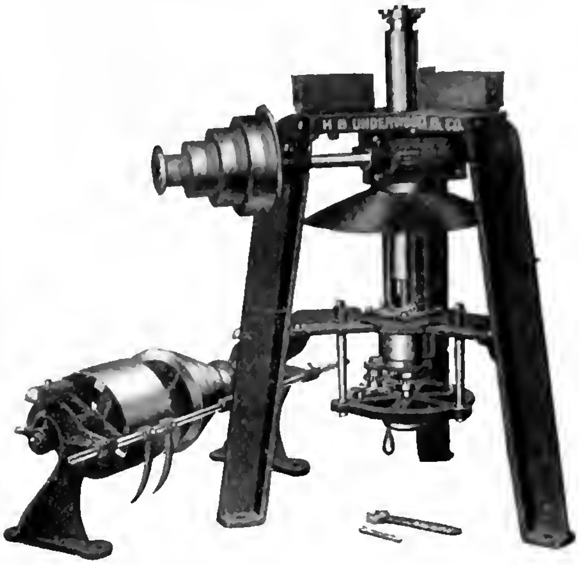
MECHANICS MACHINE CO.
19th Avenue, Rockford, Ill., U. S. A.

AGENTS: Garvin Machine Co., New York. C. W. Burton, Griffiths & Co., London. Ateliers Demoor, Brussels. R. S. Stokvis & Zonen, Rotterdam.

Vertical Boring Machine

(Automobile Cylinder Borer)

NEW
QUICK
SIMPLE
ACCURATE



Designed for boring and reboring cylinders, blind and open end, of automobile and motor boat engines, also air brake cylinders, etc.

The vertical spindle permits of the machine being used for a wide field of other work where ordinarily a large machine tool would be required, e. g., boring the hubs of large gears and fly wheels.

The work is easily set up and centered, without the use of expensive jigs and fixtures. The cutterhead leaves a smooth finish and bores very accurately. The machine is capable of rapid production, requires but little room and power, and is well built, with ample bearings to assure rigidity.

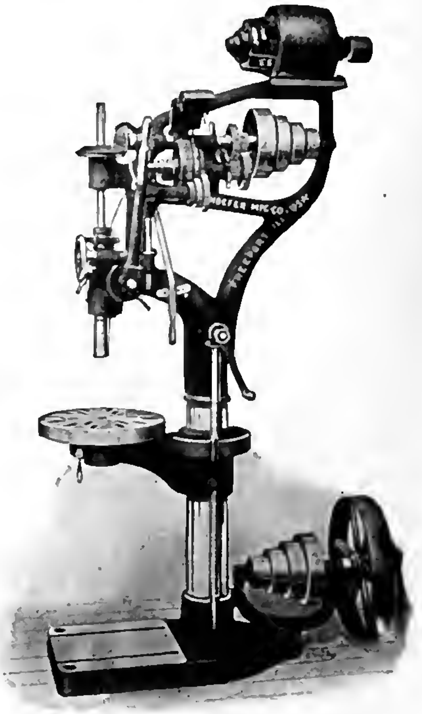
Our new catalogue explains in more detail and is yours for the asking.

(L. B. Flanders Machine Works, Est. 1870).

H. B. Underwood & Company
Manufacturers of Portable Tools
1024 Hamilton St., Philadelphia, Pa.

How an Accurate Drill Press is Built

THE BASE



The base plate of the HOEFER drill is heavy, substantial and broad enough to give a stable foundation. The upper surface is planed and slotted for the bolting down of work on all size machines down to and including 21-inch swing.

The most important point is the method of attaching the column to the base. Some people merely bolt it on, but we find that method not strong enough nor accurate enough. It is better to bore a socket in the base, square with the planed surface, and then turn the end of the column to fit in this socket so that you can be sure that the column, and therefore the spindle, are absolutely perpendicular to the base.

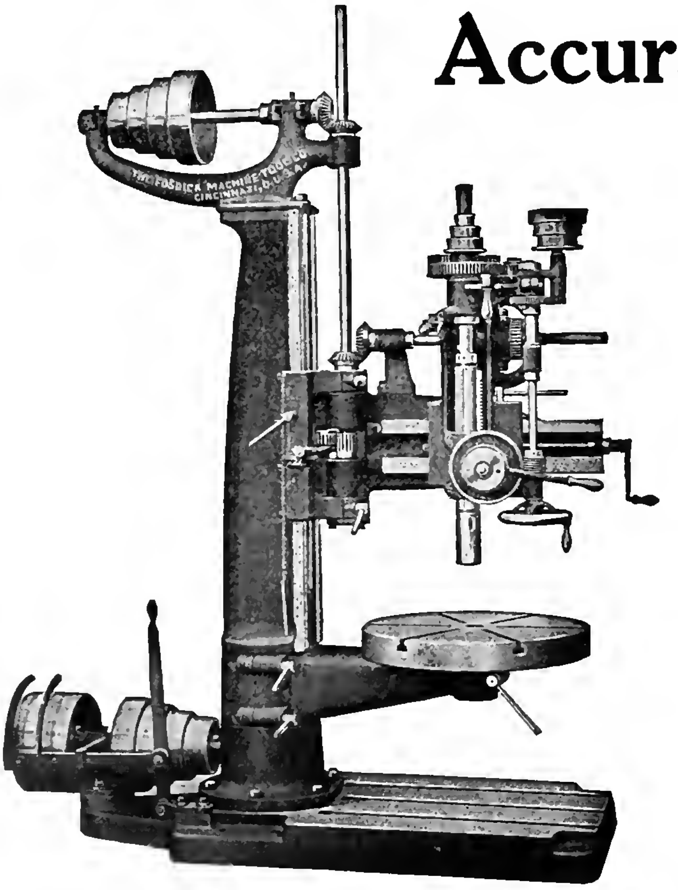
We make over 30 styles of boring and drilling machines, including, most likely, just the one you want.

Write for complete Catalog "X."

HOEFER M'F'G. CO 120 Jackson Street, - - **FREEPORT, ILL.**

AGENTS: For Great Britain, C. W. Burton, Griffiths & Company, London; for Sweden, Axel Christiernsson of Stockholm, Malmo and Gutenburg; for Finland, Axel Christiernsson, Abo; for Switzerland, J. Lambercier & Cie, Geneva; for France, Mestre & Blatge, Paris and Tunis; for Spain, Mestre & Blatge, Madrid; for Austria, Blau & Company, Vienna; for Victoria, Australia, Bevan & Edwards, Propt. Ltd., Melbourne; for New South Wales, Australia, R. S. Scrutton, Sydney; for Queensland, McLennan & Company, Brisbane.

Accurate and Rapid



No. 2. National Radial

You can do more drilling, do it better and do it with less trouble with a

FOSDICK RADIAL DRILL

than with any similar tool of like capacity. Construction and design leave nothing to be desired. Machines are strong, rapid, well proportioned; have back gears, improved tapping attachment, and full range of feeds and speed changes. Every convenience for operation has been incorporated and Fosdick machines are noted for their durability.

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The Fosdick Machine Tool Co.

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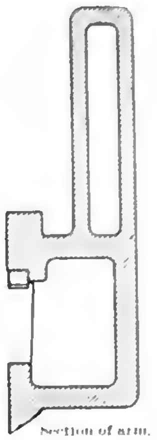
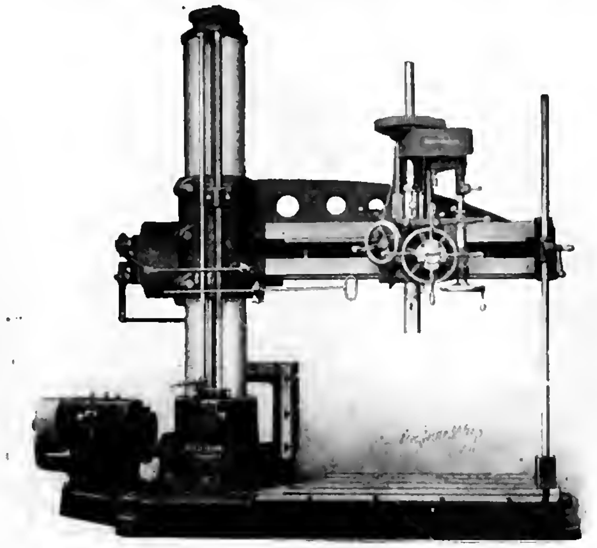
RADIAL DRILLS

The Arm is double webbed of the Planer Housing Shape which gives the greatest resistance against torsional and bending strain.


Section of arm.



Seven changes by one lever in the speed variator. Six changes of geared feed. Four tapping speeds. Four operative handles on quick return. Device preventing taps from breaking.

Sizes 2½″ x 7′. Plain, Half and Full Universal.

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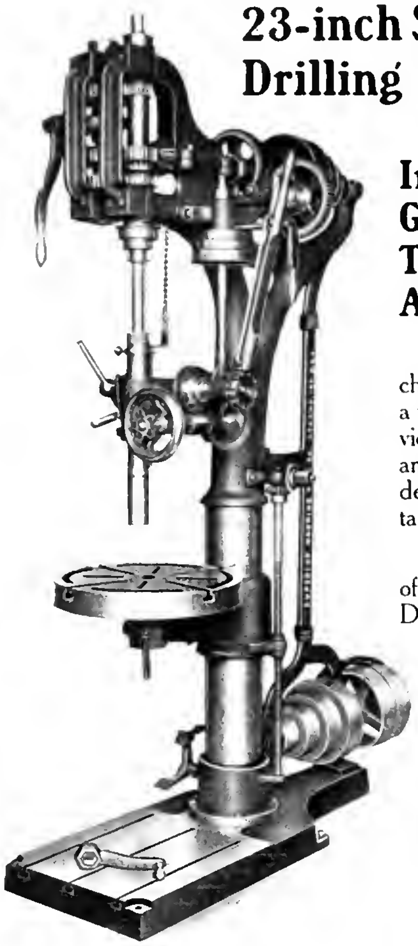

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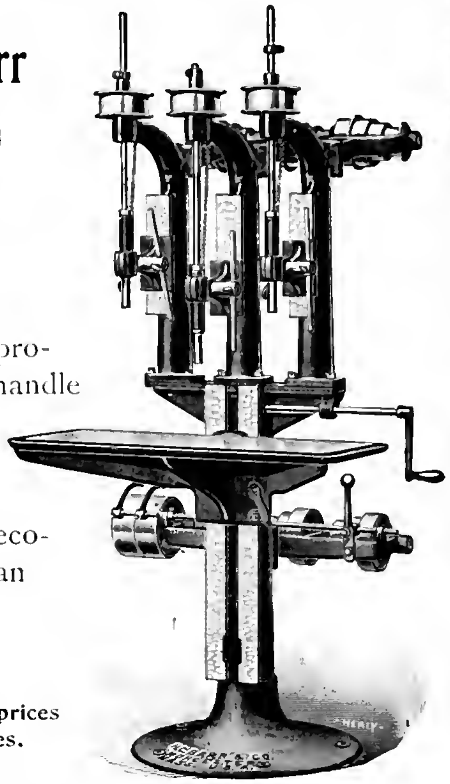

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Are great producers and handle the "hole" proposition more efficiently and economically than any like machine.

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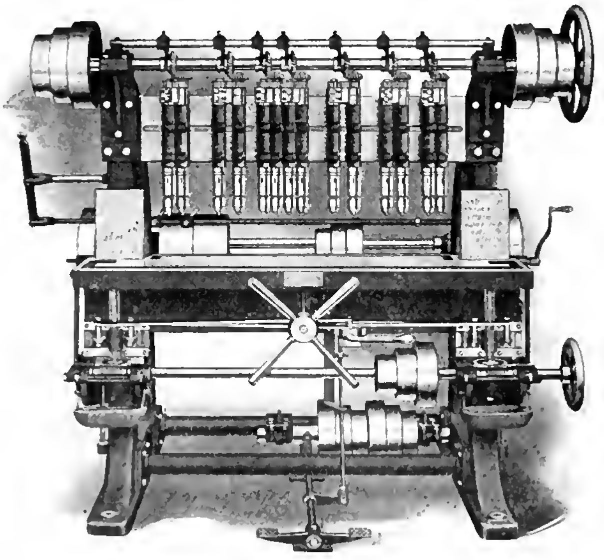

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in steel or iron drilled simultaneously to the depth of seven inches is getting into the work pretty fast, but the

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is a hustler on metal drilling of any kind—and the above is only its ordinary gait. Spindle heads adjustable; easily operated; especially valuable for duplicate work. Ask us for full description.

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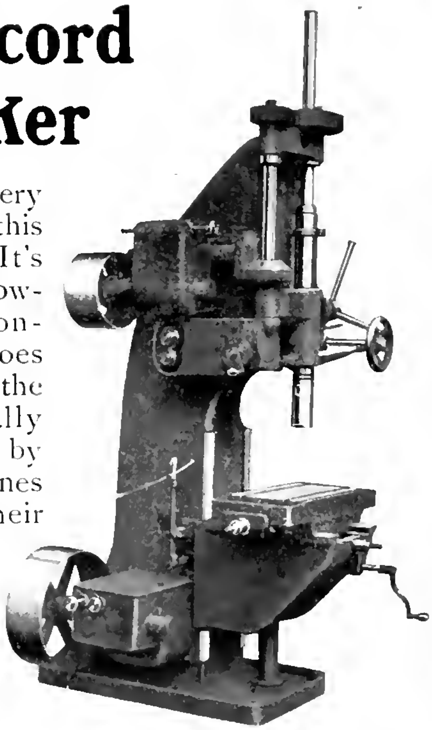

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1¼" Hole
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Per Minute

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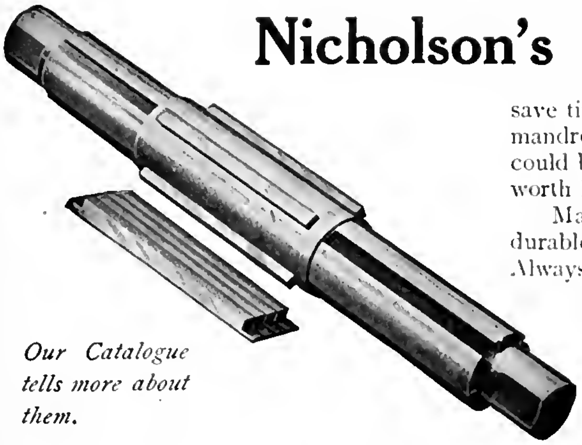

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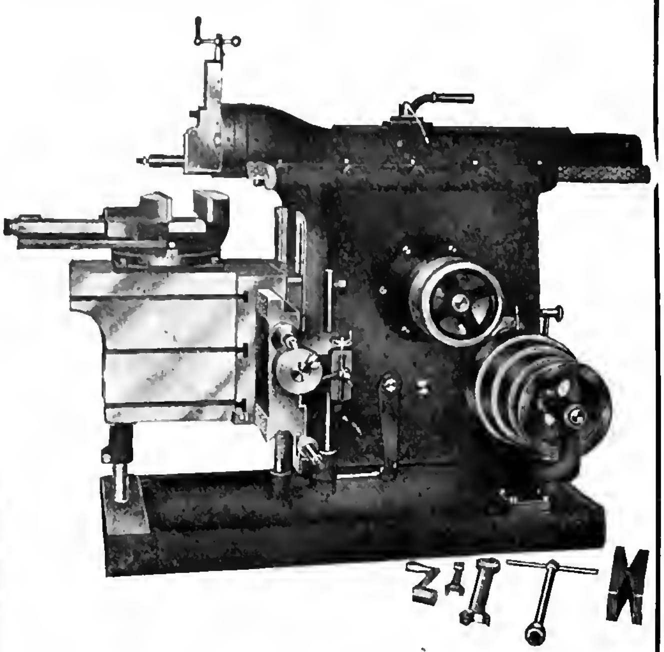

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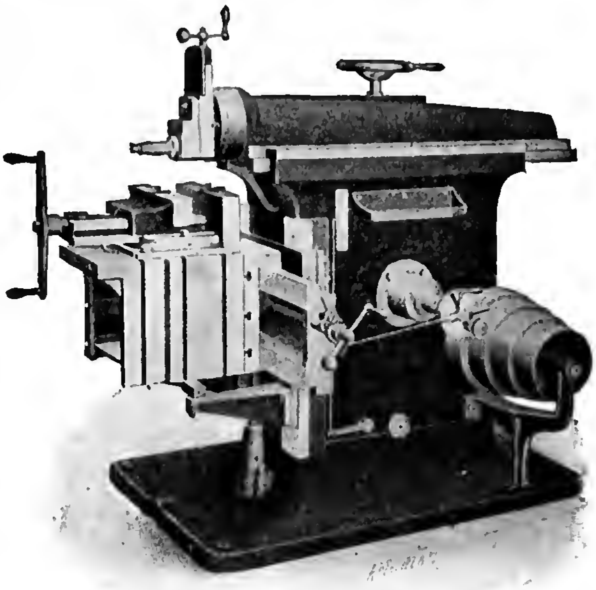

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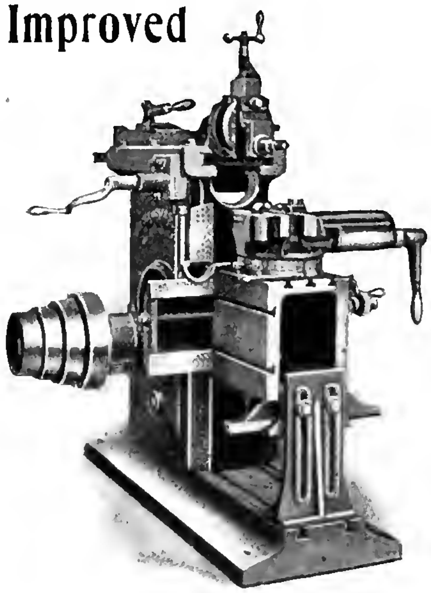

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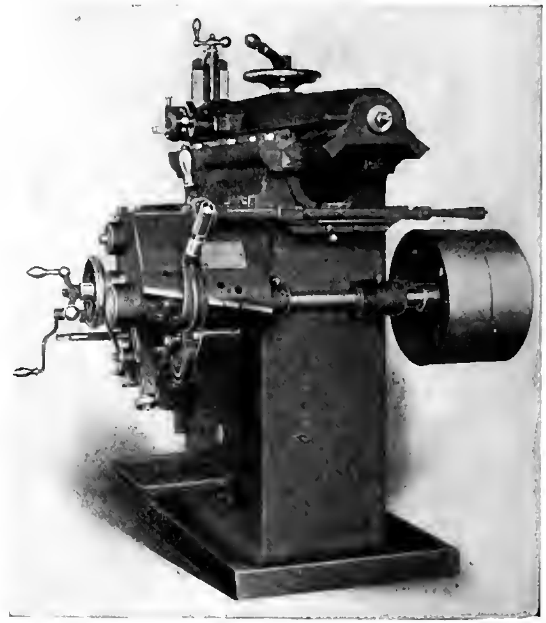

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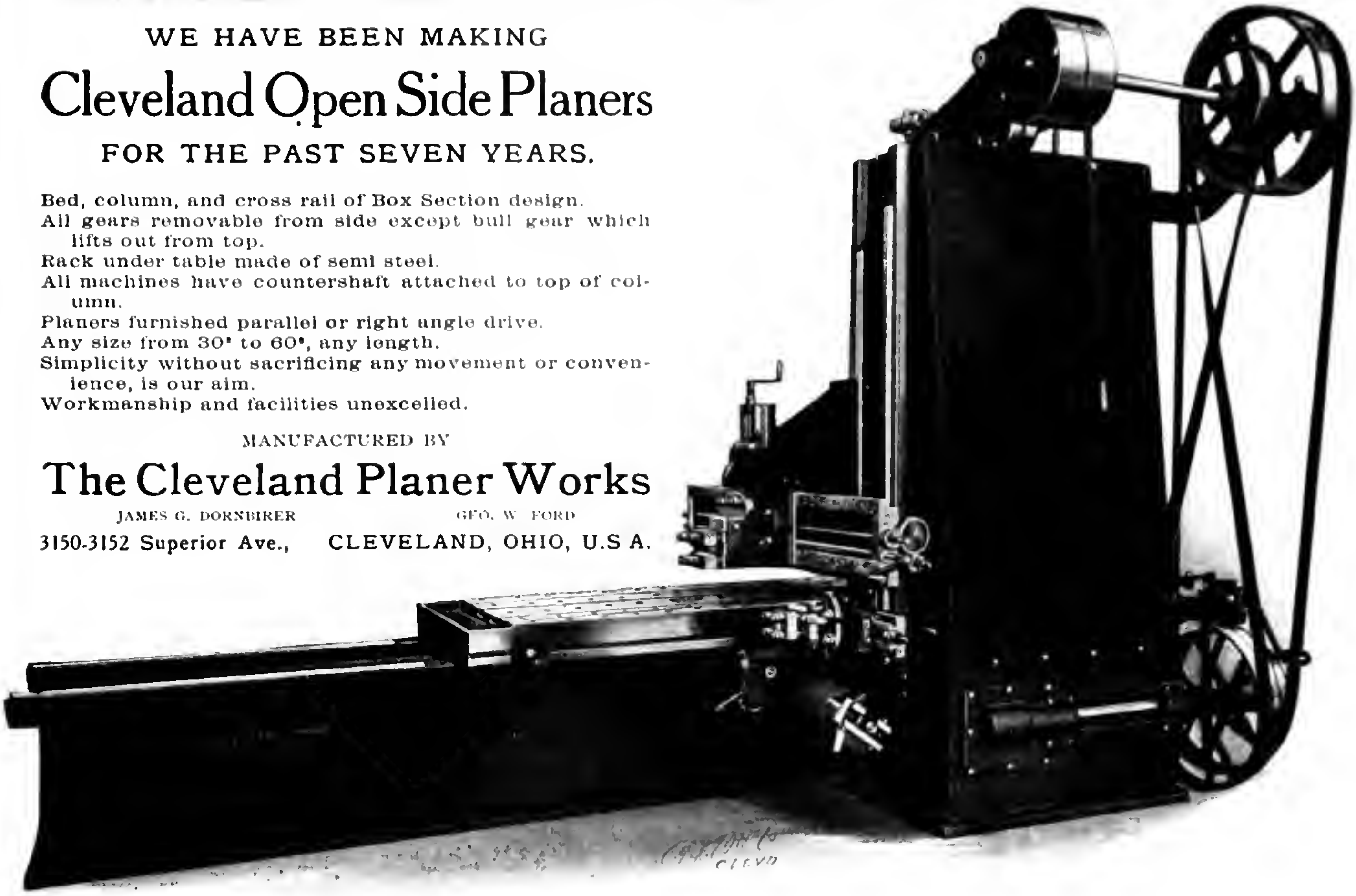

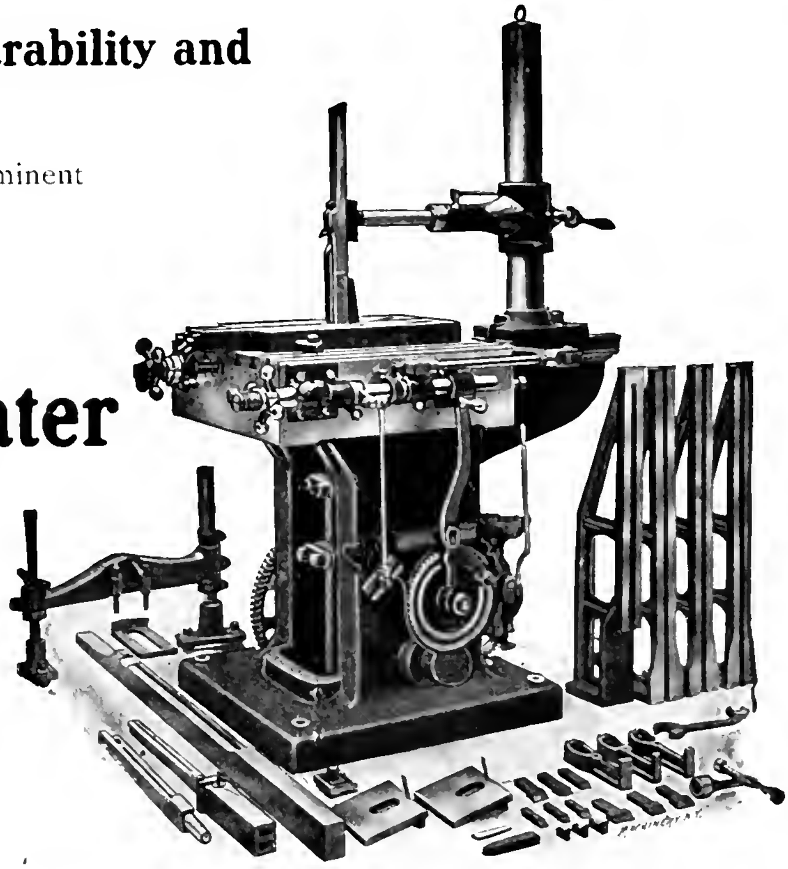

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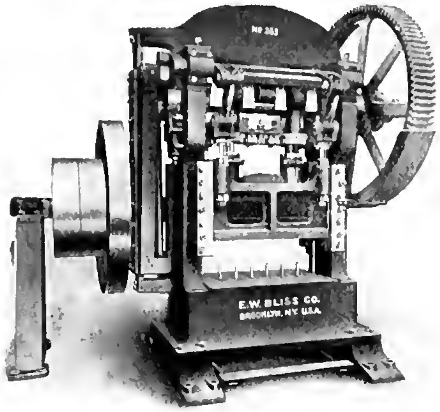

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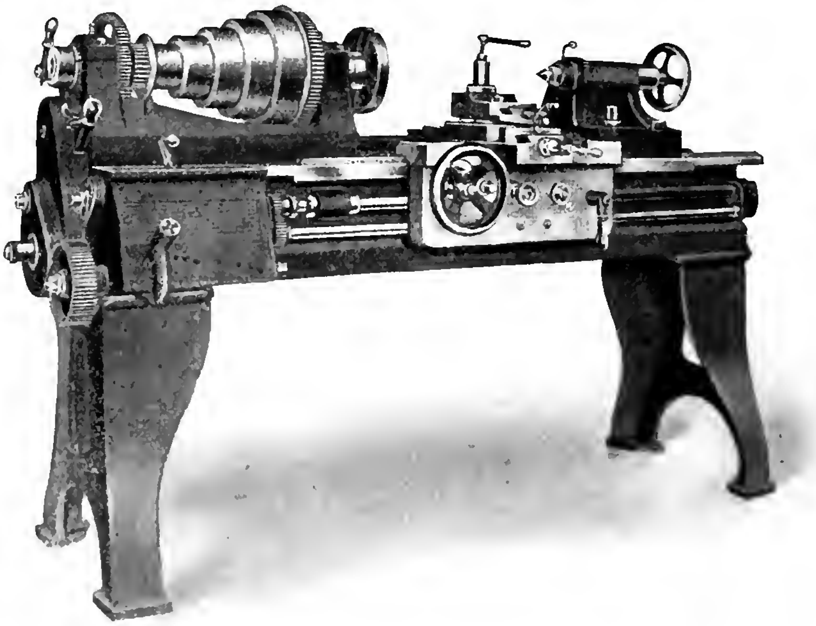

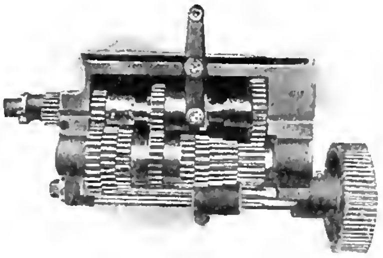

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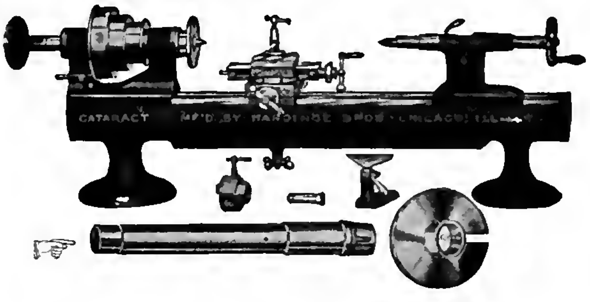

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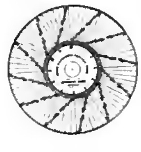

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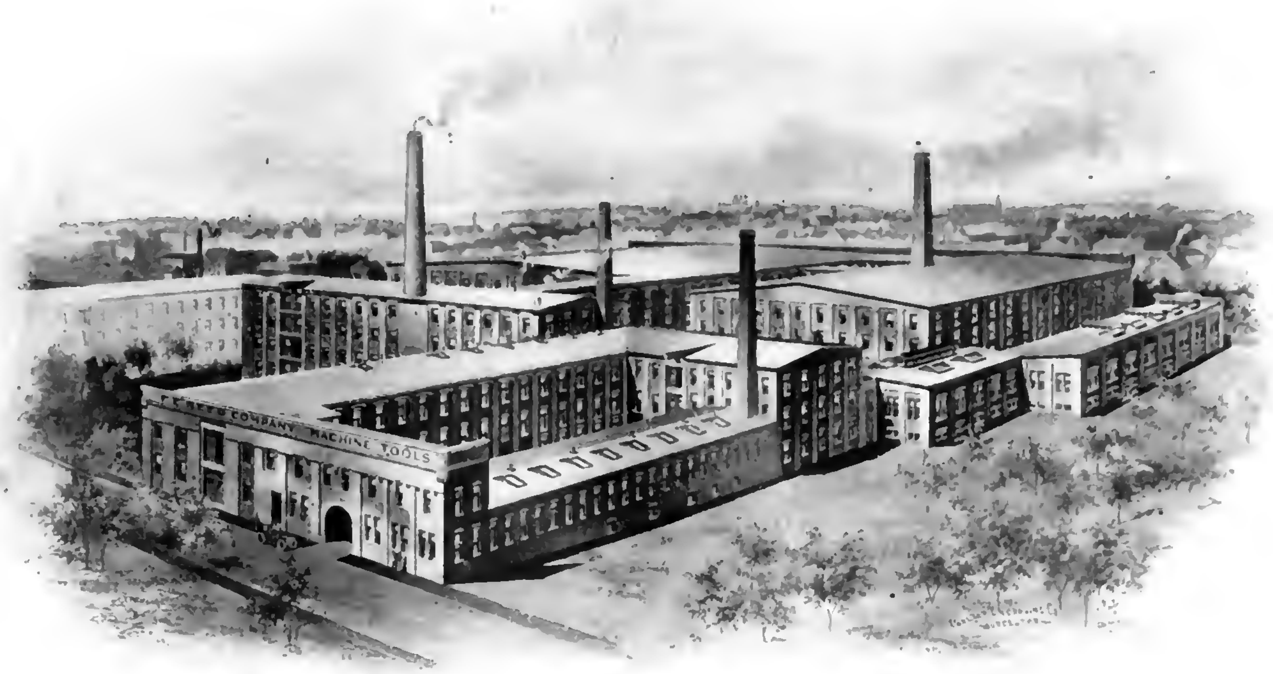

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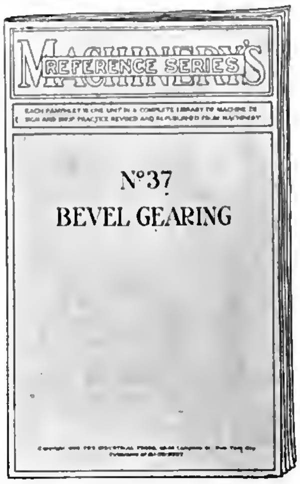

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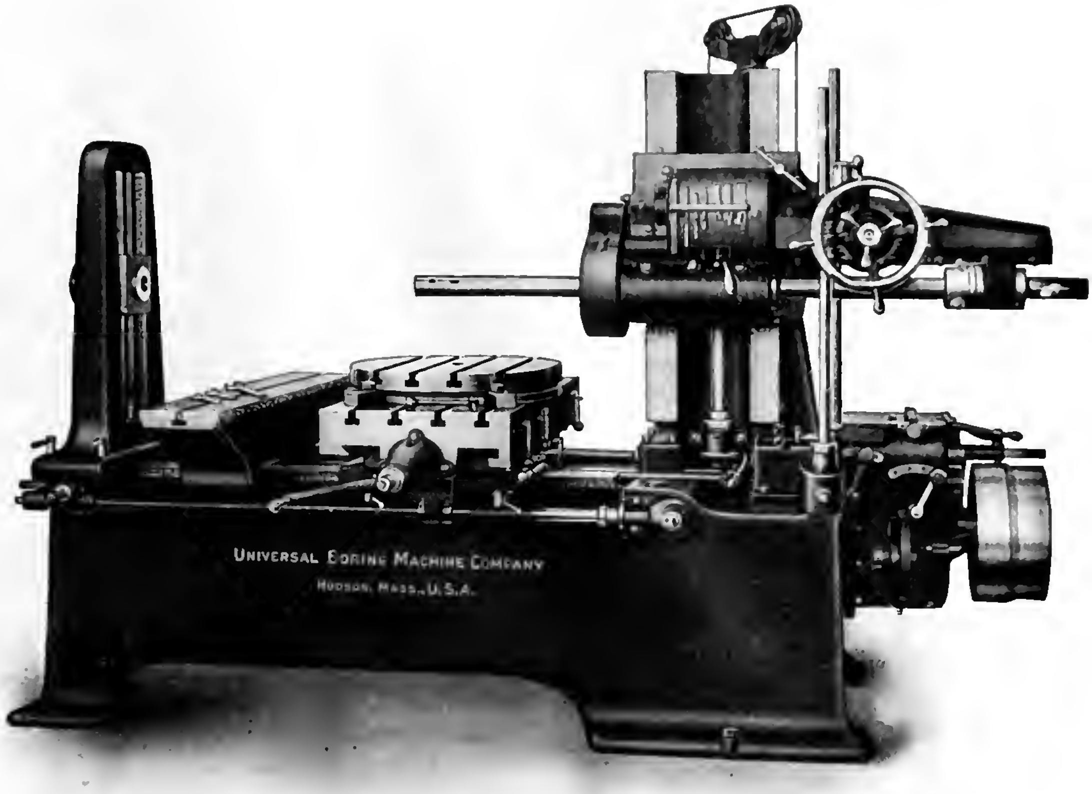

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With Rapid Milling Feeds

When using the Rotary Table but one setting of the casting is necessary in the making of jigs. The machine itself may be used to lay out the work, saving considerable time and also securing an accurately laid out jig.

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Universal Boring Machine Co., Hudson, Mass.

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THE TILTED TURRET

In Fig. 1 is shown an engraving of the No. 3 size of The Tilted Turret Screw Machine, which has an automatic chuck capacity of 1¼ inch. This machine, manufactured by the Wood Turret Machine Company of Brazil, Ind., has a plain head, oil pump and pan, and continuous automatic bar feed, together with an automatic chuck and screw feed cut-off.

The Continuous Automatic Bar Feed used on this machine is simple in construction and of few parts. There are four jaws which hold the stock central in the roller feed case. These jaws have been so constructed that they are able to take round, square, hexagon or any other shaped stock that one may have occasion to use.

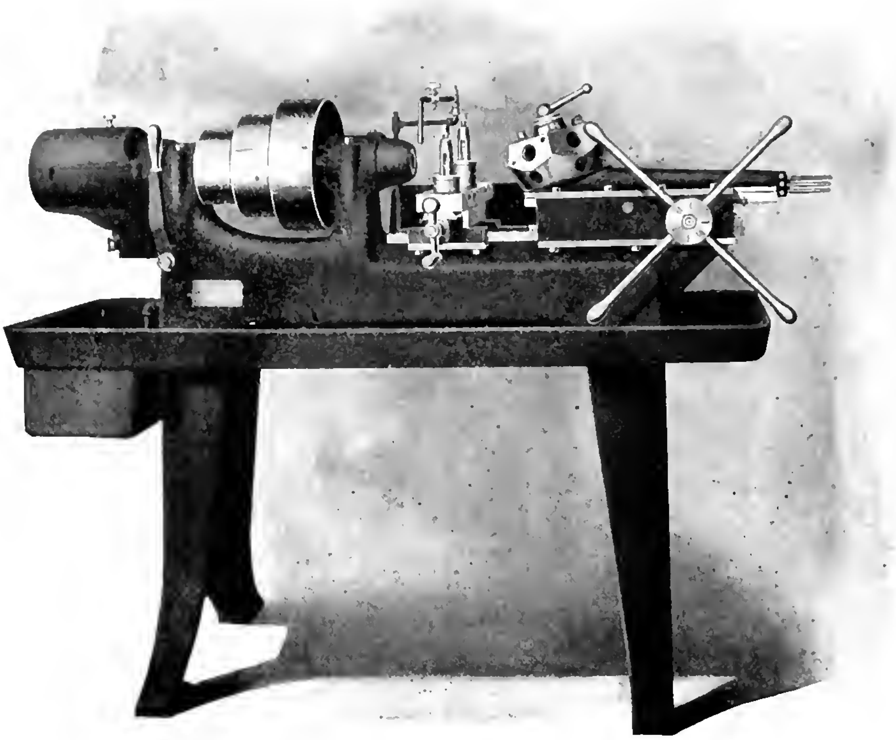

Fig. 1. The No. 3, 1 1-4 inch Complete Screw Machine

The old style high turret is shown in Fig. 2, while in Fig. 3 is shown The Tilted Turret. The machines are of the same capacity and the same swing. The two turrets each carry the same size of die head in the operating position, and also it may be seen what the respective positions would be, if swung around to the rear position. Thus is made clear one of the many purposes and advantages to be gained by having the turret tilted. The strain on the center bolt is minimized due to the fact that the tilt of the turret applies part of the thrust directly on the slide. This feature also causes a full bearing on the slide, and eliminates the tipping which usually occurred with the old style high turret.

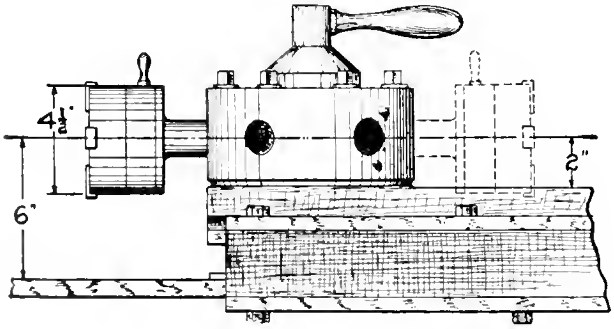

Fig 2. The Old Style High Turret

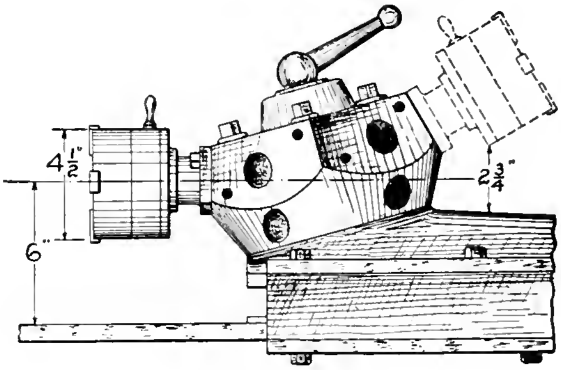

Fig. 3. The Tilted Turret

The stock may be passed into or through The Tilted Turret, since the center bolt has a hole directly through it. The die heads and box tools used on this machine require no shanks. They have a small boss on the back which fits into the counterbore of the turret hole, thus centering them. Two cap-screws hold the die head or box tool, as the case may be, against the turret face. By this arrangement long threading may be done, or long stock reducing cuts taken without interfering with a tool in the rear position on the turret.

The slide on this machine rests and moves in the saddle, being furnished with taper gibs fitted the whole length of the saddle on each side providing a means of adjusting the slide sideways. The backward movement of the slide, which is operated by a turnstile, rack and pinion automatically revolves the turret. The saddle is gibbed to the outer edges of the bed by flat gibs throughout its entire length. There is a supplementary taper base to the saddle by means of which the tool holes in the turret can be adjusted to the exact height of the center of the spindle.

A self-oiling counter-shaft is furnished with each machine. The two friction pulleys on the counter-shaft are of single piece construction. Oil reservoirs are cored out completely around the bearings, and the space is filled with cotton and oil. The hanger shaft bearings are supplied by oil boxes below them. Each of these bearings has a groove cut in it in which is laid a wicking, the ends of which dip into the oil reservoir below.

The Tilted Turret Screw Machine, manufactured by the Wood Turret Machine Company of Brazil, Indiana, may be seen in operation by a visit to one of the Demonstration Shops of Hill, Clarke & Co., Inc., of Boston and Chicago, and their branch offices at New York, Philadelphia and Cleveland.

Chicago (Duplex) Hand Millers

The Chicago Hand Millers, manufactured by the Chicago Machine Tool Company, are of the "Duplex" type, so called since a Vertical Attachment is regularly furnished with each machine. This combination of both horizontal and vertical spindles on the same machine, together with the exceptionally large range, adapts it for the quick handling of a large variety of work.

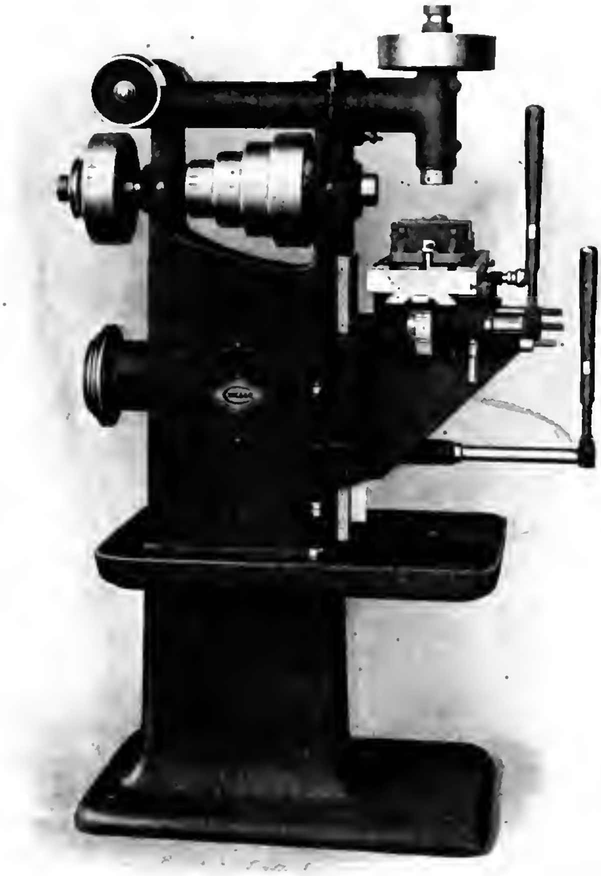

Fig. 1. The No. 3 Machine showing the Vertical Attachment in place

In Fig. 1 is shown the No. 3 Machine with the Vertical Attachment in place. This Vertical Attachment is among the important features of the machine, making it particularly adapted to tool room purposes, as well as brass workers and manufacturers of small parts. It is not practicable in general to use a heavy milling machine for the lighter class of milling machine work, that is, if the element of time is to be considered. The ability of the Chicago (Duplex) Hand Miller, due to its large range and equipment to quickly handle a large variety of work, indicates its time saving qualities.

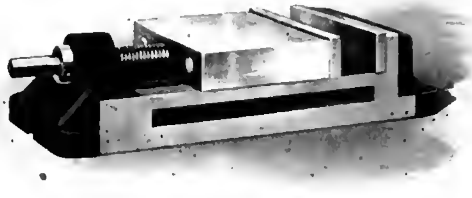

Fig. 2. The "Chicago" Vise

In Fig. 2 may be seen the Chicago vise. This vise is of proportionate design throughout to give it sufficient strength. The vise has supplementary hardened steel jaws held in place by fillster head cap screws.

The Vertical Spindle Attachment, which is regularly furnished, has no gears in connection with it, thus making it sensitive. Therefore, the full driving power is retained, hardly any being used up by friction. The Vertical Spindle runs in a split bronze bearing, provision being made for taking up any wear that may occur.

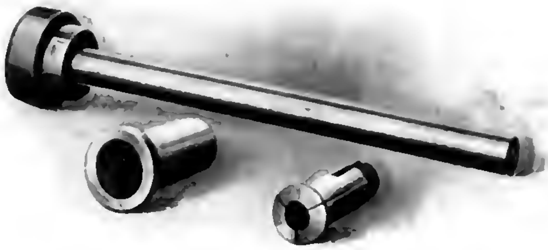

Fig. 3. The Draw Bar, Collet and Sleeve used for holding end mills and similar tools

The Horizontal Spindle runs in split bronze bearings fitted to taper bores in the column. Each bearing is provided with a threaded collar for drawing it into the taper bore, thus furnishing a means for taking up the wear evenly from all sides. This arrangement of the bearing insures great durability and smooth running of the spindle.

The horizontal and vertical spindles are each bored for No. 9 Brown & Sharpe taper. A draw bar, collet and sleeve are furnished for the vertical spindle, and a draw bar and sleeve for the horizontal spindle, the same collet fitting both spindles. Thus end mills and similar tools may be held in place on the machine.

Fig. 4 The Feed-gear Box and Universal Joint Shaft

The Power Feed on the machine is of the most improved design and extremely powerful. It is taken from a cone pulley on the rear end of the spindle to a three-step cone pulley on the rear end of the gear box. From the gear box, the drive is through a universal joint shaft to a pair of 45-degree angle spiral gears in the saddle. A worm is fastened on the same shaft with one of the spiral gears, the pair of spiral gears and the worm being held in a rocker. This rocker throws the worm in and out of mesh with the rack on the table. The worm has at all times five teeth in working contact with the rack. No argument is needed as to power, durability and smooth running qualities of this type of feed; it is too well known.

These Chicago (Duplex) Hand Millers, manufactured by the Chicago Machine Tool Company, Chicago, Ill., may be seen in operation by a visit to one of the Demonstration Shops of Hill, Clarke & Co., Inc., of Boston and Chicago, and their branch offices at New York, Philadelphia and Cleveland.

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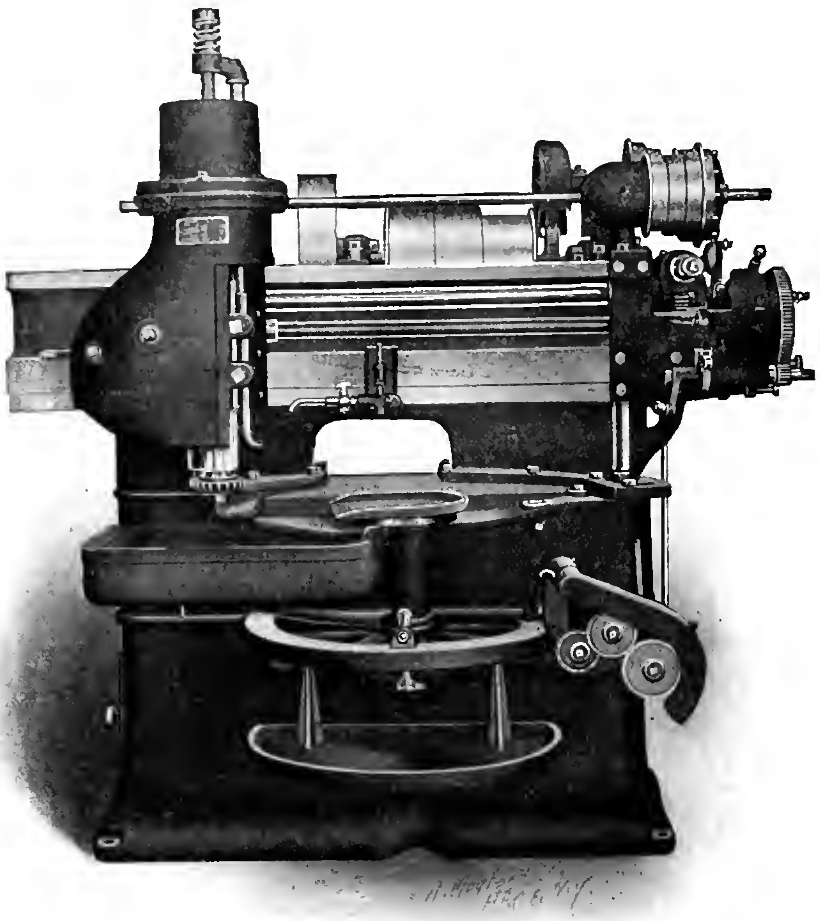

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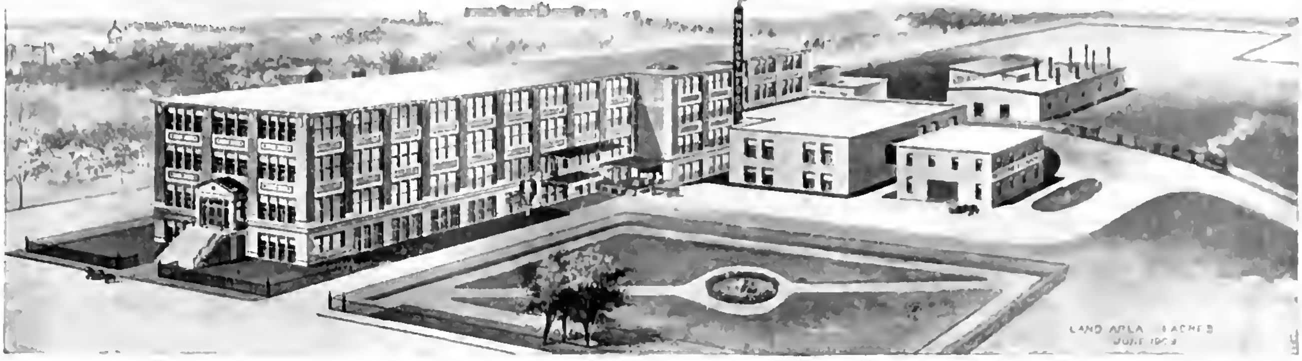

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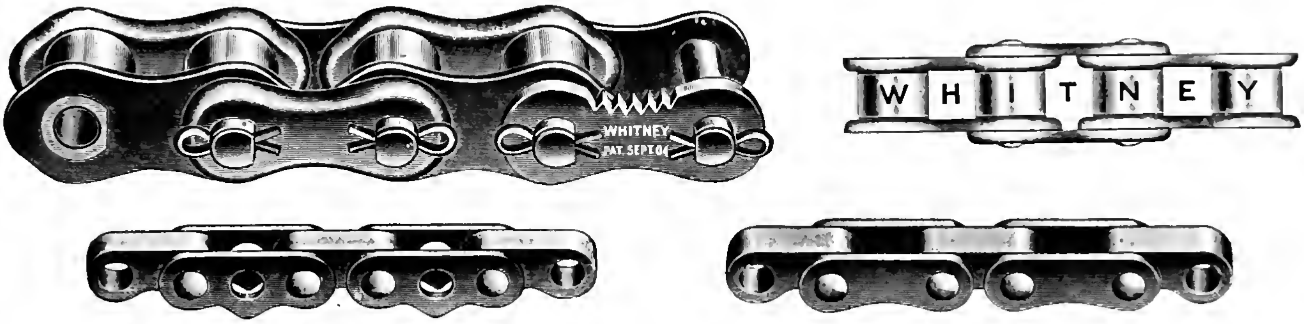

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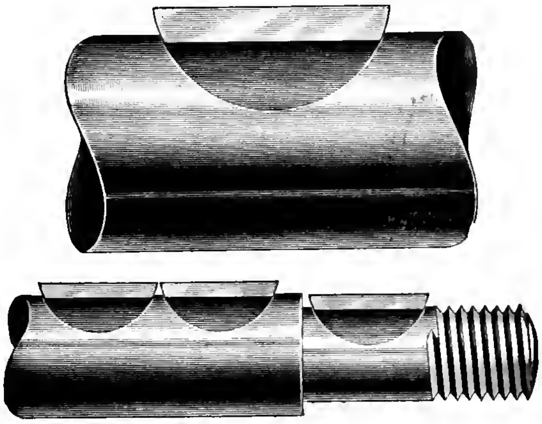

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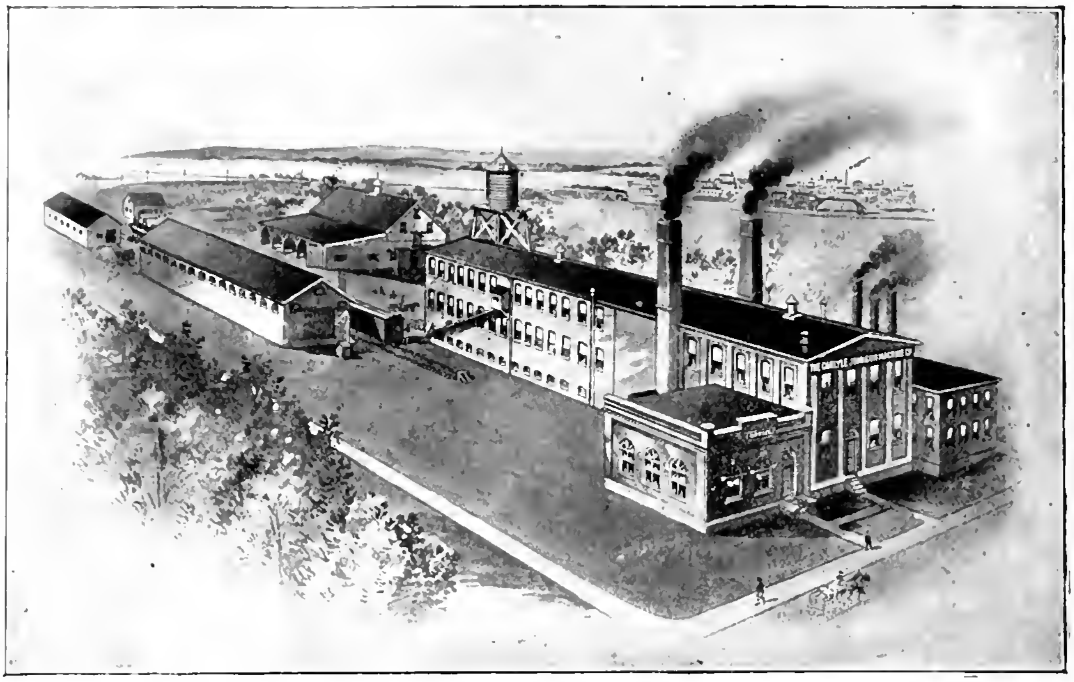

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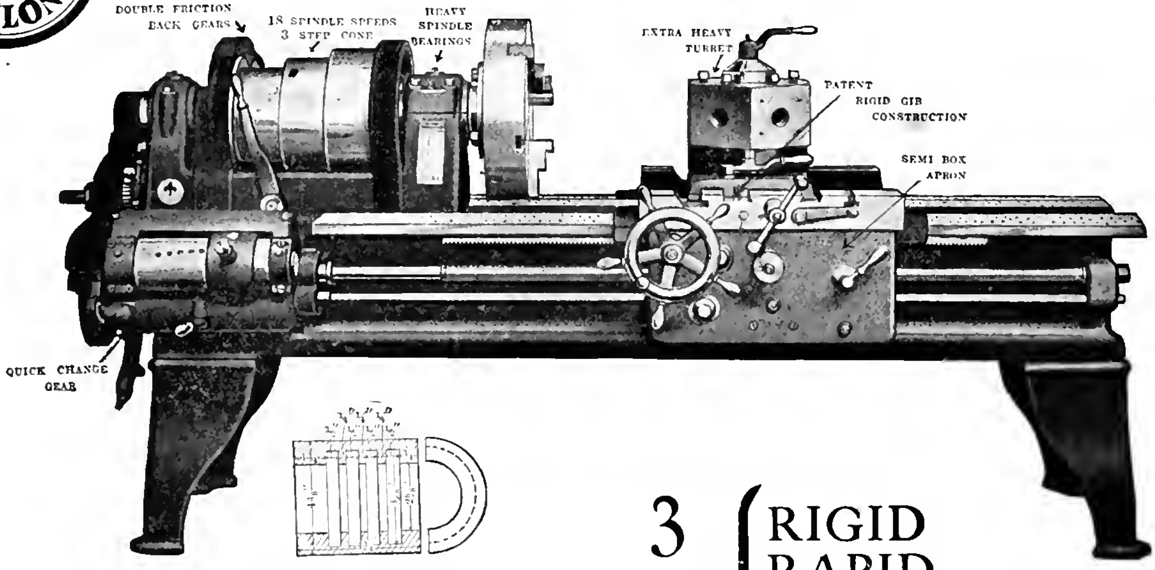

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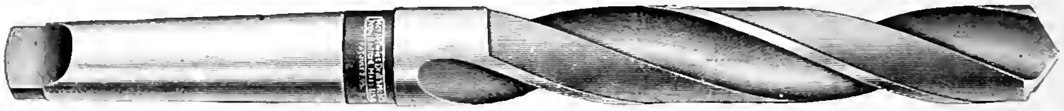

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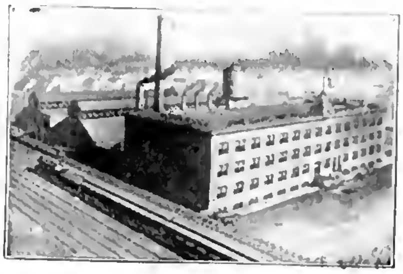

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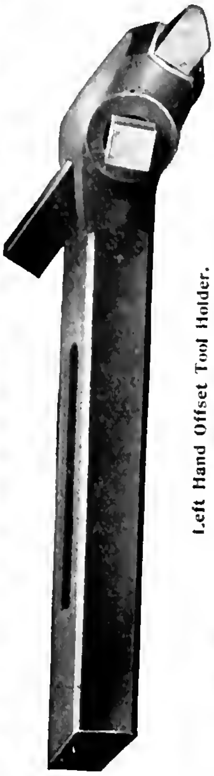

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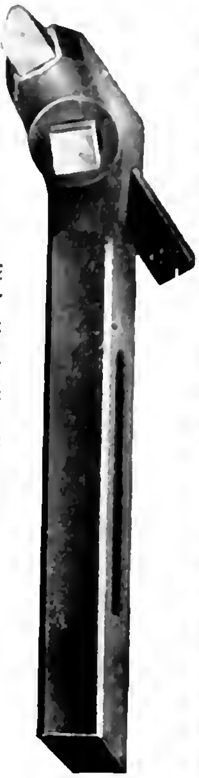

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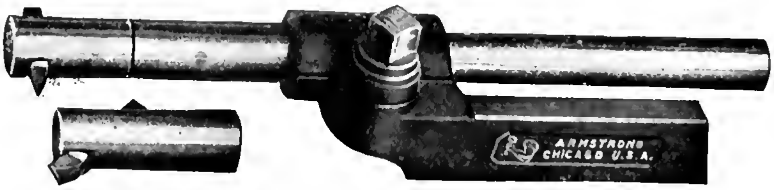

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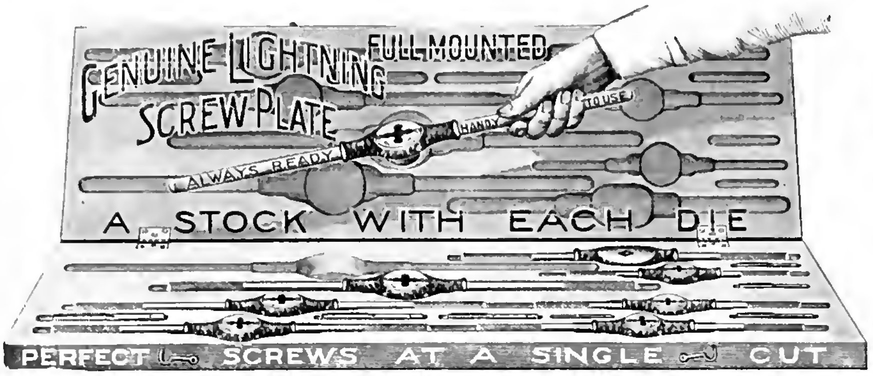

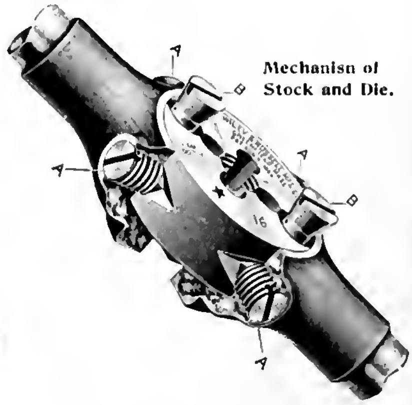

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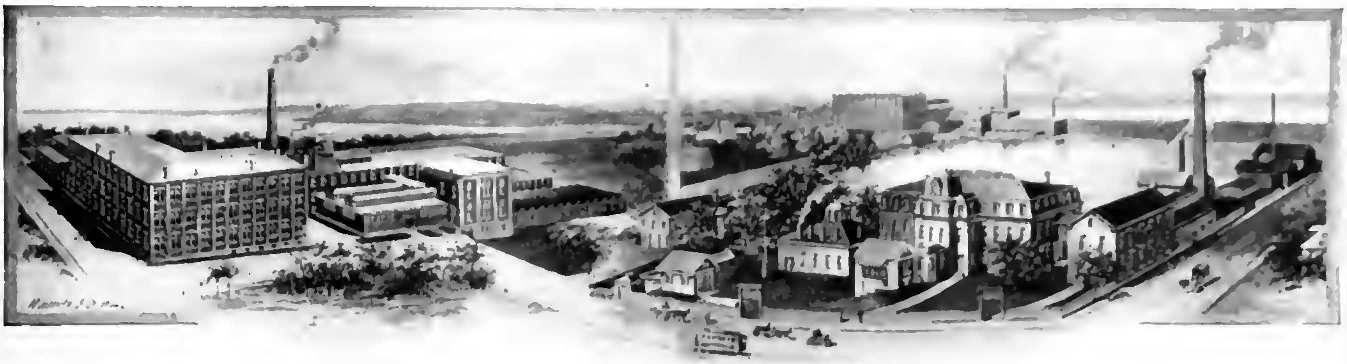

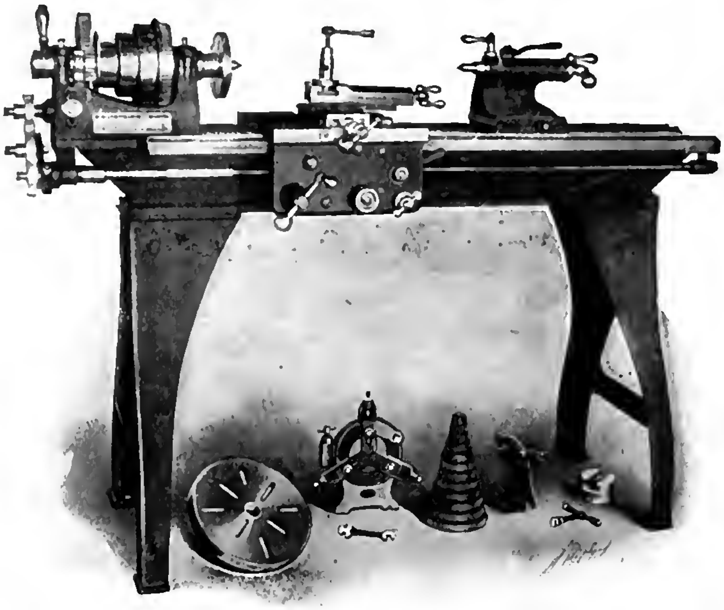

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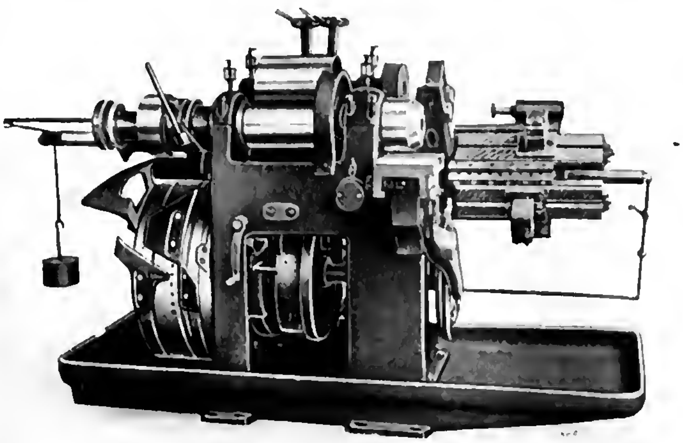

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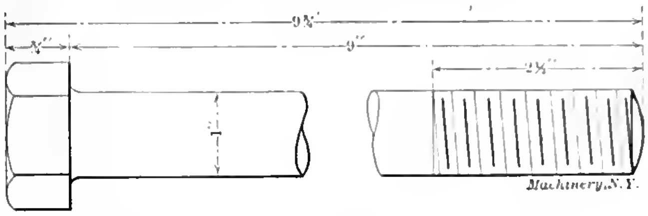

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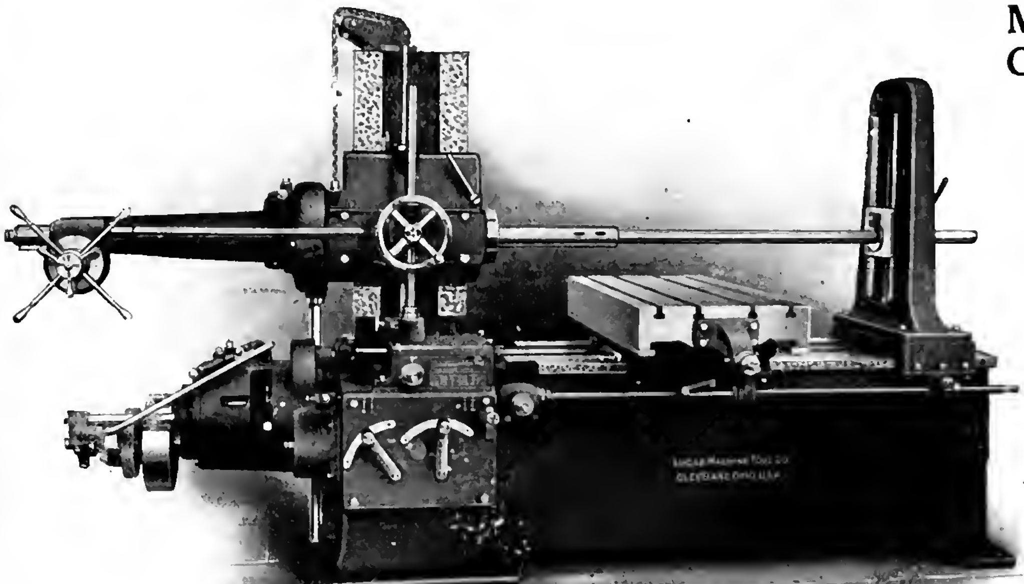

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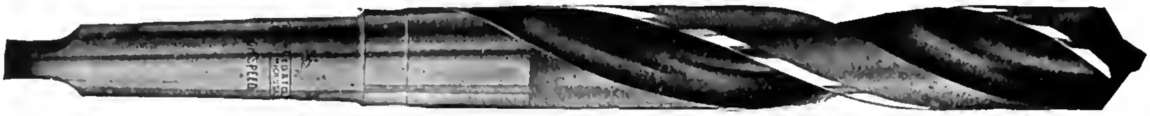

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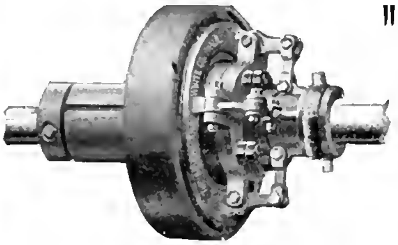

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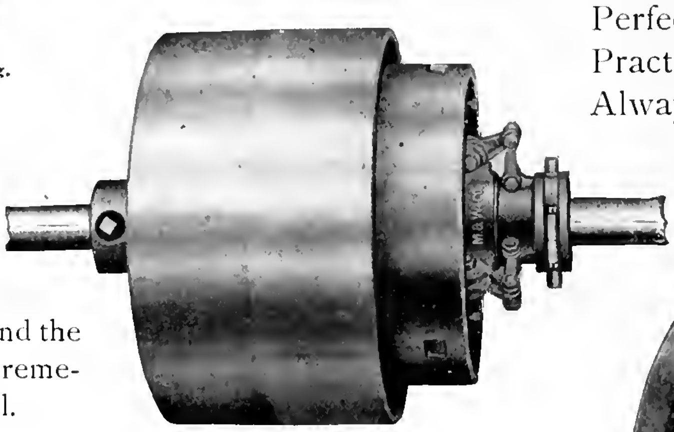

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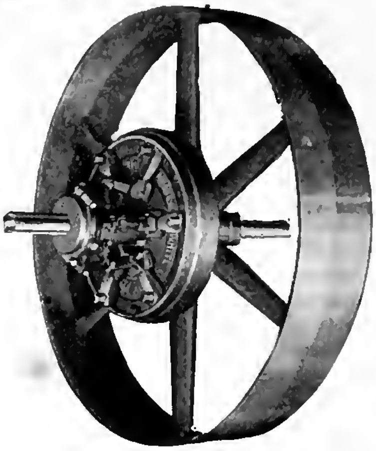

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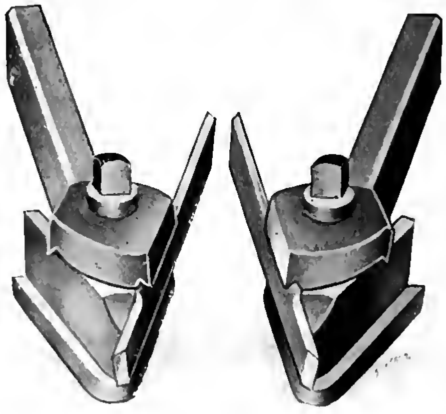

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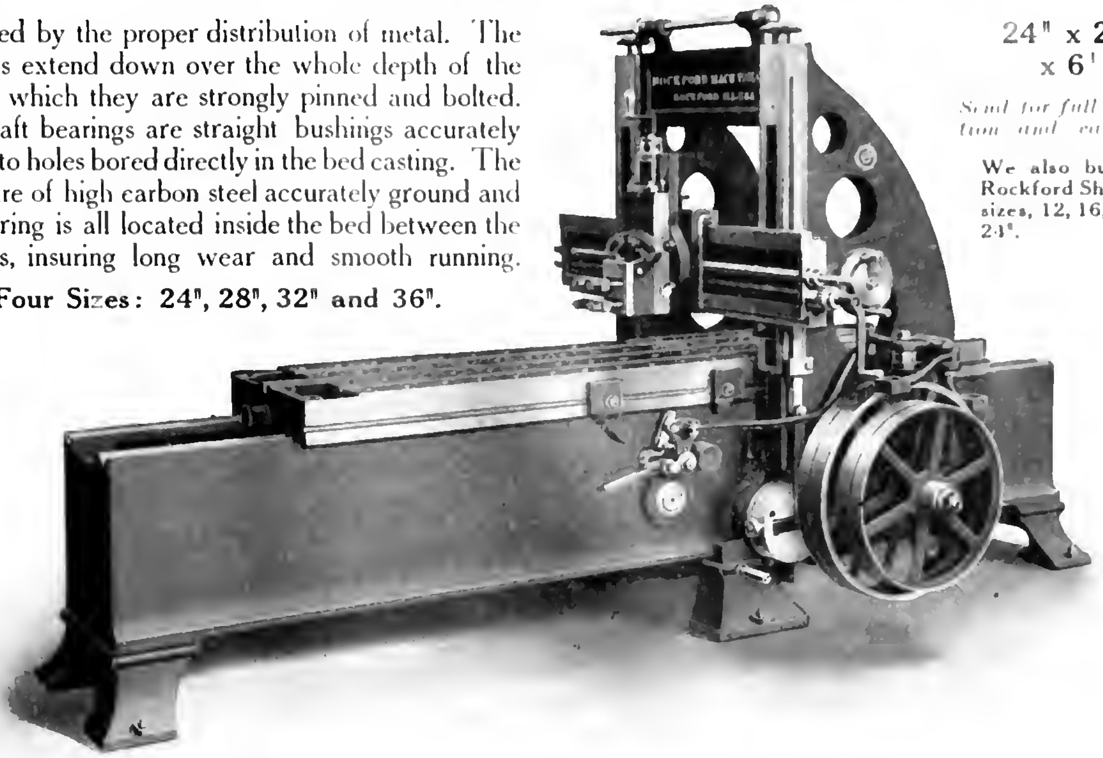

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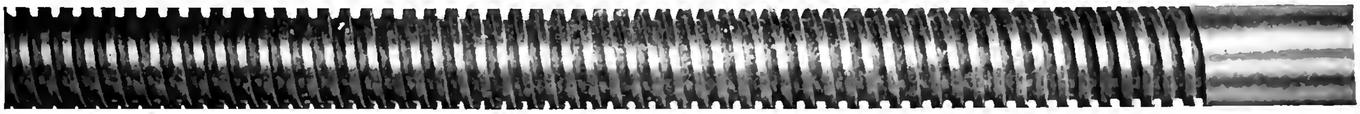

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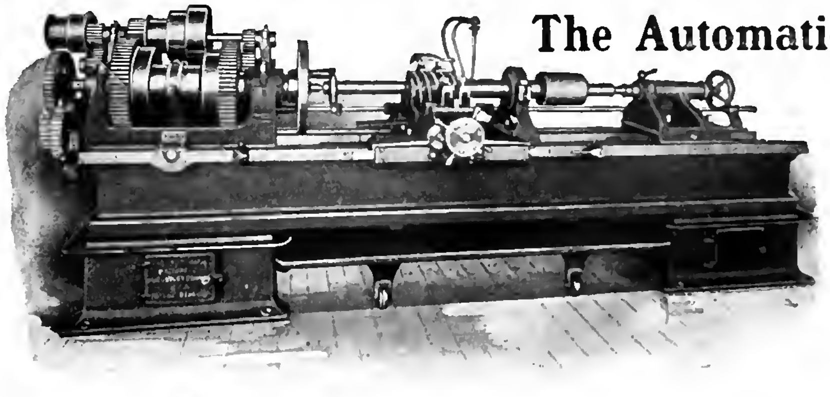

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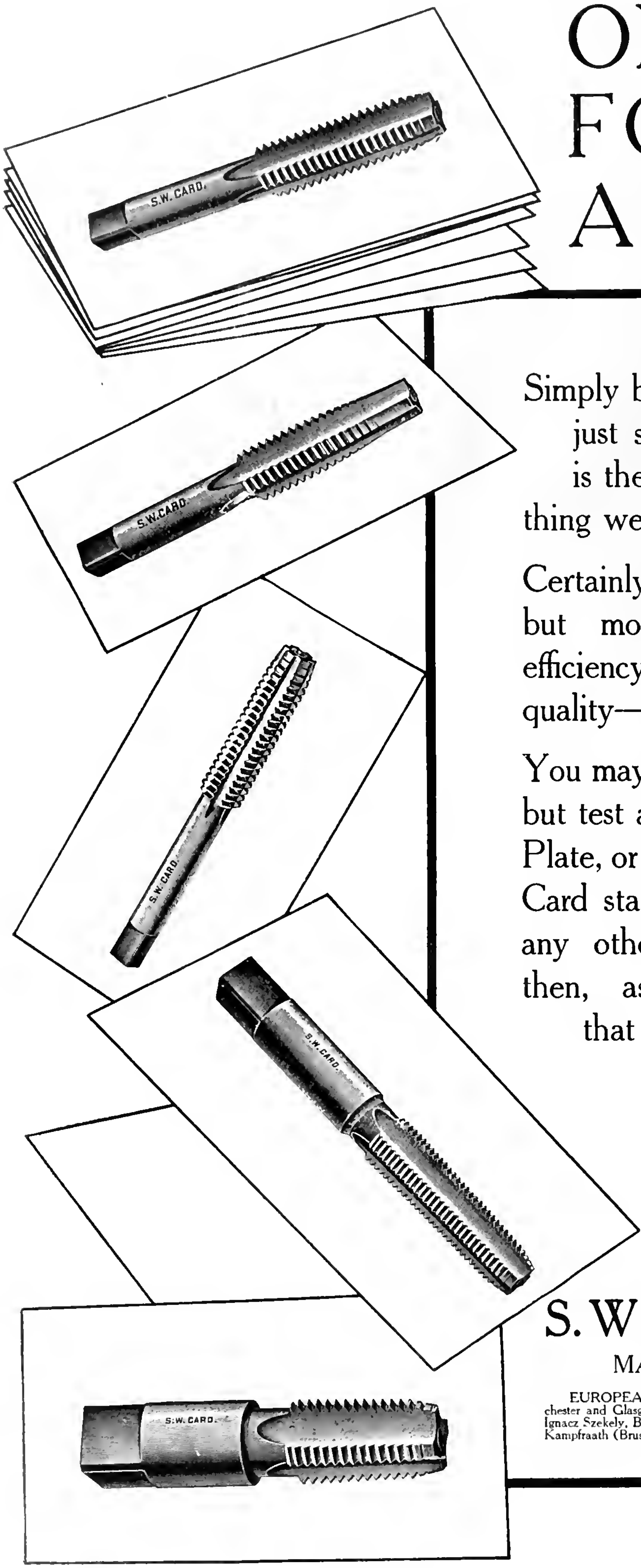

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EUROPEAN AGENTS—Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow; Markt & Co., Ltd., Paris; Fenwick Freres & Co., Milan; Ignacz Szekely, Budapest; V. Lowener, Stockholm, Copenhagen, Christiania; A. A. Kampfraath (Brussels), Ltd., Brussels: Hans Schulze, Brunn, Austria.

Make "Absolute Accuracy" a Shop Order With You

Stick it on the order sheets and on the walls. Make it a war cry. Then you'll begin to cut costs. You can't do it with the ordinary shop caliper, but you can with Slocomb Micrometers, because they give absolute accuracy in all measurements.

They are proof against wear and variation. The extra long bearing between nut and screw prevents wearing out of pitch—even after years of hard service.

89 Styles—21 Sizes—Catalog No. 12.

J. T. SLOCOMB CO., Providence, R. I.

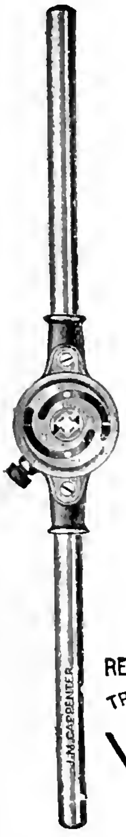
AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. Ludw Loewe & Co., Berlin. Thos. McPherson & Son, Melbourne, Australia.

Die Stocks with Collets are costly—

in the beginning and to the end. Yet collets are necessary in almost all stocks except in

Carpenter's Patent Adjustable Stocks

for holding round dies. They guide the die onto the work by a pair of hardened tempered steel jaws. Jaws are adjusted by a ring with eccentric slots, and remain in the position set. Jaws can be brought into contact with the iron when being threaded, a vast improvement over the solid collet, which has to have an entrance large enough to receive the largest iron, hence is loose on smaller sizes, and allows the die to be lipped at an angle and cut a crooked thread. Why not profit by this in buying your next die stock? Carpenter's Catalog tells everything.



Bottom View

REGISTERED TRADE-MARK C

Top View

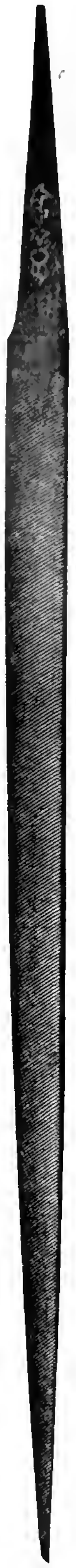
REGISTERED TRADE-MARK C

The J. M. Carpenter Tap & Die Co.
PAWTUCKET, R. I.

FILES ★ TRADE ONLY THE BEST ARE GOOD ENOUGH MARK ★ TOOLS

Quality

American-Swiss Files



The file is one of the simplest of mechanical tools—but one of the most difficult to make. Annealing must be uniform—teeth must be regular and sharp—and the hardening perfect to a degree.

For a long while it was conceded that the file of quality was a Swiss hand made file—but now the "American Swiss" embodies all the good qualities of the foreign make, combined with up-to-date requirements of America's foremost manufacturers, skilled mechanics and toolmakers.

Files of Precision

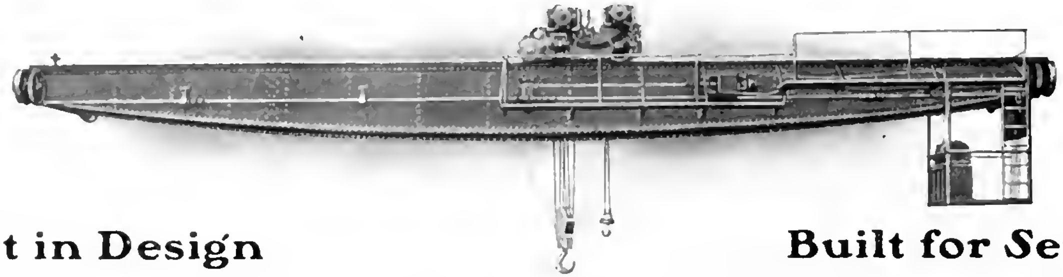
Unequaled for sterling quality, unsurpassed for high efficiency, and approved and endorsed by all plants wherever introduced.

If you want real satisfaction let us send you **FREE SAMPLES**—package of six files—Write on business letter head designating size, shape and cut—it costs you nothing to Be Convinced.

American Swiss File & Tool Co.

E. P. Reichhelm & Co.
DISTRIBUTORS
24 John St., NEW YORK

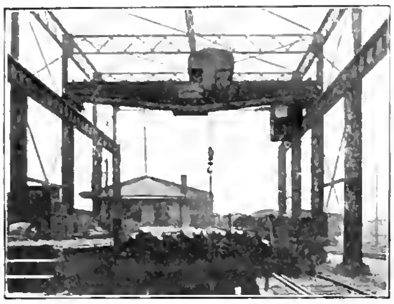
TRAVELING CRANES



Right in Design **Built for Service**

Close attention is paid to the making of every piece in our cranes. It must be right before we pass it. Your guarantee of a satisfactory crane. Write Dept. M.

PAWLING & HARNISCHFEGER, **Milwaukee, Wisconsin**



Special for outdoor service.

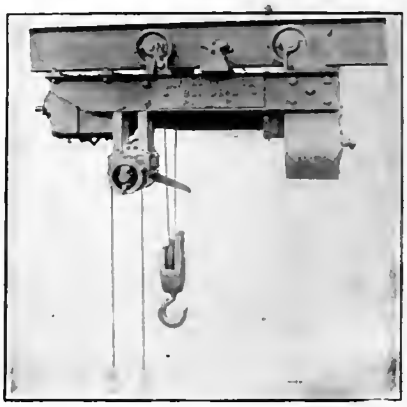
CRANES
AND
HOISTS

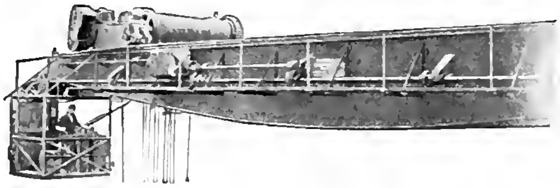
Electric and Hand Power

All Types
and Capacities

Prompt Attention—Quick Delivery

ALFRED BOX & CO.
PHILADELPHIA, PA.



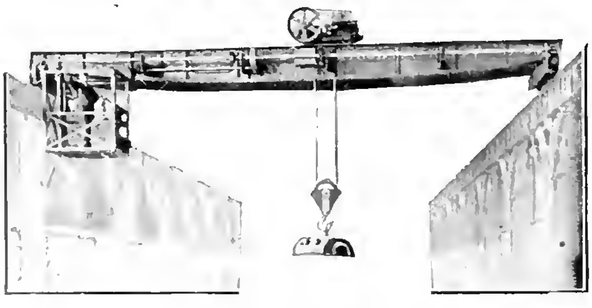


NORTHERN CRANES
AND
ELECTRIC HOISTS

Northern Traveling Electric Cranes are built in from 1 ton to 120 tons capacity and Northern Trolley Hoists (Electric) in from 1 ton to 6 tons capacity—and there's nothing better made. The more carefully you investigate this statement the better you'll please us—and it will show you what's being done in these lines. Write us.

NORTHERN ENGINEERING WORKS,
DETROIT, MICH. U.S.A.

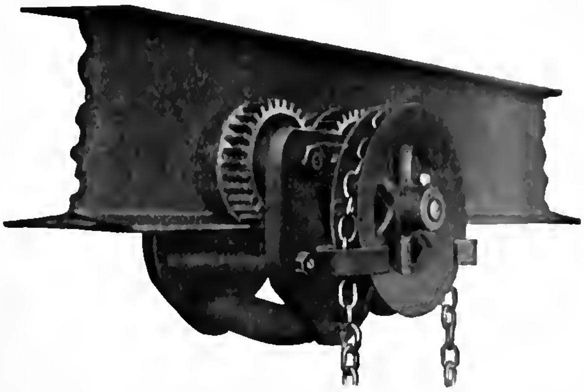
New York, 120 Liberty Street Chicago, 539 Monadnock Block

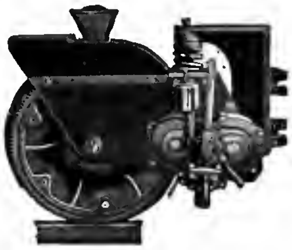


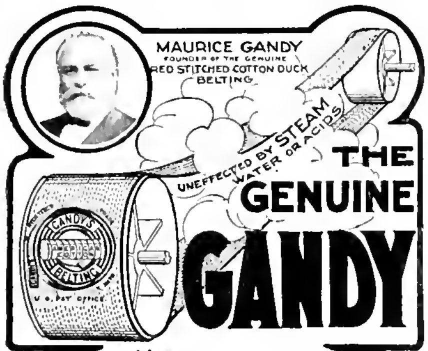
THE CLEVELAND CRANE & ~~CAR CO.~~ ENGINEERING CO.
— WICKLIFFE, OHIO. —

Cleveland Cranes

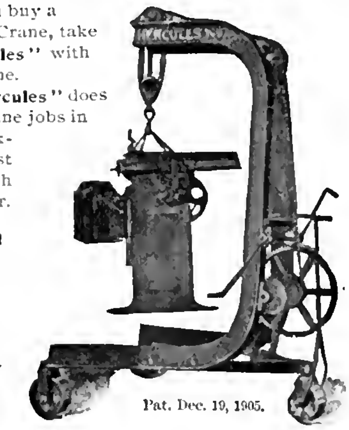
have the "stuff" in them to give you the service you require.







MAURICE GANDY
FOUNDER OF THE GENUINE
RED STITCHED COTTON DUCK
BELTING
UNEFFECTED BY STEAM WATER OR ACIDS
THE
GENUINE
GANDY
GANDY'S BELTING
U. S. PAT. OFFICE



HERCULES NO.
Pat. Dec. 19, 1905.

PHILIPS RIM LUG

THE RIM LUG

is usually a very weak point in the majority of split pulleys. The manufacturers know it and are very loath to speak of it, but not so with us—we're very glad to call attention to ours, for the

PHILIPS LUG

is the strongest point of our pulley rim. The rim lugs extend over the entire width of the pulley, and are formed by the ends of the sheets being turned inwardly from the face, thus making the strongest kind of joint and preventing the sharp ends of sheet from coming in contact with and cutting the belt.

This construction does not destroy with grooves or rivets the most important part of the pulley—the face.

That's another reason why Philips' Pulleys are so popular. They're built on the best mechanical principles and are uniform throughout.

Send today for descriptive circular.

Philips Pressed Steel Pulley Works
PHILADELPHIA

THE PEERLESS=V=BELT

The power transmitter of the future.

Operates on an entirely new principle.

This is the Belt that gives you a drive without trouble.

Once you have seen it in action you will throw aside gear drives, chain drives, leather and rubber belts.

Adapted to high and low speed.

Applicable on short and long centres.

Absolutely noiseless.

Not affected by moisture.

Any reduction in speed.

Lasting and cheap.

Write for our interesting booklet.

PEERLESS=V=BELT CO.
215 SO. CLINTON STREET
CHICAGO, ILL.

THIS

Ball Bearing Tool

is designed to be used in

The National Riveting Machine.

The spindle of the machine in which it is fitted runs at 2000 R. P. M. When the tool is brought down to the rivet, those little rollers revolve vertically on their own axis.

The Process is Noiseless.

A Perfect Polished Head in One Second.

No Bending of Rivets or Breaking of Work.

Capacity ⅜" rivets. Manufacturing Simplified.

The Cincinnati Pulley Machinery Co., Cincinnati, O., U. S. A.

The Peerless Hoist

The latest type of spur geared hoist embodying special features that make it the most efficient device of its class.

Safety, Durability, Speed, and Economy

are prominent characteristics of the "Peerless"—all qualities that go to make up the perfect hoist. The single load chain tends to light weight and compact form; all working parts are protected by dust-proof cases; the hoisting mechanism—a train of compound balanced steel gears—insures smooth action and reduces wear to the minimum; and all danger of the load slipping is eliminated by a chain guide and stripper.

We shall be glad to furnish full particulars on request.

Edwin Harrington, Son & Co., Inc.
Philadelphia, Pa., U. S. A.

CONVEYING
AND
POWER-TRANSMISSION MACHINERY

LINK-BELT COMPANY
PHILADELPHIA CHICACO INDIANAPOLIS
NEW YORK: 299 Broadway. PITTSBURGH: 1101-2 Park Bldg.
BOSTON: 84 State St. BUFFALO: 601 Ellicott Sq.
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SEATTLE: 439-440 New York Block.
DENVER: Lindrooth, Shubart & Co.
NEW ORLEANS:
Wilmot Machinery Co.

OXOILOX

You see that Coupon?

READ IT!

You can't object to putting your name and address to that.

It's a free gift of a good big sample of the greatest

BELT DRESSING

that has ever been offered to belt users.

We show our confidence in it by offering it to you for trial, we're not asking you to buy it. we won't need to, you'll do that of your own accord as hundreds of others have done, when you see how it makes belts pull. It won't injure them, on the contrary, it will preserve them.

And when you see old belts limber up and begin to have a nice sag on top while the bottom stretch is as taut as a drum, you'll begin to realize what wonderful stuff it is.

We want your friendship and patronage, and we'll get both if you'll fill in the coupon.

"It makes belts pull like chains."

F. S. Walton Co., Philadelphia, Pa.
Pressers and Refiners of Neatsfoot Oil.

COUPON

F. S. WALTON Co., Philadelphia, Pa.

Gentlemen: I'll accept a free sample of your "Oxoilox" Belt Dressing and agree to give it a fair trial, it being thoroughly understood that I am in no way obliged to purchase more whether this works to my satisfaction or not.

Name..

Address..

Employed by..

Number of belts .... Average size............

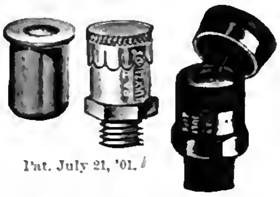
MACHINERY, August.

"CINCINNATI" PUNCHES
THE CINCINNATI PUNCH & SHEAR CO., Cincinnati, Ohio

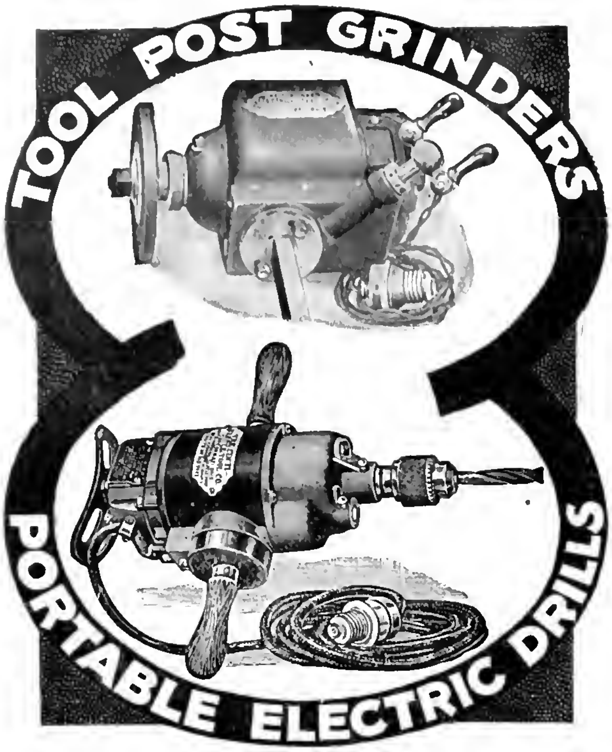
HOISTS, New Patent Whip
Patent Friction Pulleys,
NONE BETTER
MANUFACTURED BY
VOLNEY W. MASON & CO., PROVIDENCE, R. I., U. S. A.

NO MORE CUSS WORDS IN THE DARK

IF YOU CAN GET YOUR HAND ON IT YOU CAN PUT THE OIL IN
SEND FOR SAMPLES AND PRICES
European Agents, CHARLES CHURCHILL & CO., London, Eng.
BAY STATE STAMPING CO., WORCESTER, MASS.



BENNETT HANDY OILERS



Kantbebeat C.E.T. Co. Tools.

Wherever our **Portable Electrically Driven**

Drills and Grinders

have done service they have proven their efficiency.

Our Tools are AIR-COOLED and do not get hot.

DON'T FORGET THIS when considering Electric Tools.

The Drills are made in 10 sizes – 3-16", 1-4", 3-8", 1-2", 3-4", 1", 1 1-4", 1 1-2", 2" and 2 1-4".

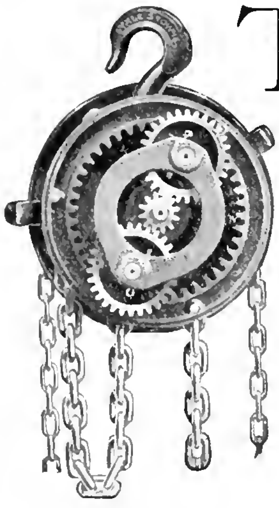
The Grinders are made in all sizes from 1-4 H.P. to 3 H.P. motor.

Let us send one on trial.
Write for Catalogue.

The Cincinnati Electrical Tool Company
CINCINNATI, OHIO, U. S. A.

The Dust-Proofness

of the Triplex Block



Dust-proof Steel Gear Cover Removed.

THE dust-proof cover of the Triplex is *dust-proof*. It is not pierced to hold bearings and is of pressed steel, not cast iron.

It is absolutely independent of the gears and can be battered and dented to any extent without affecting the mechanism in the least.

This is a great improvement over the cast iron covers which are often broken by being struck against other blocks, causing great danger where the gear bearings depend on the cover for support.

The Triplex Block is made in 14 sizes, with a lifting capacity of from ¼ to 20 tons. Other types are the Duplex: 10 sizes; ½ to 10 tons. The Differential: 7 sizes; ⅛ to 3 tons. The Electric Hoist: 10 sizes; ¼ to 16 tons. Blocks are carried in stock by Hardware, Machinery and Mill Supply dealers. *Catalog with interesting technical information on request.*

THE YALE & TOWNE MANUFACTURING CO.
9 Murray Street, New York

DA 5.

RATHER SMALL

FOR A POWERFUL MACHINE

but this pump weighing less than 100 pounds is capable of delivering an operating pressure of 500 pounds per sq. in. to each of four hydraulic presses. It is also excellent for pumping oil in forced feed lubricating systems.

Each pair of cylinders (½ in. diameter by ½ in. stroke) delivers into a separate pressure chamber and line, any one of which can be thrown out of service by leaving the valves open.

We call your attention to these sizes and capabilities merely as an example of the widely varying conditions which we are constantly called upon to meet.

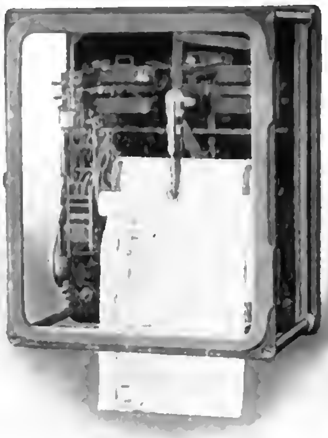
WATSON-STILLMAN HYDRAULIC PUMPS

are made to be driven by hand, belt, motor or steam engine, and to deliver any pressure up to 10,000 pounds per square inch.

We carry in stock those types and sizes which are in greatest demand and have patterns for others to meet most ordinary conditions. If your work requires special construction, our fifty years designing experience and complete mechanical facilities are at your service. We will build to order on short notice and at reasonable price.

Ask for Hydraulic Pump Catalog No. 71 and tell us what other hydraulic tools interest you.

THE WATSON-STILLMAN CO.
192 FULTON ST., NEW YORK
CHICAGO, 453 THE ROOKERY 17

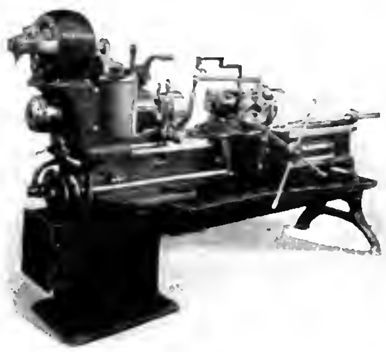


Westinghouse Curve-Drawing Meters

Connected to Westinghouse motor-driven machine tools give a graphic record of each machine operation. They show where to lessen unproductive delays and where to decrease operating costs. Send for Motor Talks No. 1, "Machine Tool Edition," it contains interesting data.

Westinghouse Electric & Mfg. Co.
Sales Offices in all large Cities. Pittsburg, Pa.

FORT WAYNE



Northern Type Motor Geared to Jones & Lamson Flat Turret Lathe.

A Saving of 50 Per Cent.

in your power costs surely ought to interest you. This is the saving which one of the largest street railway companies in the world is experiencing in its repair shops since equipping its machines with Northern Type Motors.

If you are a line shaft and belt user get out of that wasteful rut. Employ Fort Wayne Motor Drive. Get greater output with reduced power cost.

Fort Wayne Electric Works
Main Office: Fort Wayne, Ind. Factories: Fort Wayne, Ind., and Madison, Wis.

Sales Offices
Atlanta
Boston
Chicago
Cincinnati
Grand Rapids
Madison
Milwaukee
New Orleans
New York
Philadelphia
Pittsburg
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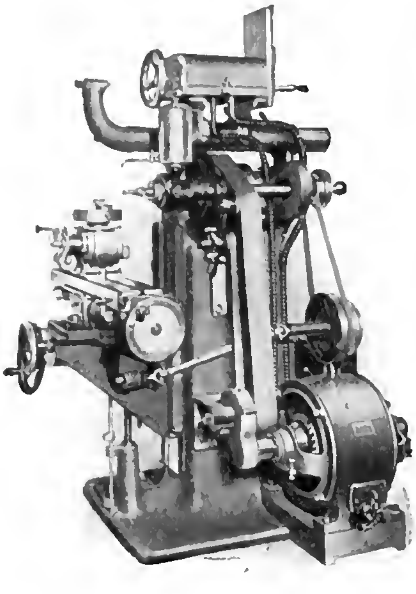
St. Louis
St. Paul
Syracuse

794



Hawthorn Motor Driving Milling Machine

Relieve the Congestion

If your shop is overcrowded you can relieve the congestion by equipping your machines with

Hawthorn

TRADE MARK

Motors

Every machine thus equipped is a compact, productive unit that requires less actual floor space—gives more head room for handling of work—may be placed just where it should be—turns out more work in a given time and at less expense—aids in improving sanitary conditions. In short, machines driven by Hawthorn Motors are best for *your* shop—and best in every way. We guarantee Hawthorn Motors under all conditions. Let us tell you about them.

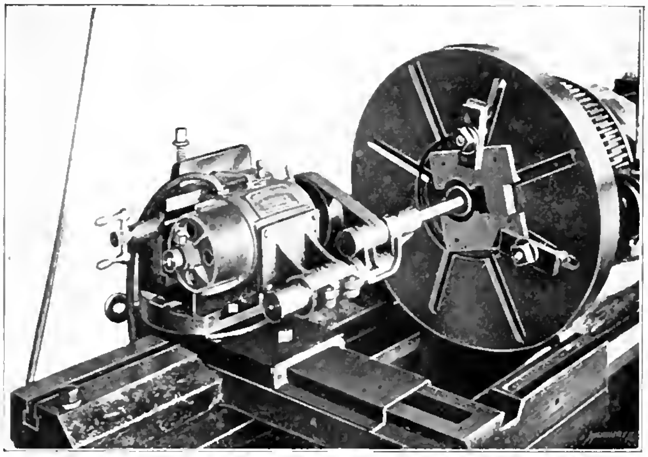
Bulletin No. 505 shows many interesting applications. We will gladly forward a copy on request.

WESTERN ELECTRIC COMPANY

EASTERN	CENTRAL		WESTERN	PACIFIC
New York, Boston, Philadelphia, Pittsburg, Atlanta.	Chicago, Cincinnati, Indianapolis, Minneapolis.	**Write Our Nearest House**	St. Louis, Denver, Kansas City, Dallas, Omaha.	San Francisco, Seattle, Los Angeles, Salt Lake City.

Northern Electric and Manufacturing Co., Ltd., Montreal and Winnipeg.

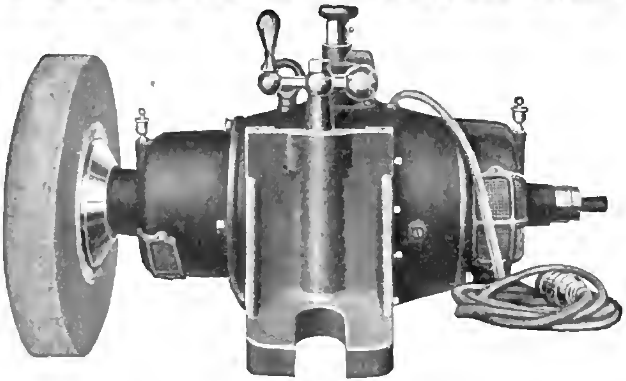
ELECTRIC GRINDER—18,000 R.P.M.



For internal grinding such as dies, journal, engine cylinders, or internal grinding of any kind. Made in three sizes to grind up to 18″ deep. Grinding attachment can be taken off for external grinding such as center, cutters, rolls or grinding of any kind, on lathe, planer or boring mill. Emery wheel for external grinding 4½″ to 12″ in diameter.

Why not buy a combination electric grinder when you buy. Direct or alternating current.

SENT ON TRIAL



3 H.P. ELECTRIC GRINDER

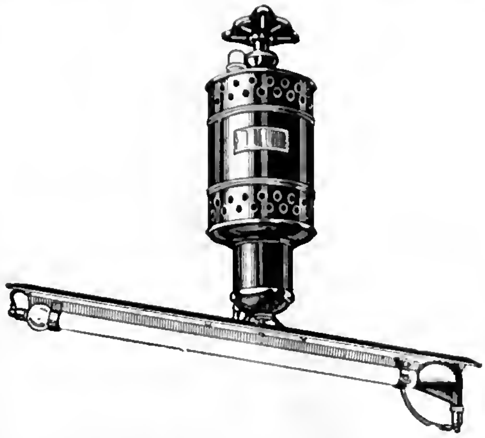
For heavy grinding, on lathe, planer or boring mill. Wheel 14″ x 2″ motor air cooled. Also make electric drills.

Write for Catalogue.

The United States Electrical Tool Co.

CINCINNATI, OHIO, U. S. A.

Cooper Hewitt Lamps



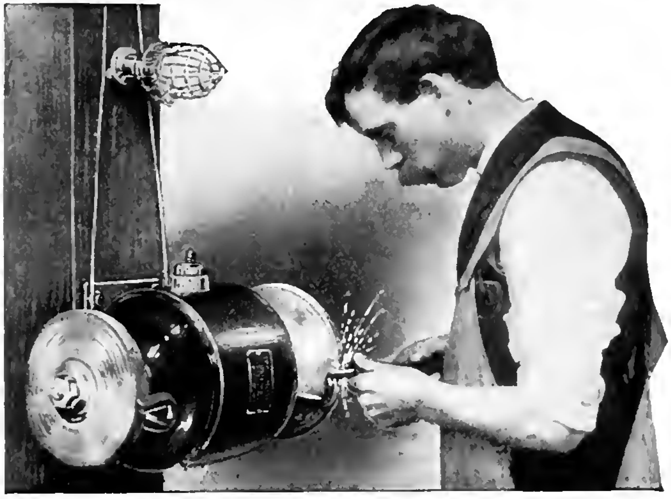
Restful to the eye

This is what a large maker of gas and electrical fixtures writes:

"After experimenting with various types of lights in our factory, we installed on our lathe, spinning, blacksmith's and polishing floors, Type H Cooper Hewitt Lamps. These have been in operation something over a year and have given perfect satisfaction. The workmen claim that the light is **restful to the eye**, and it gives us pleasure to hand you this testimonial."

For particulars of Cooper Hewitt Lamps ask for Catalogue 90.

Cooper Hewitt Electric Co.
220 West 29th St, New York



Dust-Tight Frame Grinders

The accurate balance and perfect adjustment give this motor the highest efficiency. The dust-tight features give it extra life. The end brackets form a dust-tight and water-proof enclosure for the windings and electrical parts of the motor.

Our policy of specialization has made the

Robbins & Myers "STANDARD" Motors

(Direct Current—All purposes $\frac{1}{30}$ to 15 H.P.)

far superior to any other small motor on the market.

We have already designed a number of different types of motors for special purposes - adding machines, air compressors, pumps, etc., which we now carry in stock. If we haven't the right motor in stock we will make it for you.

Write to our Engineering Department for free advice.

The Robbins & Myers Co., Main Office and Factory, 1327-1427 Lagonda Ave., **Springfield, O.**

New York, 145 Chambers St.
Philadelphia, 1109 Arch St.
Boston, 176 Federal St.
Cleveland, 1408 West 3rd St., N. W.

New Orleans, 312 Carondelet St.
Chicago, 48 W. Jackson Boulevard
Kansas City, 120 W. 13th St.
St. Louis, Locust and 11th Sts.

A MOTOR FOR EVERY MACHINE IN YOUR SHOP.

"It is better to buy Crocker-Wheeler machines than to wish afterwards that you had."

Gauze Inclosed Form I Motor (see Bulletin 100R.) One of standard types of **C-W** *machines.*

This remark was made by one of the most experienced buyers of machinery in the United States.

CROCKER-WHEELER COMPANY

Manufacturers and Electrical Engineers
AMPERE, N. J.

"RELIANCE"
High Speed Twist Drills

MADE FROM FLAT BAR STOCK

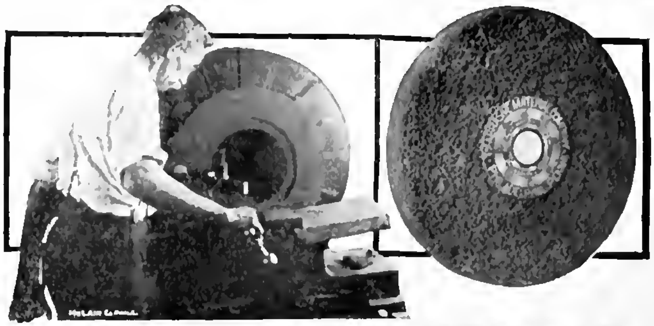
For a quarter of a century we have been making Twist Drills. Being progressive manufacturers, we are constantly improving the quality of our product.

Tests recently made by the largest drill users in the world have proven the superiority of both our carbon and high speed drills.

We are now introducing our "Reliance" High Speed Drills made from Flat Bar Stock.

Write for "Reliance" catalog and discount sheet.

New Process Twist Drill Co.
TAUNTON, MASS., U. S. A.



ABRASIVE

Care in Finishing the Product

is another feature that makes

**ABRASIVE
FAST GRINDING WHEELS**

so popular with the operators. Our wheels never leave the factory until they are as perfect as modern skill can make them, consequently when they reach your shop they are ready to show you that—

"They don't merely grind—they cut."

This is not altogether due to their finish, of course, it's the material and bond they're made of that does that; but the method of manufacture and finish helps—helps a lot.

Tell us your grinding troubles, we'll tell you how to remedy them.

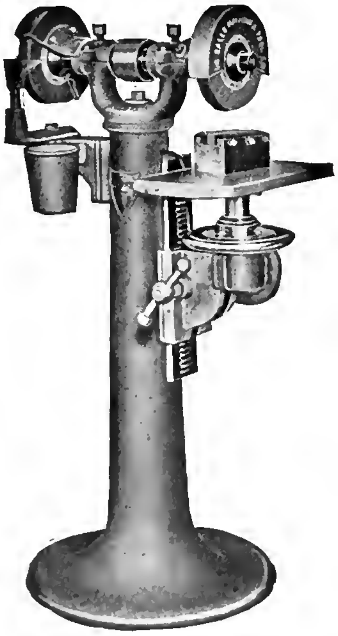
ABRASIVE MATERIAL CO., Philadelphia

AGENTS—H. A. Stocker Machinery Co., Chicago, Ill. E. Sonnenthal, Jr., Berlin, Cologne and Vienna. Wilh. Sonesson & Co., Malmo and Copenhagen. Glaenzer, Perraud & Thomine, Paris, France. R. d'Aulignac, Barcelona, Spain.

The LaSalle No. 1 Plain and Surface Grinder

Micrometer Feed

TRADE MARK.



With the advantage of absolute accuracy, strength to fully meet the demands of the wheel and every convenience for operating, this grinder will pay its way in any shop. It will handle much work now finished by filing, with a subsequent saving of time and labor, is admirably adapted for sharpening punches and dies, fitting keys and a wide range of similar work. The micrometer feed to table permits the finest adjustments to be easily and quickly made.

Catalogue mailed on request.

LaSalle Machine and Tool Company
LaSalle, Ill., U. S. A.

BAY STATE

TAPS & DIES

BACK of every success you'll find experience. That's one reason why Bay State Taps are being used exclusively by the best shops and mechanics.

They know that the superior temper, the correct lead and uniform pitch was never gotten by accident, but by hard work and experience.

It is the quality that makes them wear so long.

**Try just one "Bay State"
and you'll use no others.**

BAY STATE TAP AND DIE CO.
MANSFIELD, MASS., U. S. A.

The Abrasive Metal Cutter

Cuts off High Speed and Carbon Steel bars 5-16" diameter in 5 seconds without drawing the temper.

It is the most rapid machine for cutting metal ever invented. Effects a saving in time and material when cutting up stock, which is hard to credit until it is actually proved to you. Is designed to handle metal in any form and is especially adapted for tubing-cutting clean and true without burrs or irregularities.

Our Special Patent Cutting Wheel developing a speed of 4000 revolutions per minute does the cutting. Each wheel will cut up from 300 to 400 pounds of ½" high speed steel in lathe tool lengths.

Full description and reports of work done, sent on request.

Slack Manufacturing Co., Springfield, Vt.

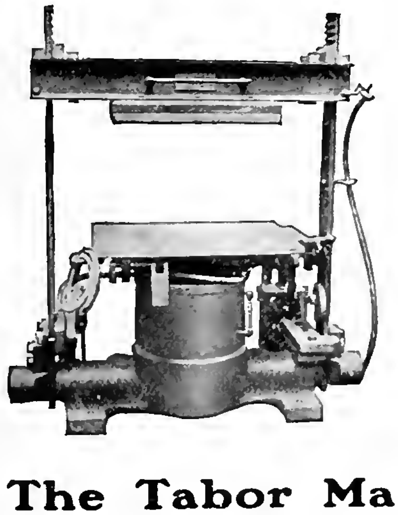
Modern Pipe Machines.

Our line of Pipe Threading and Cutting Machines is up-to-date in every particular. Designed for labor-saving and increased output. The machines of the hour. Write us.

The Stoever Foundry & Mfg. Co., Myerstown, Pa.

NEW YORK OFFICE: 140 Cedar Street.

Tabor Molding Machines



Cut shows 13" Cylinder Power Squeezer designed to squeeze the sand to the proper density instead of ramming by a blow.

Machine is adapted for use with Vibrator Frame, Paraffine Board or Plated Pattern.

Write for Catalogue.

The Tabor Manufacturing Co.

18th and Hamilton Streets
PHILADELPHIA, PENNSYLVANIA

You've tried the rest. Now try the best

It is hard to make a man realize, when he has tried a lot of different things for his belts, that Cling-Surface will give him the results he has been looking for all the time.

You want your belts and ropes pliable, waterproof and preserved.

You want to run your belts easy or slack and carry full loads. You hear a good deal about slack belts.

Don't you know that it was Cling-Surface that started this movement towards slack belts? And before that time every one ran their belts tight and expected to?

Cling-Surface has made it possible and Cling-Surface is the only thing that ever has.

An occasional belt, underloaded, can be run slack without it but only Cling-Surface lets them *all* run easy or slack, some slacker than others—none tight.

It means long-lived belts, cool bearings, economy of oil, fuel, power and work and less worry on you.

We guarantee it. Write us and ask for photographs of belts and our trial terms. Write us now.

CLING-SURFACE CO
1018 Niagara Street Buffalo N Y
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C S E O

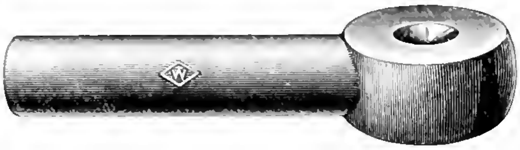
COLD ROLLED STRIP STEEL

For Stamping and Drawing Purposes

EXTRA QUALITY

THE COLUMBIA STEEL CO. - ELYRIA, OHIO

TRADE W MARK Mind the Mark TRADE W MARK

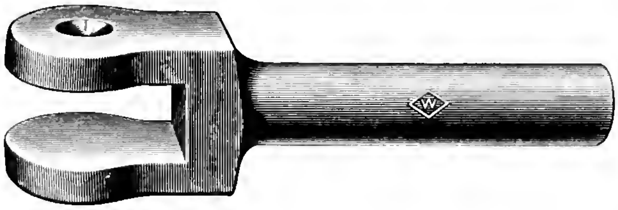


Williams' Rod and Yoke Ends

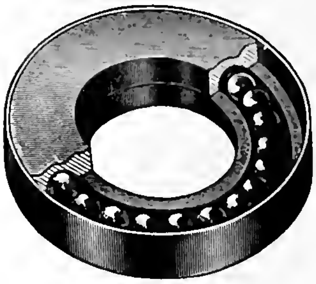
as handy as a pin in a ladies' bazaar. Inexpensive drop-forgings with capacity of hand or specially made goods. Carried in stock in lengths as per catalogue; extra lengths to order. Yoke Ends milled with slot 1-32" narrower than thickness of corresponding Rod Ends; milled also to order or left blank. Get details and new B-'09 Catalogue at once—see pages 78-79. Discount from dealers.

J. H. WILLIAMS & COMPANY

SUPERIOR DROP-FORGINGS Brooklyn, New York

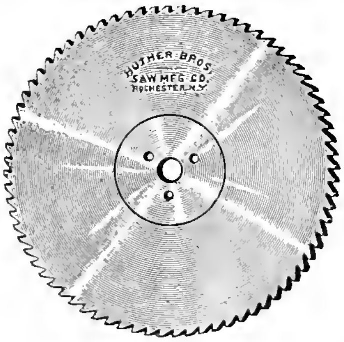


THRUST BEARINGS



Bantam Anti-Friction Co.

Bantam, Conn.



MILLING SAWS

And Cutters

Saws made from High Speed and Carbon Steels.

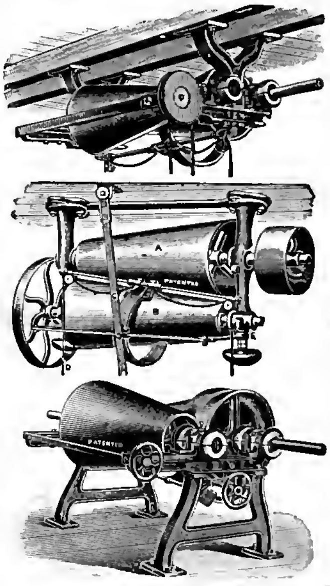
LET US SEND YOU ONE TO COMPARE RESULTS OBTAINED.

Huther Bros. Saw Mfg. Co.

ROCHESTER, N. Y., U. S. A.

Evans Friction Cone Pulleys

VARIABLE SPEED COUNTERSHAFTS



Will drive your machine at any desired speed from 1 to 6. Over ten thousand sets in operation in this country and Europe. Send for catalog.

G. F. Evans, Newton Center, Mass.

SHAPERS

14-inch to 32-inch Stroke.

Crank and Triple Geared.

John Steptoe Shaper Company, Cincinnati, Ohio.

OUR SPECIALTY,

Automatic Machinery for making **Wood Screws,**

Asa S. Cook Co., HARTFORD, CONN., U. S. A.

AIR FURNACE IRON OR ACID OPEN HEARTH STEEL

Castings up to 100 Tons in One Piece Our Specialty

CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa., U. S. A.

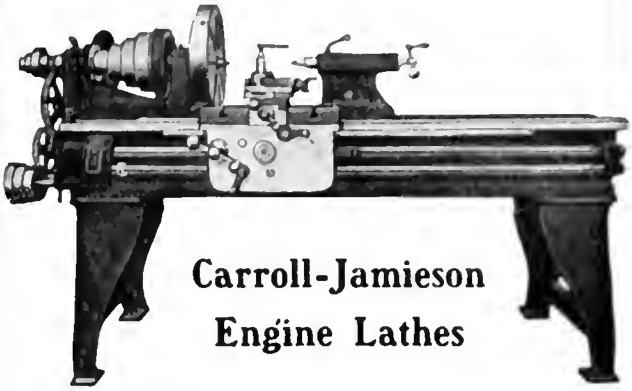
New Haven Tools

10-Inch Back Geared Slotter

This machine is well designed, convenient to operate and is adapted for a wide range of work. The very powerful back gears and extra large driving pulleys together give four changes of speed. Table has automatic power feed in all directions. Cutter bar has a stroke of 10 inches, is easily adjusted and has "Whitworth" quick-return motion. *Special Circular on request.*

New Haven Manufacturing Company
NEW HAVEN, CONN.

14-inch Lathes Exclusively



Carroll-Jamieson
Engine Lathes

are especially adapted to meet the the demands of jobbing and repair shops and manufacturers. They are accurately and substantially built, modern in every particular. Positive feed, as well as belt feed reverse in the apron, and will cut right or left hand threads. Cross feed is automatic and graduated.

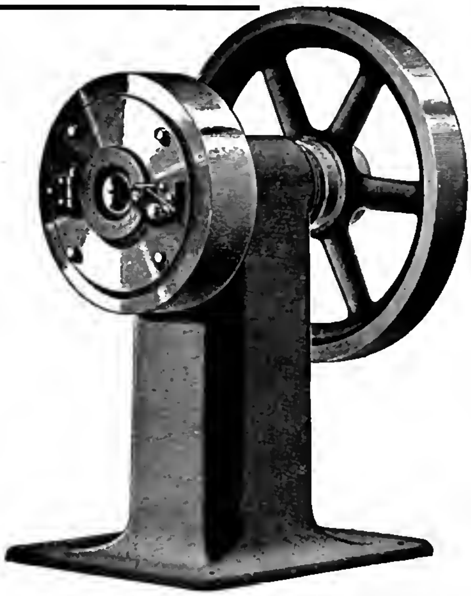
Ask for Circular of our
new Quick Change Lathe.

Carroll-Jamieson Machine Tool Co.
BATAVIA, OHIO

2000 to 6000 Blows Every Minute

Are struck by a

Dayton Swaging Machine



giving a reduction by pressure—not by blows.

The result is a steady flow of metal, allowing a readjustment of the molecules, preventing all warping, straining, unevenness, and all with no waste of material such as follows reduction by grinding, milling, or by other methods, and the finished pieces more nearly uniform.

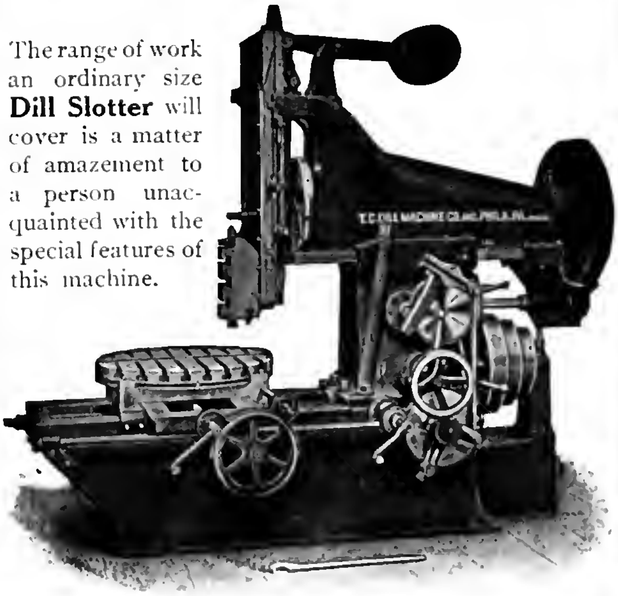
Get our book "The Modern Art of Swaging."

THE EXCELSIOR NEEDLE CO.
TORRINGTON, CONN.

Coventry Swaging Co , Ltd , White Friars Lane, Coventry, England, Agents for Great Britain. Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

The All Embracing Dill

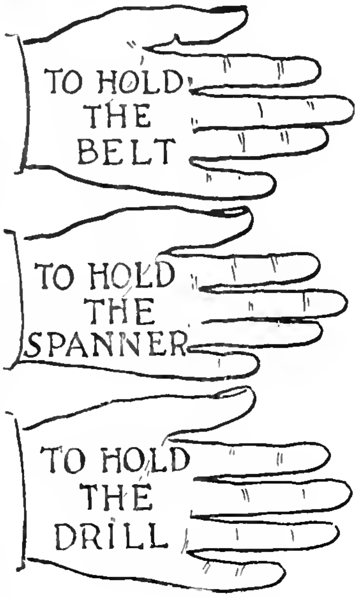
The range of work an ordinary size **Dill Slotter** will cover is a matter of amazement to a person unacquainted with the special features of this machine.



But a little consideration of the traveling head, quick traverse gear, new quick return, automatic knock-off, hand wheel controller, new intermittent feed and other exclusive Dill points, soon shows the reason and explains why it is the most economical tool of its class you can have in your shop.

THE DILL SLOTTER PEOPLE
Kensington, Philadelphia, Pa.

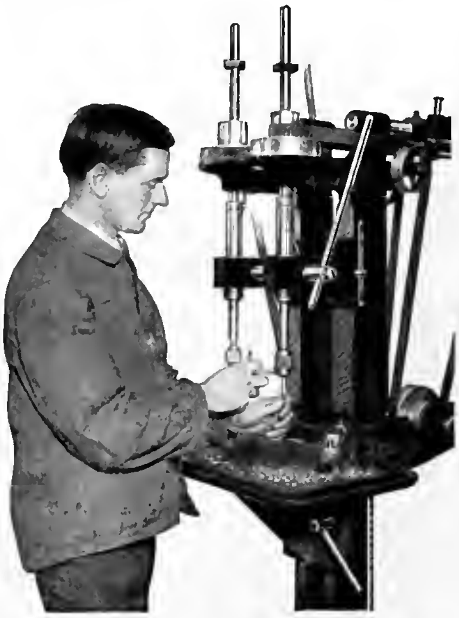
It Used to be Hard for Three Hands But Now It's Easy for Two



THE OLD WAY

The Jacobs Improved Drill Chuck besides being the most convenient of all chucks to operate is the most secure in its hold on the drill, the most durable under trying conditions of service and by far the most economical in final cost.

Write for our New Catalog.

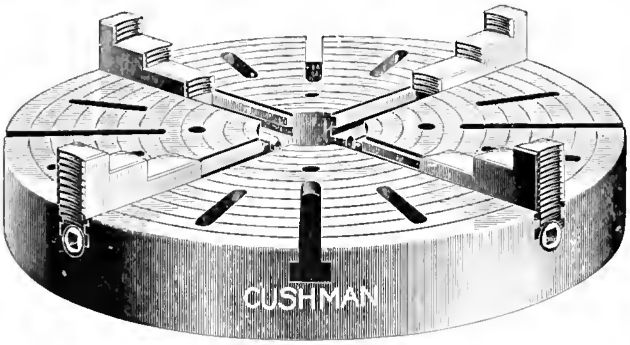


THE NEW WAY

THE JACOBS MANUFACTURING CO.

HARTFORD, CONN., U. S. A.

"CUSHMAN" CHUCKS



Lathe Chucks; heavy pattern for hard service.

Face Plate Jaws; for large machines.

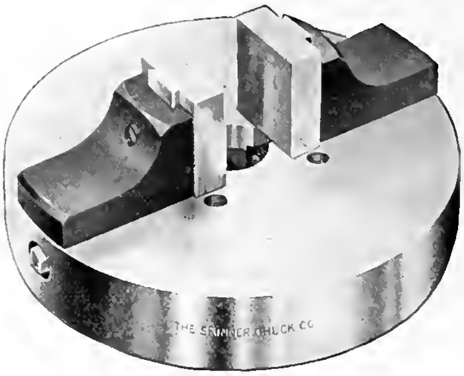
Also Drill Chucks.

Let us send you our catalogue and price list.

The Cushman Chuck Co.

179 Allyn St., Hartford, Conn.

Odd Shaped Pieces

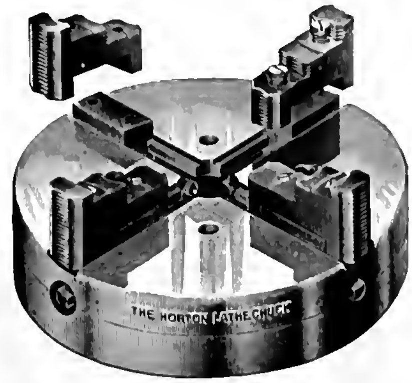


How do you grip them? Do you get a firm bearing all around while they are being machined? If you would use a Skinner Two Jaw Chuck, Style "G", you could machine the steel slip jaws to bear on your work all around. Additional slips for additional pieces and only one chuck, as the slips are interchangeable. This is the chuck we recommend for brass workers for holding delicate pieces which would be crushed if gripped at points only. Jaw screws arranged to prevent clogging by chips.

The Skinner Chuck Co.

94 Reade St. NEW YORK CITY	94 N. Stanley St. NEW BRITAIN, CONN.

HORTON COMBINATION CHUCK



Horton Chucks have had an enviable **reputation** for more than **fifty** years. They are durable, accurate, reliable. They are in use in all parts of the **world** where machine tools are used.

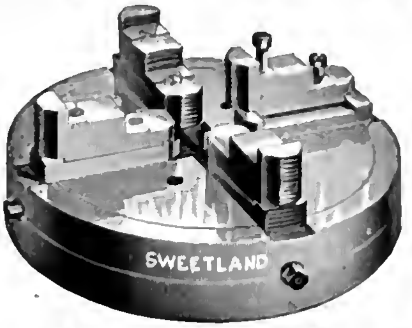
Chucks for Lathes, Drill Presses, Milling Machines, Cutting-off Machines, etc.

Shall we mail Catalogue?

The E. Horton & Son Co., Windsor Locks, Conn., U.S.A.

Or Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Glasgow. Schuchardt & Schutte, Berlin, Cologne, Vienna, Stockholm, St. Petersburg and New York. Fenwick Freres & Co., Paris, France. Van Reitschoten & Houwens, Rotterdam, Holland.

Sweetland Chucks



Sweetland Chuck No. 4, with Reversible Jaws

Adapted for a wide range of work. Screw relieved of all strain; all the advantages of a solid jaw. Accurate, simple, strong and durable.

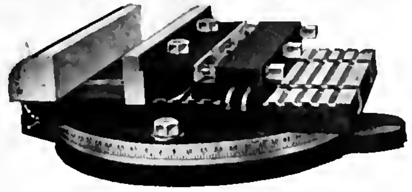
Catalogue on request

The Hoggson & Pettis Mfg. Co.
103 Chambers St., New York. NEW HAVEN, CONN.

UNION PLANER CHUCKS

ROUND BASE AND SQUARE BASE

Made in Eight Sizes.



No. 76—Round Base

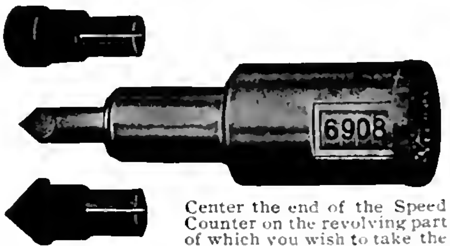
All Thrust Plates Hardened. Screws made of Tool Steel.

UNION MANUFACTURING COMPANY
26 Cortlandt St., New York **New Britain, Conn., U. S. A.**

WATCH the WATCH

That is all you have to do when using a

Veeder Speed Counter



Center the end of the Speed Counter on the revolving part of which you wish to take the speed, let it run idle until the second hand comes to the point from which you wish to start to take the reading Then press the counter, which throws the clutch, and let it remain until the minute is up. Then read the counter and the trick is done.

Simple operation, isn't it?

You would think so if you used one.

The instrument is ball bearing and very durable.

Price, complete—$3.00.

Send for further information.

THE VEEDER MFG. CO.
39 Sargeant St., Hartford, Conn.

Makers of Cyclometers, Odometers, Tachometers, Tachodometers, Counters and Die Castings.

SAVE THE DRILLS

the operator's time and insure accurate work by using

Russell Anti-Friction Drill Chucks

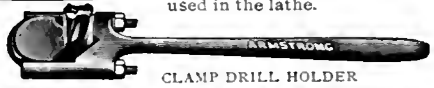
The "Russell" is self-tightening, automatic, will not slip under any stress—requires no key, wrench or spanner for adjustment, and incidentally is the only successful drill chuck for automatic machines. Jaws are interchangeable also. Catalogue?

RUSSELL ANTI-FRICTION DRILL CHUCK CO.
ELMIRA, N. Y., U. S. A.

Distributing Agents for Canada: The General Supply Company of Canada, Ltd., Ottawa.

Save Your Drills

and Reamers from being broken and torn when used in the lathe.



CLAMP DRILL HOLDER

For Straight Shank Tools
Patented Apr. 18, 1898

MORSE TAPER DRILL HOLDER

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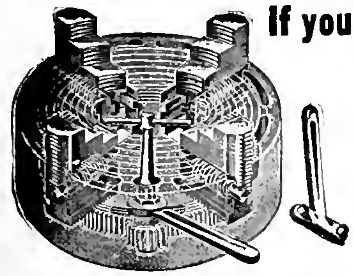
ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
113 N. Francisco Ave., CHICAGO, U. S. A.
SEE OUR TOOL HOLDER AD. PAGE 117

If you want the best Lathe or Drill Chucks—buy Westcott's

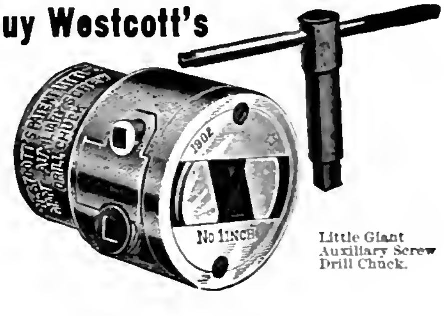


Spur Geared Scroll Combination Lathe Chuck.

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

Strongest Grip, Greatest Capacity,
Great Durability, Accurate.

WESTCOTT CHUCK CO., Oneida, N. Y., U. S. A.
Ask for catalogue in English, French, Spanish or German.



Little Giant Auxiliary Screw Drill Chuck.

THESE MAGIC CHUCKS AND COLLETS CHANGE YOUR SINGLE SPINDLE DRILL INTO A MULTIPLE SPINDLE DRILL PRESS

Their cost is but a trifle while the advantages resulting from their use are almost incalculable.

With them you are able to use as many tools as you may have operations in your piece of work.

They certainly merit an investigation.

MODERN TOOL COMPANY, ERIE, PA., U. S. A.

Also manufacturers of Self-Opening Die Heads, Solid Dies, Tap and Die Holders, and Tapping Attachments for Drill Presses.

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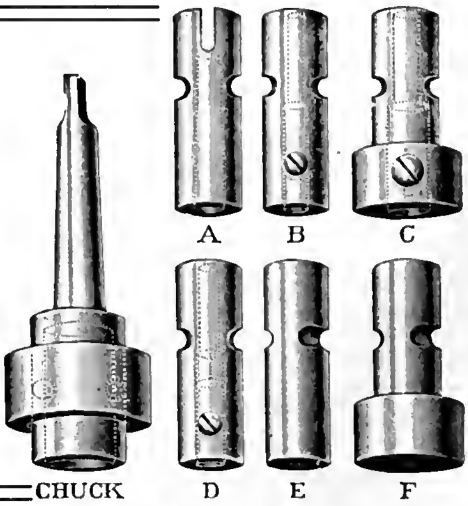
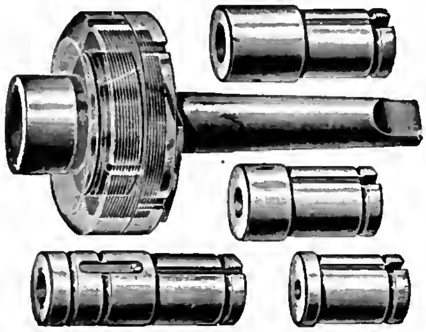




THE

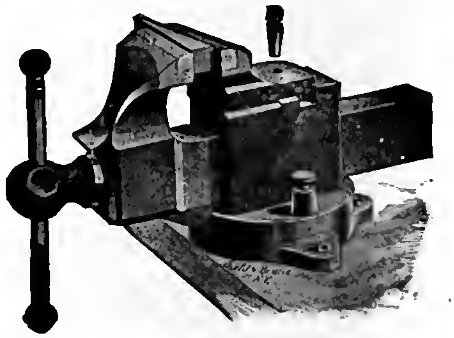
Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction, and is

UNEQUALLED in Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

Nothing to Break or get out of Order. Made in 4 sizes, covering from 0 to 2¼ in. diameter.

The Beaman & Smith Co., Providence, R. I., U. S. A.



Machinists' Swivel Vise

with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list.

Prentiss Vise Company
44 Barclay Street, New York

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THE REED GUARANTEE

is for LIFE. Any

REED VISE

which does not give absolute satisfaction will be replaced, or your money refunded. Can you think of a fairer proposition?

Catalogue H for the asking.

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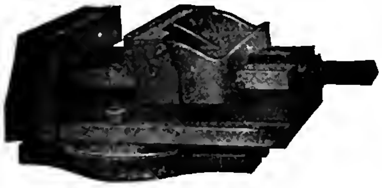


Plunket Improved Vises

Made with Plain or Swivel Base

Specially adapted for the hard service of the machine shop. Can be used with every style drill-press, shaper and milling machine. Strongest construction, steel screw, steel faces to jaw, cast steel handle. Write for further information.

J. E. PLUNKET, Chicago. Ill.
444 West Lake Street.

DRILL VISES AND DRILL SPEEDER

KNURL HOLDER FOR TURRETS

THE GRAHAM MFG. CO., Providence, R. I.

WROUGHT STEEL BAR COMBINATION BASE

MERRILL BROS., MASPETH, NEW YORK, N. Y.

"REECE"

DIE

WE WANT 1 8 REECE 7 4 YOUR ORDERS

FOR THE GENUINE

Reece Screw Plates, Stocks and Dies

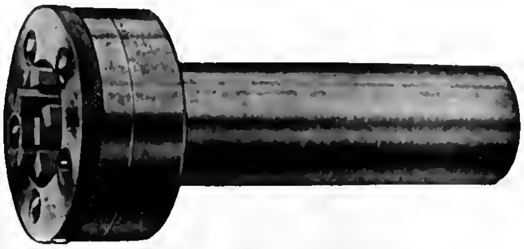
Hercules Taps, Tap Wrenches, Counterbores, Reamers, Etc.

Send us your orders or inquiries and we will give you prompt and satisfactory service.

E. F. REECE COMPANY, Greenfield, Mass., U. S. A.

NEW YORK OFFICE, 101 Reade Street. LONDON OFFICE, 13-15 Wilson Street, E. C.

One Reason for the Popularity of the Adjustable Hollow Milling Tool is that no other device can so rapidly produce Accurate, Uniform Diameters.



Adjustable Hollow Milling Tool

It is a tool designed for use on screw machines, hand turret lathes, or it may be rotated in any way required. It can be quickly set to any diameter within its capacity by means of the index, and as quickly changed from one diameter to another; will reduce work of any length and will mill close to a shoulder.

Simple in construction, strong, calculated to stand rough usage and made in various sizes.

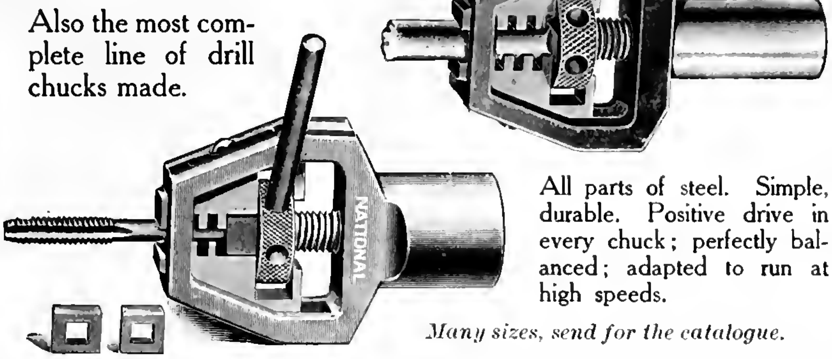
Write for Catalogue of time saving tools.

THE GEOMETRIC TOOL COMPANY WESTVILLE STATION NEW HAVEN, CONN., U.S.A.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Schuchardt & Schutte, Vienna, St. Petersburg, Stockholm, Berlin.

The Most Powerful Drill Chucks are the "NATIONAL"

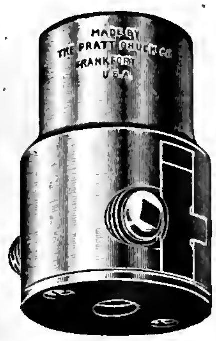
Also the most complete line of drill chucks made.



All parts of steel. Simple, durable. Positive drive in every chuck; perfectly balanced; adapted to run at high speeds.

Many sizes, send for the catalogue.

Oneida National Chuck Co., Oneida, N. Y.



Well Begun is Half Done

If it's a job of drilling on hand, begin it right—secure the drill with a

PRATT CHUCK

and you can count on a satisfactory finish.

There's never a slip in the Pratt Chuck grip, it holds the tool easily but firmly; it is simple, convenient, durable and especially well adapted for high speed drilling.

Ask for the book and then ask your dealer for a Chuck.

THE PRATT CHUCK CO., Frankfort, N. Y.

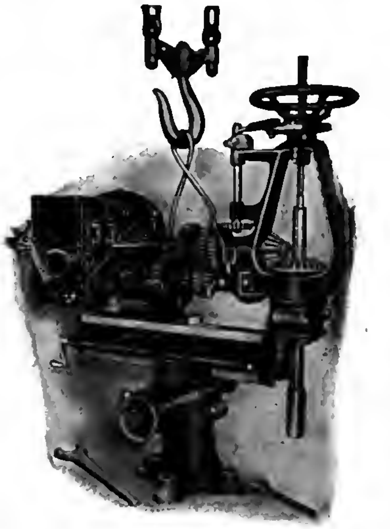
EUROPEAN AGENTS: Selig, Sonnenthal & Co., 85 Queen Victoria St., London, Eng.

Almond Inclosed Pinion Drill Chuck

With pinion and gear teeth always in perfect mesh there is practically no opportunity for wear.

T. R. ALMOND MFG. CO.
ASHBURNHAM, MASS.
NEW YORK CITY, 40 Murray St.

"Dallett" Motor-Driven Portable Drills



For Drilling in Every Position; Portable, Standard and Radial Drill in one.

THREE SIZES:—
No. 1—Weight 225 lbs.
No. 4—Weight 720 lbs.
No. 5—Weight 1300 lbs.

Write for Bulletins.

Thos. H. Dallett Co.
23d and York Sts., PHILADELPHIA, PA.

HAND MILLING MACHINE

Adapted for small and duplicate work, built from best materials and with unusual weight and rigidity for its size. Table has long bearings, adjustments can be made without wrenches or other tools and machine is fitted with draw-in spindle and collet or chuck for arbors or end mills.

First class in every particular—send for circular.

DALIN BROS., Rockford, Ill.

BARGAINS NEW AND SECOND HAND MACHINERY TOOLS AND SUPPLIES

Second-Hand Machine Tools

Located at Boston, Chicago & New York.

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7"x32" P. & W. Plain.
12"x5' R. F. LeBlond.
16"x6' R. F. Flather.
16"x6' C. R. Flather.
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16"x6' C. R. Putnam motor drive.
16"x8' Taper, Reed.
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18"x10' Geared Hd. Draper.
22"x16' Shafting. Lathe, Fitchburg.
24"x8' C. R. Putnam, not screw cutting.
24"x12' C. R. Putnam motor drive.
28"x15' C. R. Blaisdell raising blocks to 36".
30"x12' C. R. and Taper, Johnson Trl Gd.
30"x30' geared hd. Lodge & Shipley.
48"x10' Plain Engine Lathe.
50"x30' C. R. Pond Trl. Gd.
13" Gisholt Turret Lathe.
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MILLING MACHINES.

No. 00 Bench, P. & W.
Brainard Index Miller.
No. 0 Plain.
No. 2 Plain Garvin.
No. 3 Plain Garvin.
No. 4½ Plain Becker.
No. 4 Plain B. & S. Old style.
No. 1 Universal LeBlond.
No. 4 Universal B. & S. Old style.
No. 2 Lincoln, P. & W.
No. 5 Vertical, Becker.
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RAILROAD MACHINERY.

Bement Single Axle Lathe.
Bement Double Axle Lathe.
No. 2 Niles Double Axle Lathe, belt or motor.
No. 3 Putnam extra heavy Axle Lathe.
36" Baker Car Wheel Borer.
300 ton 48" Niles Wheel Press.

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12" Crank, Springfield.
15" Friction, Hendey.
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17"x17"x4' Whitcomb Planer.
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30"x30"x24' 2 hds., Sellers.
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72"x72"x24' 3 hds., Bement.
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34" Colburn Turret Borer.
36" B. & S. Turret Borer.
37" Vertical 2 hds., Bullard.
21' Vertical 3 hds., Pond, motor.
96" Swing Special Hor. Bor. Mill.

TURRET MACHINERY.

No. 00 Automatic, slotting attachment, Brown & Sharpe.
¼" No. 00 Garvin Wire Feed.
½" No. 1 P. & W. Wire Feed.
⅝" No. 2 P. & W. Wire Feed.
1—¾" No. 3 B. & O. Wire Feed, Gd. Hd.
2" No. 3 P. & W. Wire Feed, Gd. Hd.
¼" No. 0 Hartford Automatic Pin Machine.
¼" Cleveland Automatic Pin Machine.
¼" No. 00 Hartford P. & W. Auto. Pin Machine.
5/16" No. 0 P. & W. 2-sp. Auto. Pin Machine.
⅜" No. 1 Acme old style 4-sp. Auto. Pin Machine.
21/32" No. 2 old style B. & S. Auto. Pin Machine.
½" No. 1 P. & W. 2-sp. Auto.
½" No. 1 Spencer, Single Turret.
½" No. 1 Spencer, Double Turret.
¾" No. 2 P. & W. Automatic.
1" No. 2 Hartford Automatic.
1—¾" No. 3-A. P. & W. Automatic.

MISCELLANEOUS.

30" Draw-stroke Slotter, Baker Bros.
No. 6 Bulldozer, Williams-White.
No. 2 Cutter Grinder, B. & S.
5' 6" Radial Drill, Niles.
Single Spindle Drills.
Multiple Spindle Drills.
14' Arm Cleveland Wall Radial Drill.
¼" capacity 10-sp. Adjustable Drill.
1—½" capacity 10-sp. Adjustable Drill.

Send for New List No. 16.

Miscellaneous Department.

Niles-Bement-Pond Company,
111 BROADWAY, NEW YORK.

MACHINE TOOLS

Condition Guaranteed.
Send for Yellow List No. 101.

LATHES

81"x40' Putnam, Rod Feed.
39"x16' New Haven.
27"x20' Bement.
3-40"x18' Compound Triple Geared Engine Lathes.
40"x22½' Pond.
36"x12' Putnam.
28"x20' Pond.
12"x6' Hendey Tool Room Lathe.
14"x6' Hendey Tool Room Lathe.

PLANERS

84"x84"x27' Lowell, 2 Heads.
84"x84"x24' Putnam, 1 Head.
36"x14' Detrick & Harvey Open Side, 3 Heads.
36"x36"x17' Sellers.

HAMMERS

250 lb. Morgan Single Frame Steam Hammer.
1000 Chambersburg Steam Drop.
800 lb. Pratt & Whitney Board Drop.

SHAPERS

16" Ohio.
20"x30" Pedrick & Ayer Open Side Shaper.
18" Ohio Crank.
16" Back Geared Cincinnati.

SPECIAL

30" Bullard Turret Head Boring Mill.
No. 2 Becker-Brainard Plain Miller with Vertical Attachment.
1—No. 2 Brown & Sharpe Universal Miller with vertical attachment.
1—No. 2 Owen Plain Miller.
1—36"x14' Detrick & Harvey Open Side Planer, 3 Heads.
3—24" Swing Potter & Johnston Turret Lathes.
1—6" Eaton, Cole & Burnham Pipe Machine.

Full stock of smaller tools for the ordinary machine shop always on hand.

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Who can furnish us Round Screw Cylinders and Knot Catchers for raw and felt Cardboard Machines (wool paper)?

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10 ft. wide by 30 ft. long, good as new.
50" Boring Mill, good as new. Bargain.
200 lb. Bradley Hammer.
150 lb. Beaudry Hammer.
Large Duplex Multiple Flange Drill, 16 spindles on each end.
Many other second-hand machine tools.

T. Crowther & Co., Boston, Mass.

We have got the Tools got to sell them going to sell them at prices that will

We haven't allowed an "old Tool" to escape our notice and get in—

LATHES—Triple-geared

60"x36' Bement.
54"x24' Worcester.
52"x18' Fifield.
48"x17' Putnam.
39"x16' Putnam.
38"x12' Gleason.
36"x20' Pond.
36"x14' Fitchburg.
32"x12' Fifield.
30"x16' Fitchburg.
28"x14' Harrington.

LATHES—Back-geared

28"x16' Fay & Scott.
26"x18' Putnam.
26"x12' Bogert.
24"x12' Sellers, ex. heavy.
24"x12' Taper, Fitchburg.
22"x8' heavy, Pond.
18-16-14-13 in. Draper, American, Pratt & Whitney, Young.

PLANERS

54"x16' Sellers, 4 hds.
50"x16' Bement, 2 hds.
48"x16' Gray, 4 hds.
42"x12' Whitcomb, 3 hds.
36"x10' Putnam, 1 hd.
32"x10' Pond, 2 hds.
30"x12' Newark, 1 hd.
30"x8' Putnam, 1 hd.
24"x6' Pond, 1 hd.

BORING MACHINES

37" Double hd., Niles.
30" Turret head, Bullard.
72" Double head, Niles.
3¾" bar Hor. Bor. & Dr. Machine, Bement.
60" Upright Pulley Borer, Niles.

TURRET MACHINERY

27" Semi-automatic American.
2x24" Flat Turret, Jones & Lamson.
2¼" Wire feed, Pratt & Whitney.

GEAR CUTTING MACHINERY

60" Spur, full automatic, Brown & Sharpe.
36" Spur, full auto., Gould & Eber.
22" Spur, full auto., Gould & Eber.
18" Spur, heavy, Brown & Sharpe.

MISCELLANEOUS

120" Radial Drill, Box table, Prentice.
84" Radial, Niles.
Knee type Milling Machine, large size, Pedrick & Ayer.
Univ. No. 4 Milling Machine, Kempsmith.
Plain No. 2 Milling Machine, Cincinnati.
Universal Grinder, capacity 12"x40". Brown & Sharpe.
Slotter, 12" stroke, Niles.
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Steam Hammer, 250 lbs. Bement-Miles.
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Punch 50" Throat, wt. 33,000 lbs.
10' Bending Rolls, Hinged Housing.
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1—37" Bridgeport, one head.

CENTERING MACHINE.

1—5" D. E. Whiton, 2-spindle.

DRILL PRESSES.

1—Dallett Portable.
1—6-spindle Quint turret 22" Barnes drill.
1—33" Bement-Miles.

DRILL PRESSES--RADIAL.

2—36" Dresea Plain Radials.

GEAR CUTTERS.

1—Grant Lees Hobbing Machine.
1—36"x9"x4-p Gould & Eberhardt.
1—36"x9"x5-p Gould & Eberhardt.
1—48"x10"x3-p Gould & Eberhardt.
2—50"x11"x3-p Gould & Eberhardt.

GRINDERS.

1—BTA Heald American Drill.
1—"A" Yankee Drill Grinder.
1—"PO" Yankee Drill Grinder.
2—Leland & Faulconer wet.

HAMMERS.

1—60-lb. Bradley, cushion helve.

LATHES.

1—14"x5' Windsor, friction countershaft.
1—14"x6' LeBlond, quick change gear.
1—14"x8' Flather.

LATHES.

1—16"x6' Reed, belt feed, plain rest.
1—16"x6' Lodge & Shipley, quick change gear.
1—18"x6' Lodge & Shipley, quick change gear.
2—20"x8' Flather, compound rest.
1—22"x10' Lodge & Shipley, quick change gear.
2—22"x12' Lodge & Shipley, quick change gear.
1—22"x12' Walcott.
1—24"x10' Lodge & Barker.
1—24"x12' Lodge & Shipley, quick change gear.
1—24"x16' Lodge & Shipley, quick change gear.
1—26"x12' Reed.
1—27"x14' Lodge & Shipley, quick change gear.

LATHES--POLISHING.

1—No. 3 Diamond, 52x1¼ spindle.
1—No. 7G Diamond, 46x1¼ spindle.

MILLING MACHINES.

1—No. 3 Cincinnati, plain all feeds.

PLANERS.

1—10" Bush Crank.
1—20"x20"x4' Wheeler, 1 head.
1—33"x33"x8' Cincinnati, 2 hds.
1—36"x36"x8' Cincinnati, 2 hds.
1—36"x36"x8' Cincinnati, 2 hds., variable speed box.

PLANERS.

1—36"x36"x8' Detrick & Harvey, 3 heads, supplemental rolling table.
1—36"x36"x10' Gray, 1 head.
1—42"x36"x8' Cincinnati, 2 hds.
1—42"x36"x14' Cincinnati, 2 hds.

PRESSES.

2—No. 20 Bliss.
1—No. 62 Toledo.
1—No. 8 Greenerd arbor.

PUNCH AND SHEAR.

1—No 13 Williama & White single end.

SAWS.

1—3½" Burr.
1—6" Newton.
1—Millers-Falls Hack.
1—26" Crescent hand.

SHAPERS.

1—14" Lodge & Davis.
1—16" Gould & Eberhardt.
1—18" Steptoe.
1—20" Hendey.
1—24" Gould & Eberhardt.
1—24" Potter & Johnston.
1—26" Cincinnati, triple geared.
1—28" Hendey.
1—32" Gould & Eberhardt.
1—34" Walcott, shifting belt.

TURRET LATHES.

1—No. 5 Warner & Swasey.
1—26" Universal, chuck fitted.

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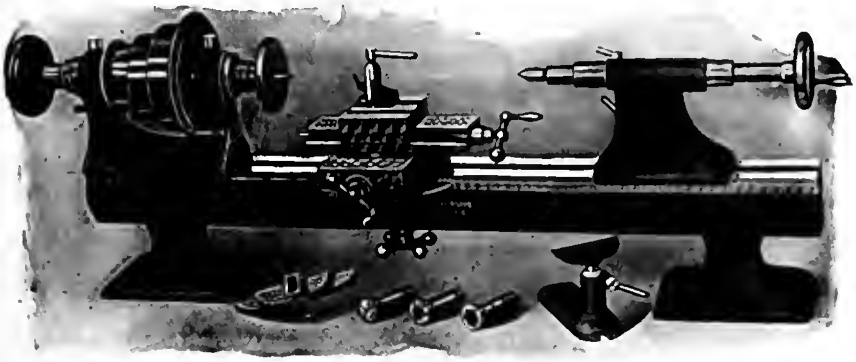

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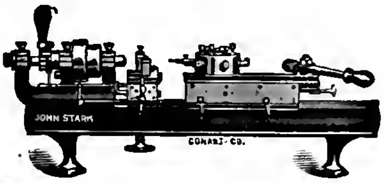

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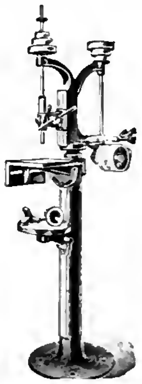

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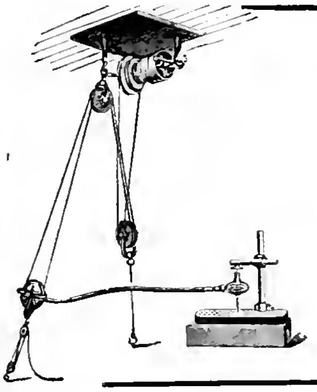

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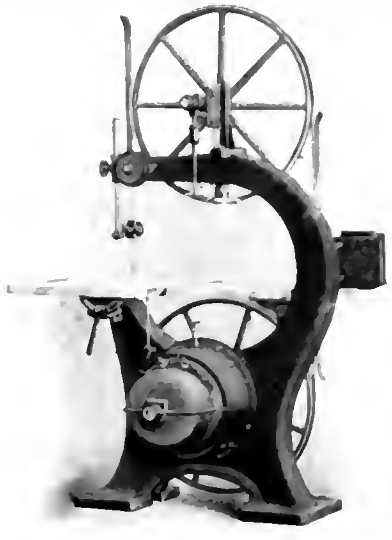

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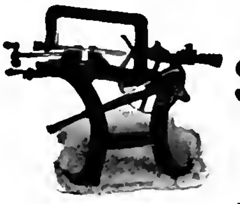

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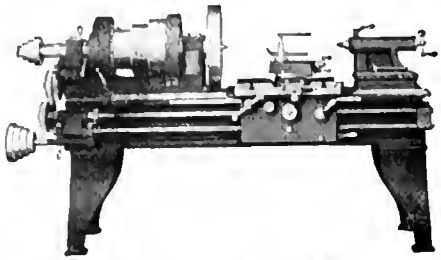

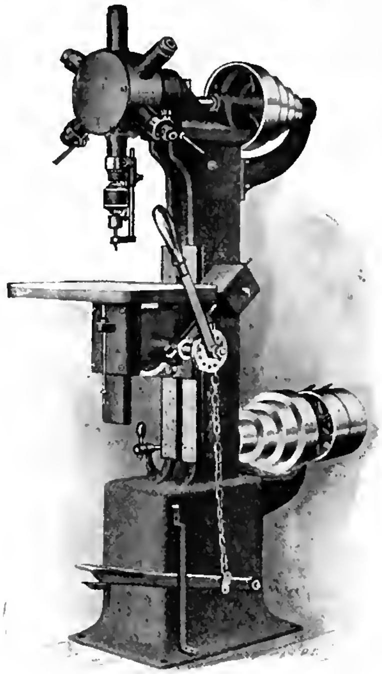

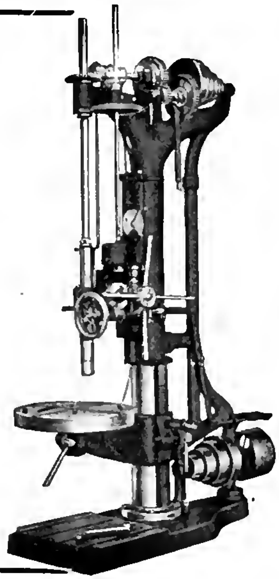

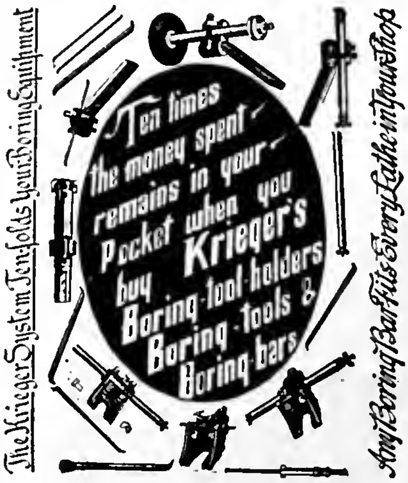
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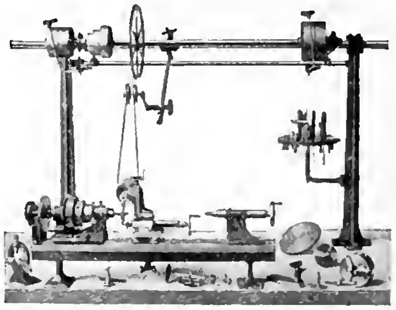

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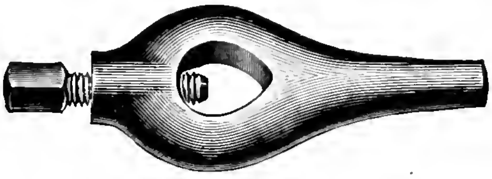

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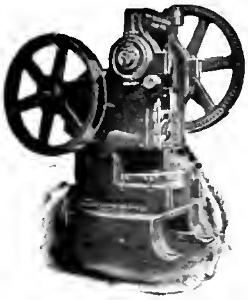

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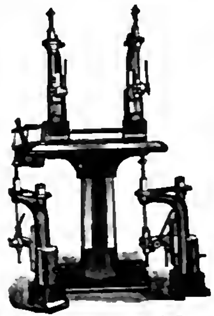

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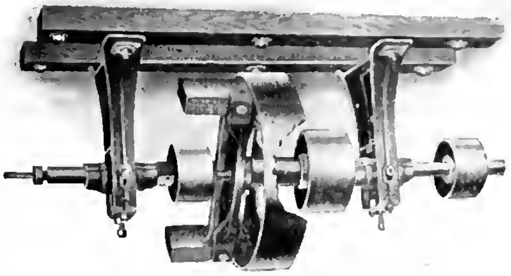
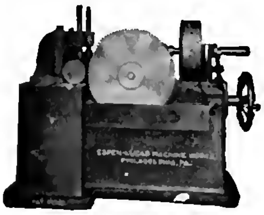
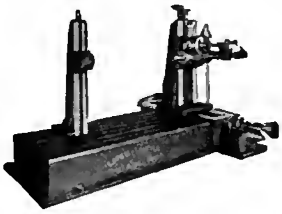


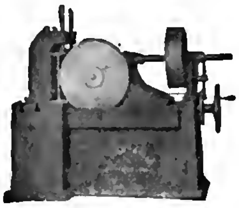
Variable Speed Clutch Co., Milwaukee, Wis.



No. 7 Bar Cold Saw



No. 2 Horizontal Floor Boring Milling and Drilling Machine.



PATENTS PENDING
No. 2 I-Beam Cold Saw

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ESPEN-LUCAS MACHINE WORKS

Broad and Noble Sts., PHILADELPHIA, PA.

COUNTERS

Did you ever stop to think that it costs money to count the number of pieces made, not to speak of what mistakes cost?

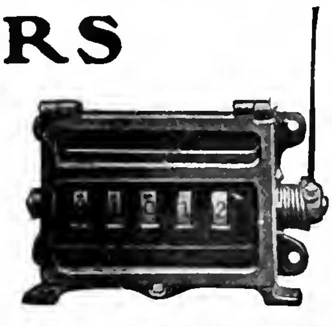
Our No. 4207 Counter costs $5.00 and the cost stops there. It doesn't make mistakes.

Size 5¾ in. x 4¾ in. x 2½ in. Weight 4¾ lbs.

It is a check on inaccuracy—not on dishonesty. Can be attached to presses (both printing and punch) and all automatic machinery.

No key required for resetting for each run.

Figures large—black enamelled—easily read.



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11 Wooster Street **New York City, N. Y.**

Finished Machine Keys

Cheaper than you can make them. **Finished "Ready to Drive."**

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All sizes carried in stock
Write for discounts.

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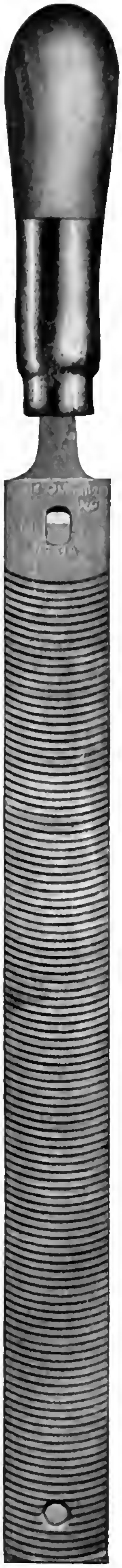

This is the Famous "VIXEN" Patent HAND MILLING TOOL

The way that the **"VIXEN"** Milling TOOL behaves, when dealing with that prince of file discouragers, PHOSPHOR-BRONZE, is enough single handed to render that tool famous.

Is it—content to simply glide over its Slick—almost greasy surface—with a scarcely perceptible—little scrape—file fashion. Eh? No! my friend, quite otherwise. It "sails"—into that discouraging metal and shreds off chips of it after a fashion that must be as much of a shock to the BRONZE as of a pleasure to the **"VIXEN"** PUSHER—With ALUMINUM it is precisely the same story of clean cut versus "Scrape."—and so too with Copper, a well-known "doer up" of ambitious files. Any man who uses FILES to cut anything "filable" would be wise to "get next" to a **"VIXEN"** MILLING TOOL as soon as may be if only to watch IT CUT DOWN HIS FILING—COSTS—!

"VIXEN" AGENTS—are all over the continent——Shall we send you the name of the one nearest YOU?

For soft metals, wood, etc., use coarse-cut **"VIXEN"** For harder materials use fine-cut ones.

Manufactured by

NATIONAL FILE AND TOOL CO.

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No. 1.

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Gear Wheels and Gear Cutting

of every size and kind on hand and to order. Facilities complete.

Grant's Treatise on Gears
One dollar—worth ten.

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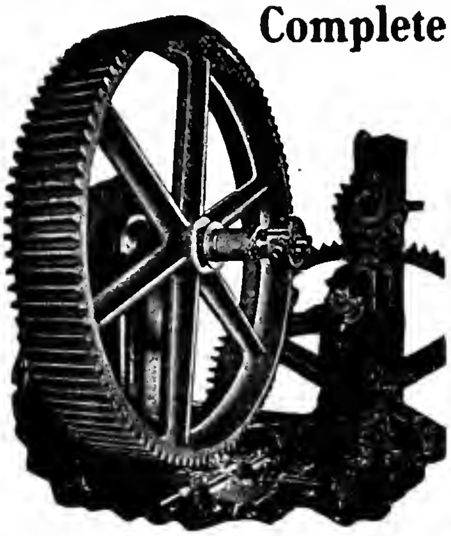

We have a large capacity and range of tools. Our prices are low and deliveries prompt. Bevel and mitre gears planed.

Our catalogue sent to any firm on request. The most valuable book on gearing published.

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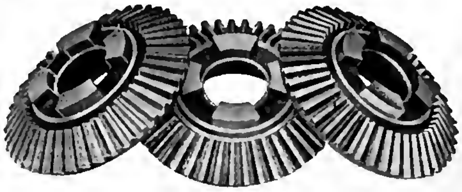

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Gear—75" diameter, 3" pitch, 19" face.

Pinion—19" diameter, 3" pitch, 19" face.

We make a specialty of heavy gearing and can show some very unusual achievements. Figures submitted for large or small gears.

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Gears and Gear Cutting

Spur, Bevel, Mitre, Worm and Spiral Gears—

"MECHANICALLY CORRECT"

We have special facilities for "break-down" jobs and can handle orders of all kinds with dispatch. Let us figure on your work.

THE VAN DORN & DUTTON CO.

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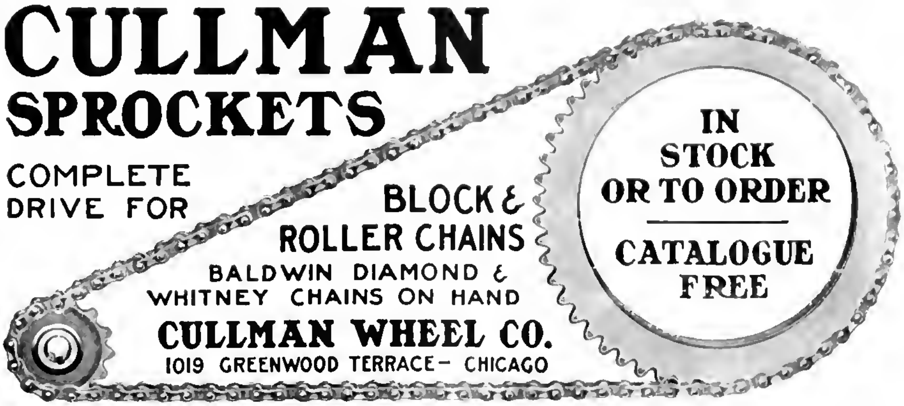


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Non-overfilling Factory Dispenser
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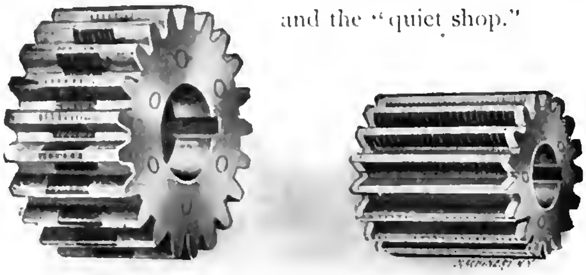
QURIDE

The Quiet Shop

has the endorsement of master and men—no division of opinion, the vote is unanimous for

Peerless Rawhide Pinions

and the "quiet shop."



PEERLESS RAWHIDE PINIONS are noiseless, durable, smooth running, adapted for light or heavy work and are specified where efficiency from every point is considered.

We also make Cut Metal Gears of all descriptions.

Send for Blue Book on Gearing.

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GEAR CUTTING MACHINE CO.

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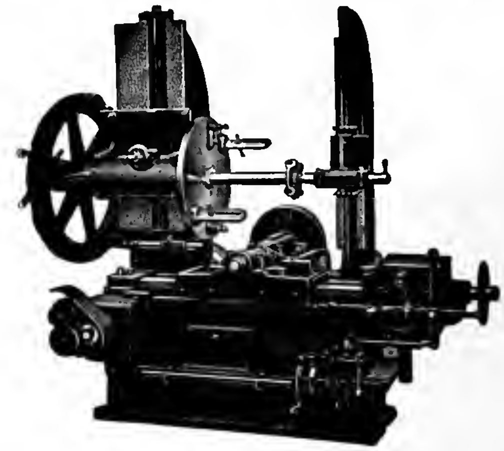


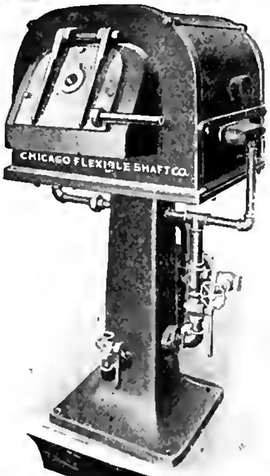
AUTOMATIC GEAR CUTTING MACHINES

FOR ALL REQUIREMENTS

66 Union St., NEWARK, N. J., U. S. A.

The Sure Way to Heat Tools

Use the STEWART Gas Blast Furnace



There is no risk of spoiled tools—no risk of breakage—no wasted time—if you heat tools in a Stewart Furnace.

Fine Steel Tools, Machine Parts, Dies, Milling Cutters, Cutlery, Springs, Reamers, etc., are probably some of the items you heat. Will you investigate this process that insures better results at a lower cost than ordinarily?

We furnish the Stewart Gas Blast Furnace in 55 different styles and sizes. Write us particulars about your individual requirements.

CHICAGO FLEXIBLE SHAFT CO.,
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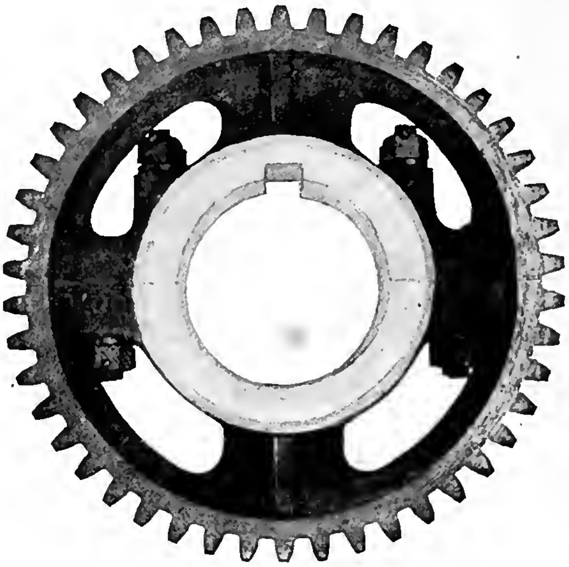
Foreign Agencies—Chicago Flexible Shaft Co., 11 Denmark St., Charing Cross Road, London, W. C. Fenwick Freres, 21 Rue Martel, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

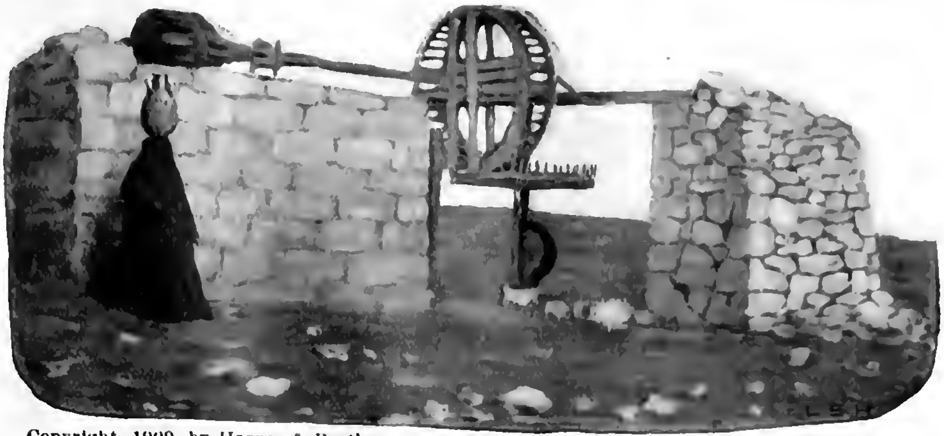


Have you gear troubles?

A standard remedy is to use only Nuttall cut or planed gears. They cost no more than others, but—save trouble and expense.

Nuttall—Pittsburg

If in a hurry, wire us



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Abraham's Well

The theory and principles of gear driving were no doubt understood by the ancients, but from the old well to the modern pump a constant development has taken place—resulting today in the high duty Triplex Pump, gear driven through Hindley worm by electric motor.

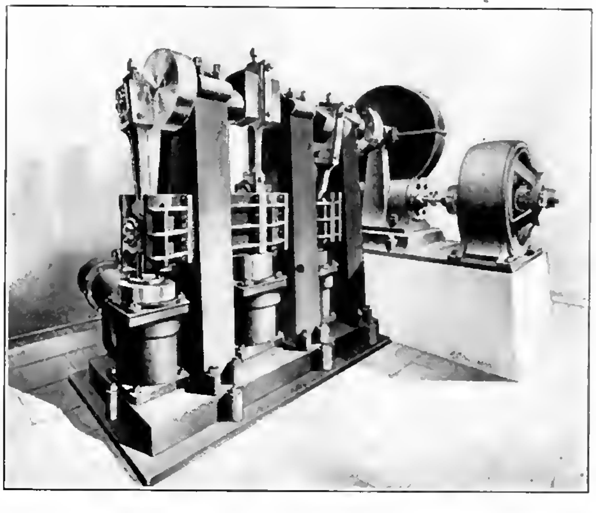
Not only in pumps but all classes of machinery **HINDLEY** Gearing has done its part toward this development.

Morse, Williams & Company

PHILADELPHIA, PA.

Gear Designing and Cutting for the Development of American Machinery.

Hindley Worm-Driven



Triplex Pump

SPIRAL GEARS AND HELICAL GEARS WITH GENERATED TEETH

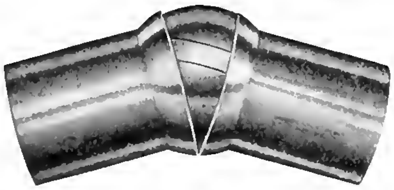
We have four Gould & Eberhardt hobbing machines for generating accurate teeth in spiral and helical gears and are in position to furnish these of any material and in any quantity required. If you are using anything in this line, send us your blue prints for estimate. We can doubtless save you money and give you better gears than you are now getting.

The New Process Raw Hide Co.
SYRACUSE, NEW YORK

BOSTON ALL STEEL GEARS

Have the advantage of uniformity of pitch, face, hole and hub and can be duplicated at any time.

The superiority of the material used in Boston Gears is one of our special claims—they will outwear cast iron, rawhide or fibre and are particularly adapted for high speed machinery.



Our New Solid Ball Universal Joint

meets general requirements. Is the strongest joint on the market—simple, compact, dust-proof and oil-retaining at all reasonable speeds.

1909 Catalog contains much useful information and is sent free on request.

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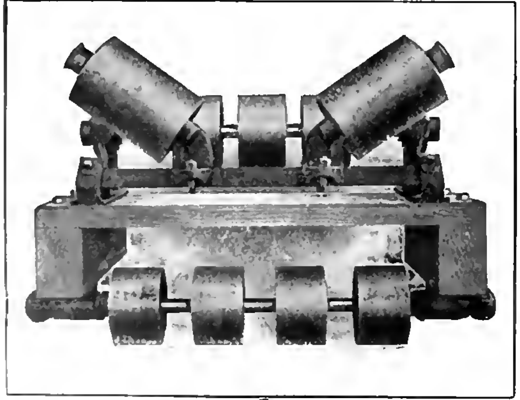


Improved Belt Conveyers

We manufacture Improved Belt Conveyers of several styles, troughing the belt or running it flat, as conditions may warrant. These conveyers are economical of power, simple in design, capable of running 24 hours per day, and require little time or attention from any one. There's no harm in writing us.

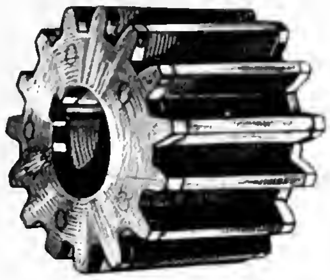
H. W. Caldwell & Son Co. Western Ave. 17th-18th St. **Chicago**

NEW YORK: Fulton Bldg., Hudson Terminal, 50 Church St.
BOSTON: Oliver Bldg., 141 Milk St.

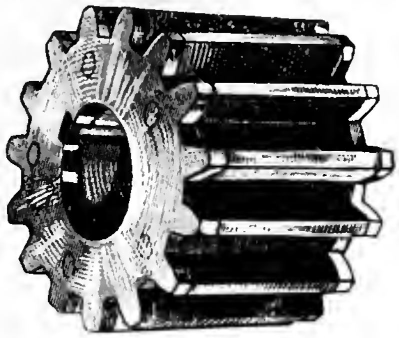
NEW PROCESS

EACH YEAR

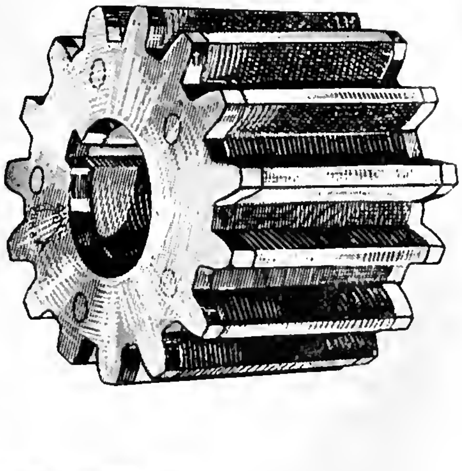
witnesses a growth
in the popularity
and use of



New Process Noiseless Pinions



They should be used on every geared motor drive.



They make every gear drive a silent drive, and wear like iron.

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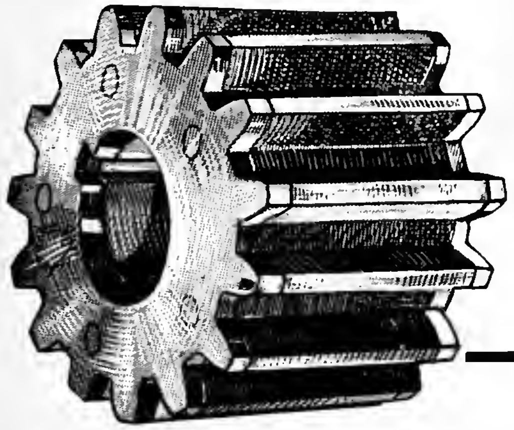
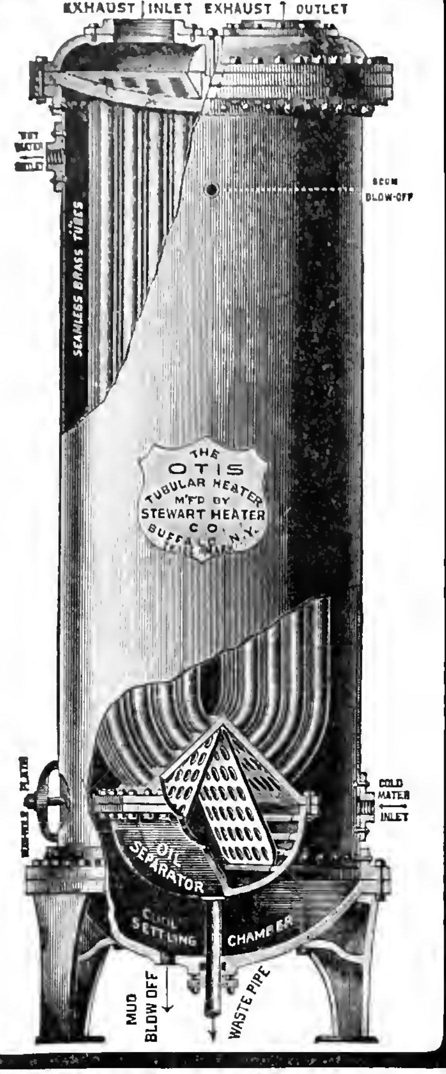


The New Process Raw Hide Co.

Syracuse, N. Y.



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Tubular Feed Water Heater, Oil Separator and Purifier

is not an experiment but a tried and trusted appliance that the makers are not afraid to

GUARANTEE

To heat the feed water to the *boiling point* (210 to 212 degrees) with the exhaust steam without causing any back pressure, *also to extract the oil from the exhaust*, so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the *additional expense* of an *eliminator*.

We are so sure of the OTIS that we agree to pay all cost of a trial—freight, cartage, piping, etc.—if it fails to do all we claim for it.

Catalogue and Prices at your Service

The Stewart Heater Company

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POOLE ENGINEERING & MACHINE CO.

ENGINEERS, FOUNDERS AND MACHINISTS.

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MANUFACTURERS AND DESIGNERS OF ALL KINDS OF

HEAVY MACHINERY,

REQUIRING FIRST CLASS WORKMASHIP AND MATERIALS.

BAND, ROPE AND FLY WHEELS. FRICTION CLUTCHES, SHAFTING, PULLEYS AND HANGERS.

MACHINE MOLDED AND PLANED GEARING.

MACHINERY FOR WHITE LEAD AND FERTILIZER WORKS, GRAIN ELEVATORS AND FLOUR MILLS, BRASS, COPPER TIN PLATE ROLLING MILLS CABLE AND MARINE RAILWAYS,

POOLE-LEFFEL TURBINE WATER-WHEELS

DREDGING MACHINES.

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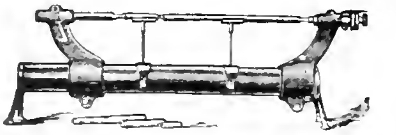
IRON CASTINGS, 30000 LBS TENSILE STRENGTH



(Style of 12 and 24 Sizes.)

Measuring Machines.

Measuring screw, 10, 16 or 20 threads to the inch, graduated to read thousandths or 32ds without calculation.

☞ The only Micrometer that will not lose its accuracy by wear.

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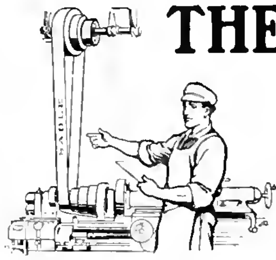
Chas. Churchill & Co., Ltd., London, Eng., Agents for Great Britain.



THE BELT FOR WEAR

is **Shultz Sable Rawhide**

One of our 26-inch **Sable Belts** was in operation for 26 years, and then it wasn't worn out. It was cut up and made into narrower belts, which are still in use. Do you know of any other belt which will wear as long as this?

Our **Sable Rawhide Belting** is complete in itself. It is all leather; that is the reason it can be cut up. You don't have to coat it with some dressing to make it stick or make the insides of canvas to give it strength. The rawhide interior is so tough and pliable that the belt will stand any amount of service. The original texture of the hide is not destroyed and therefore it will cling to the pulley surface.

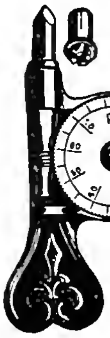
Write for our Booklet No. 32 telling of some other good qualities of this belt.

SHULTZ BELTING COMPANY

St. Louis, Mo.

NEW YORK BOSTON PHILADELPHIA

34



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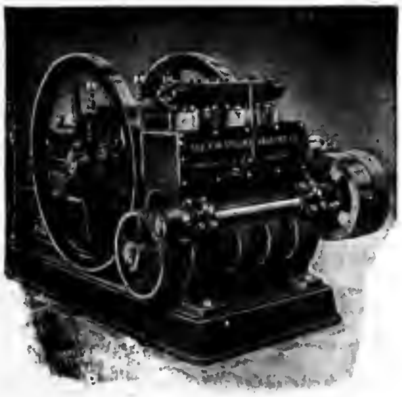
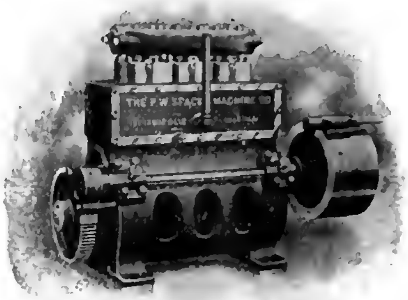
An ingenious little instrument for ascertaining the correct speed of Dynamos, Steam Engines, Shafting, Floor Machines, etc. No first class mechanic, superintendent or factory should be without one. They are adapted to hollow or pointed centers, and are absolutely correct. Every indicator is handsomely nickel-plated and of convenient size to carry in the pocket.

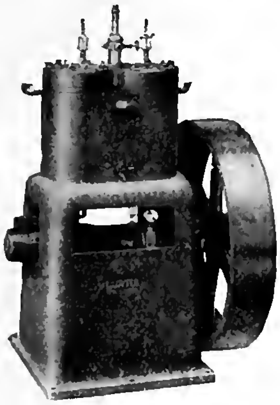
Price: Split Cap, adapted to either pointed or hollow centers, $1.00.
Plain Cap, for hollow centers only, 75c.

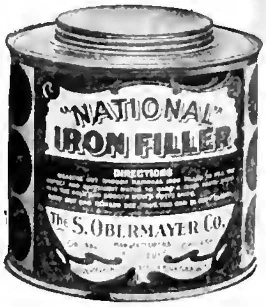
We also keep a Double Registering Speed Indicator. Prices on application.

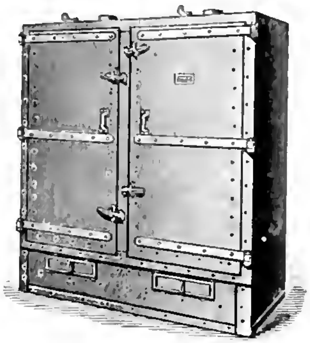
The R. Woodman Mfg. and Supply Co., 63 Oliver Street, BOSTON, MASS.

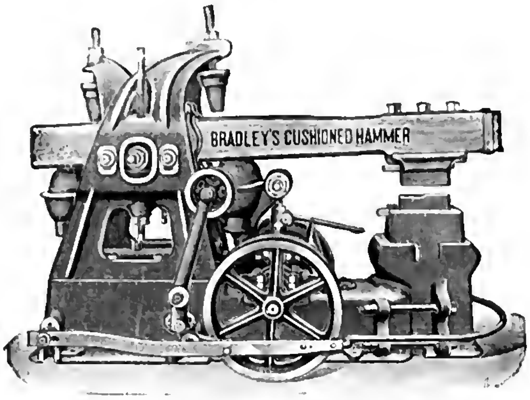



THE F. W. SPACKE MACHINE CO.




"NATIONAL"
IRON FILLER
DIRECTIONS
The S. OBERMAYER CO.

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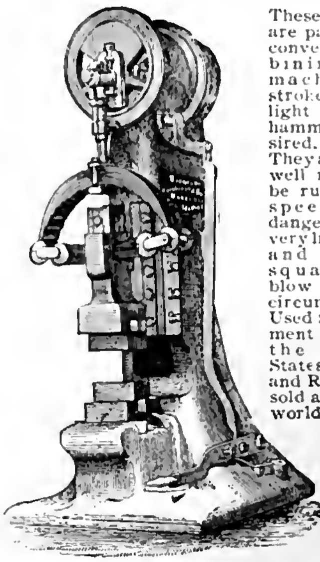

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U. S. Standard Punches

For all Structural Work

PROVIDENCE, R. I., U. S. A.

Scranton
Power Hammers

COST LESS than any other hammer that will produce an EQUAL AMOUNT OF WORK.

By our construction we avoid breakdowns.

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The most useful reference manual published on the subject, because it is up-to-date and is years in advance of any similar compilation. No mechanical engineer, designer or draftsman should be without it. Third edition, morocco, $2.00, postpaid. Write for circular.

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None better—few as good. Just the machine for Boiler Shops, Railroad Shops, Structural Works and Machine Shops. Machine is right; so is price.

New catalogue just out. Ask for one.

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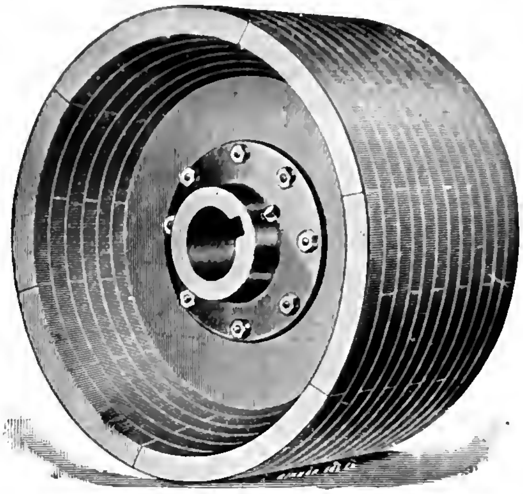
CUT OUT AND FILE the three SHOP OPERATION SHEETS in this number. Your set may be worth a hundred dollars to you some day.

For Dynamos, Trip Hammers or other Heavy Work.



STYLE D. SPECIAL PULLEY.

We manufacture a solid web pulley especially adapted for extremely severe service and guarantee that it will do the work specified, no matter how heavy. Style D. built of selected, thoroughly seasoned maple, having an iron center fitted with key seat and set screw, is the lightest, strongest, stiffest, and best finished Dynamo Pulley on the market.

The Gilbert Wood Split Pulleys are universally acknowledged to be as perfect, both in material and construction, as it is possible to make them, and can be used successfully wherever a leather belt can be operated. Excel all others in correctness of balance and trueness of running.

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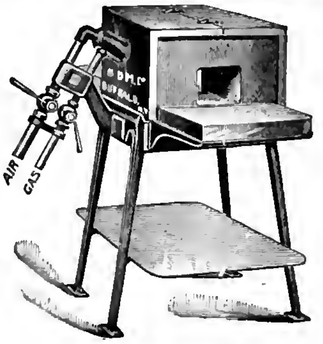
Saginaw, W. S. Michigan.

SALES AGENCIES IN ALL THE PRINCIPAL CITIES IN THE WORLD.

New York Branch, 88 Warren Street. Chicago Branch, 28-32 South Canal Street.
Cable Address, Engrave. A. B. C. and Lieber's Codes.



No. 19 Cyclone Forge for coal gas $10.00.

Hot Weather Comforts

are now in demand, and we offer you our Cyclone Tool Forge for hardening and tempering tools, dies, etc. The heat is confined in the furnace where it belongs and the operator suffers no inconvenience from radiation. The work is also constantly in sight, therefore results must be perfect. No fires to build; no coal to handle, just light the gas, turn on the air blast and the work is accomplished in one-third the time employed in the old coal forges.

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Made for coal gas, natural gas and gasoline gas.

Buffalo Dental Manufacturing Co.
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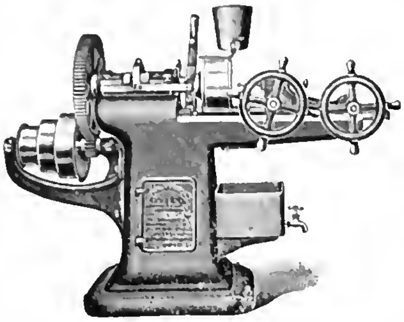
A BOLT CUTTER IS MUCH LIKE A MAN IN THIS:

The Head Is Nearly Everything



The Merriman Bolt Cutter Head is Noted for

1. Simplicity of the head; Only four parts, consequently,
2. Great Durability. Few repairs needed.
3. Square Bearing of the Dies in the Ring; consequently,
4. Solidity of the Dies like a Solid Die; Consequently,
5. Uniformity of the product; Bolts all the same size.
6. Effectiveness of Operation; Cheapest help can understand and run it.
7. No machine turns out work more rapidly.

THE H. B. BROWN CO., EAST HAMPTON, CONN.

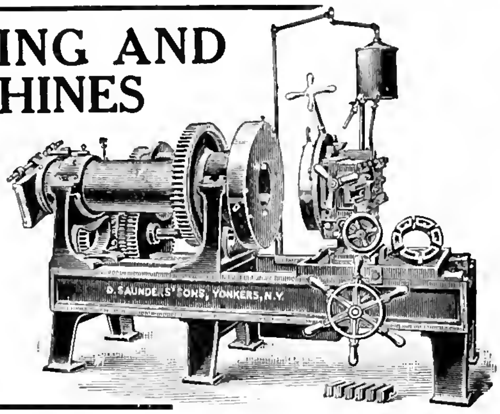
Send for Catalog No. 12.

PIPE THREADING AND CUTTING MACHINES

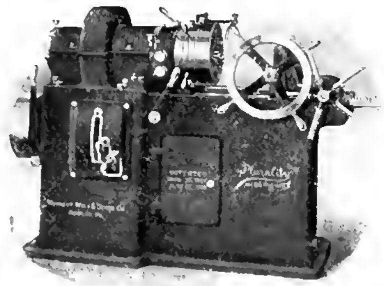
Our Improved No. 6 Standard Machine with patent adjustable expanding die head and interchangeable chasers

Cuts off and threads pipe 2½ to 8 inches. A special arrangement of gearing permits ample power and suitable speeds for working the various sizes of pipe and avoids the use of large pulleys and tight belts. Every improved feature for rapid and accurate operation.

Write for detailed description.



D. SAUNDERS' SONS
YONKERS, N. Y.



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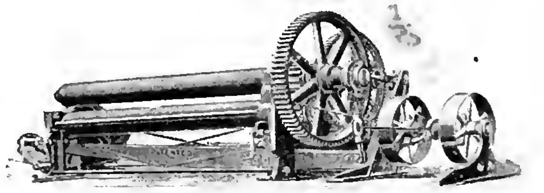

This Bending Roll can be opened, the formed shell removed and the machine closed automatically by means of our Patented Opening Device, by one man, in less time than is required for opening alone on any other machine. It is built with Motor, Engine or Belt drive.

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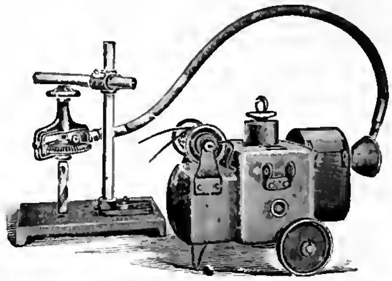

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Selig, Sonnenthal & Co., General European Agents, London, Eng.

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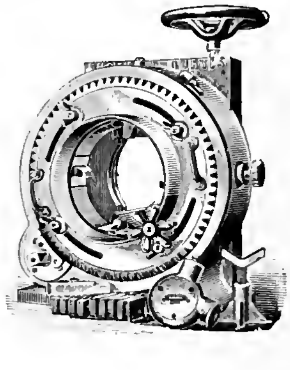

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VARIOUS SIZES. HAND AND POWER.

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The Ferracute Machine Company, of Bridgeton, New Jersey, builds hundreds of sizes and styles of presses from a small bench foot-press for steel pens and buttons to ponderous machines weighing a hundred tons, capable of exerting a pressure of a thousand tons and used for bathtubs, metallic coffins and boats. Many articles that are now cast or forged may be made more rapidly, cheaply and of better quality in presses and dies. All presses built by this company are scientifically designed, the metal being put where it belongs. Valuable improvements—the result of years of experience—have recently been made. The leading types are: "C," (Cutting), for tinware, cans of all kinds, lamps, cutlery and an endless variety of work in sheet-metal, paper, cloth, etc., "D," (Drawing), for cups, gong-bells, pans, pot-covers, automobile hubs, sinks and other deep work; "E," (Embossing or Coining), for watch cases, medals and coins; "G," (Gravity or Drop), for drop-forgings; "P," (Punching), for bar-metal; "S," (Stamping or Double-crank), for ceiling-plates, metallic shingles and armature disks. Send sample or specification and ask for catalog and photographs.

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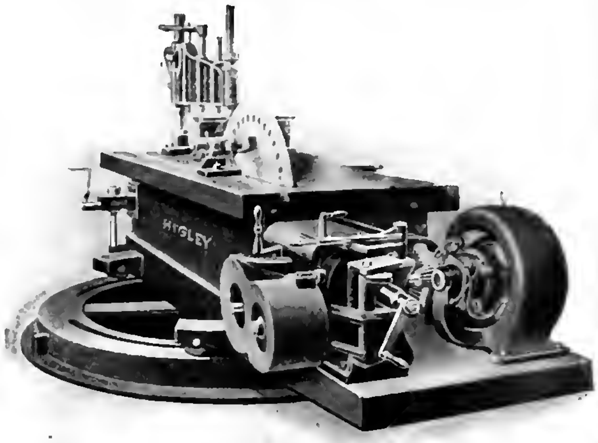

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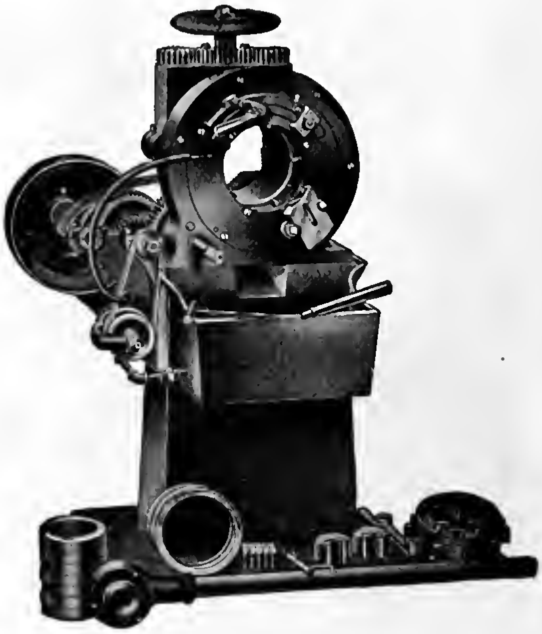

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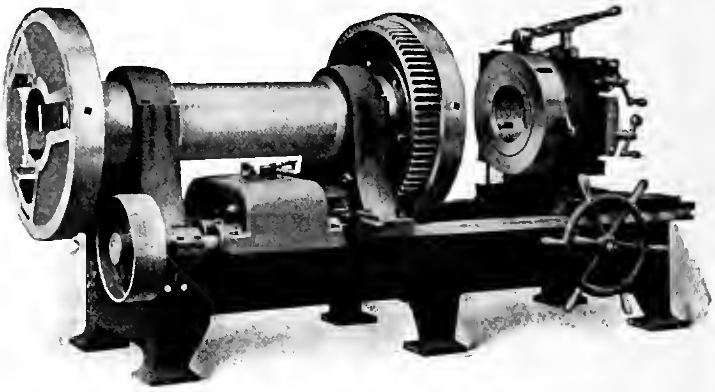

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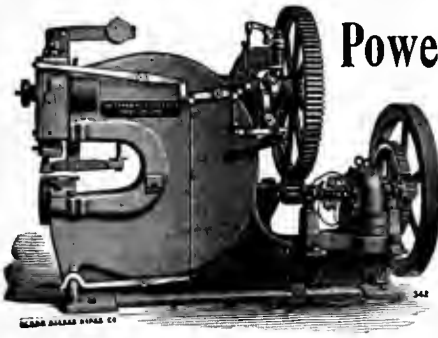

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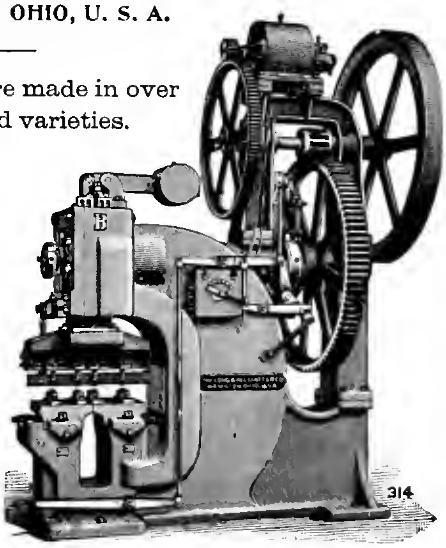

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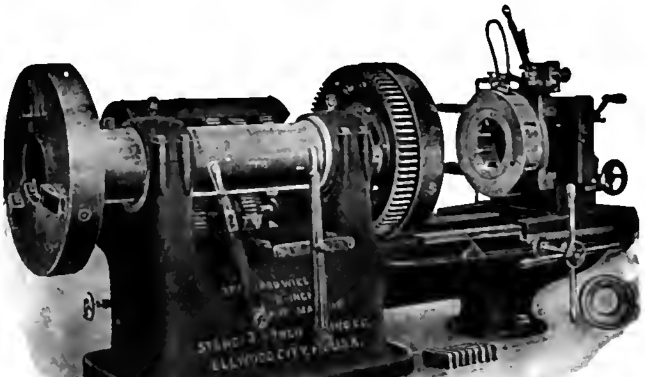

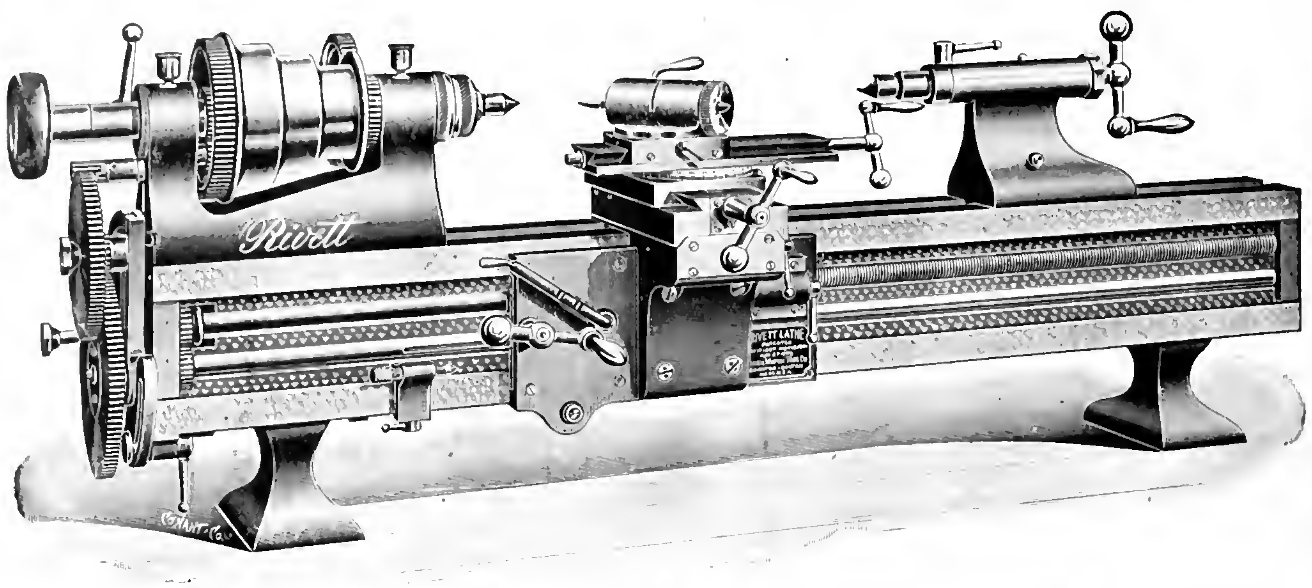

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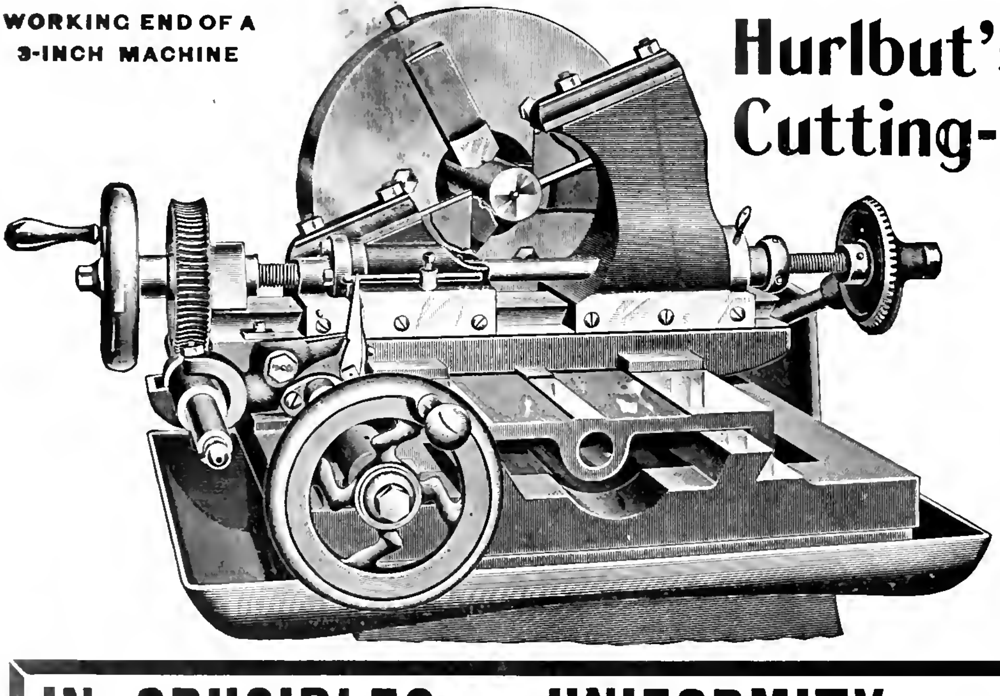

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